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Supplemental Baseline Human Health and Ecological Risk Assessment: Oxbow Area Floodplain Soil and Sediment

Centredale Manor Restoration Project Superfund Site North Providence, Rhode Island

Prepared for:

U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

Prepared by:

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Duxbury, MA 02332

June 2011

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Part I

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CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

Submitted to:

Department of the Army
U.S. Army Corps of Engineers
New England Division

Contract No. DACW33-03-D-0004
Delivery Order No. 26

Under Contract to:

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ACRONYMS

ABS	absorption factor
ADD	average daily dose
ADD_C	chronic average daily dose
ADD_s	subchronic average daily dose
AhR	Ah Receptor
AT	averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
BHHRA	Baseline Human Health Risk Assessment
BW	body weight
CDI	chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPCs	chemicals of potential concern
CSM	conceptual site model
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
ED	exposure duration
EF	exposure frequency
EPC	exposure point concentrations
FI	fraction ingested
HCX	hexachloroxanthene
HEAST	Health Effects Assessment Summary Table
HI	hazard index
HQ	hazard quotient
IR	ingestion rate
IRIS	Integrated Risk Information System
LADD	lifetime average daily dose
LOAEL	Lowest Observable Adverse Effect Level
MF	modifying factor
mg/kg	milligrams per kilogram
mg/cm^2	milligrams per square centimeter
MOA	mode of action
MOE	margin-of-exposure
MRL	method reporting limit

NCEA	National Center for Environmental Assessment
NCP	National Hazardous Substances and Pollution Contingency Plan
NIOSH	National Institute of Occupational Safety and Health
NOAEL	No Observable Adverse Effect Level
OCDD	octachlorinated dibenzo-p-dioxin
OHM	oil and/or hazardous materials
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCDDs	polychlorinated dibenzodioxins
PCDFs	polychlorinated dibenzofurans
PRGs	preliminary remediation goals
PRTVs	peer reviewed toxicity values
PPRTVs	Provisional Peer Reviewed Toxicity Value
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk Based Concentration
RfC	Reference Concentration
RfDs	Reference Doses
RfD_ss	Subchronic Reference Doses
RME	Reasonable Maximum Exposure
RSL	Regional Screening Levels
SA	surface area
SAB	Science Advisory Board
SF	Slope Factor
cm^2/day	square centimeter per day
STSC	Superfund Technical Support Center
SVOCs	semivolatile organic compounds
TCDD	tetrachlorodibenzo-p-dioxin
TEF	Toxicity Equivalent Factor
TEQ	toxic equivalent quotient
UCL	Upper Confidence Limit
UF	Uncertainty Factor
UR	Unit Risk
USACE	U.S. Army Corps of Engineers, New England District
USEPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

A Supplemental Baseline Human Health Risk Assessment (BHHRA) has been prepared to characterize risks for the Oxbow Area at the Centredale Manor Restoration Project Superfund Site located in North Providence, Rhode Island (hereafter referred to as "the Site") in response to recent additional data collection activities. Previously an Interim-Final BHHRA (MACTEC, 2005) was completed in 2005 for the Site. However, the Interim-Final BHHRA did not evaluate the Oxbow Area because data were not available. In 2006 an Addendum to the Interim-Final BHHRA was completed which evaluated the Oxbow Area (MACTEC and Battelle, 2006). The Addendum to the Interim-Final BHHRA was based on a limited data set for the Oxbow Area and evaluated risk to surface soils. This Supplemental BHHRA has been prepared because additional surface soil and sediment data have been collected in the Oxbow Area in 2010.

The Oxbow Area is a forested wetland area located to the southwest of Allendale Dam. A site location map is provided as Figure 1. An aerial photograph of the Oxbow Area and the surrounding areas is provided as Figure 2. This Supplemental BHHRA has been prepared in accordance with the U.S. Environmental Protection Agency (USEPA) Risk Assessment Guidance for Superfund (RAGS) Parts A, D, and E (USEPA, 1989, 2001a, 2001b), as well as USEPA Region I risk assessment guidance contained in Risk Updates (USEPA, 1994a, 1995, 1999).

The main area of the Site, consisting of approximately 9 acres, is located in North Providence, Rhode Island, just south of Route 44 on the eastern bank of the Woonasquatucket River. The main area of the Site is known as 2072 and 2074 Smith Street, including two apartment complexes and three capped areas. The remaining portions of the Site consist of reaches, man-made ponds, and wetlands associated with the Woonasquatucket River.

The Oxbow Area is an undeveloped parcel that is bisected by a former river channel remnant and lies mostly within the 100-year floodplain. The abandoned channel previously received flow at its eastern end and flowed westward and then in a southerly direction to Lyman Mill Pond. Currently the channel receives flow from flood waters overtopping the bank at the eastern side of the Oxbow. The water in the channel is typically over a meter deep and contains water throughout the year. Figure 2 shows the abandoned channel, which is the surface water feature running from east to west.

Available data indicate that flooding of the Woonasquatucket River may have deposited Site-related contaminants in and on the surficial soils and sediment in the Oxbow Area. Historic surface soil and sediment sampling and analysis at the Site have detected elevated (above typical background) levels of dioxin (particularly 2,3,7,8- tetrachlorodibenzo-p-dioxin (TCDD)), some pesticides and polychlorinated biphenyls (PCBs) (primarily Aroclor-1254), and selected metals (Battelle, 2004a). Recent surface soil sampling and analysis results include similar compounds, and in addition polycyclic aromatic hydrocarbons (PAHs), and Aroclor-1268 have been detected.

Currently, local residents and visitors to the area may enter the Oxbow Area and walk along a riverside earthen trail. There is some evidence that adolescents or young adults have at some time been present in the area, because a weather-worn wooden tree-house was observed within the area. There is no evidence that hunting is an activity in the Oxbow Area. It is possible that as the Site and the Woonasquatucket River are restored, the Oxbow Area might become a more attractive area for passive recreation (hiking, bird-watching, picnicking, etc.). It is assumed that recreational visitors to the Site could contact these surface soils during passive recreational activities within the Oxbow Area. The goal of this Supplemental BHHRA is to evaluate current and potential future risks to human health associated with human contact with surface soils in the Oxbow Area.

The Supplemental BHHRA analyzes potential human health risks for both current and likely future conditions associated with hazardous substance releases from the Site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action). Current and potential future exposure to surface soils may occur at the Oxbow Area. The Oxbow Area soils have been divided into two exposure areas, the human health concern area and the general area. The Oxbow Area is evaluated as two different areas because the use and access to the areas differs. The human health concern area is mostly upland and can be accessed by an earthen trail. In contrast the general area is within the 100 year floodplain, is more susceptible to flooding throughout the year, and overall is a less attractive area with respect to passive recreational activities.

HAZARD IDENTIFICATION

The purpose of the hazard identification section is to present a compilation of the available sampling data for the hazardous substances present at the Site, to identify data sets suitable for use in a quantitative risk evaluation, and to identify contaminants of potential concern in surface soils in the Oxbow Area. The Supplemental BHHRA is based on surface soil collected during the remedial investigation (i.e., November and December 1999, July 2001, and June 2004

investigations), as well as on surface soil data collected during supplemental investigations performed in September through November 2010.

The data used in this risk assessment were transmitted to MACTEC in an electronic database from Battelle.

Chemicals of Potential Concern Selection for Surface Soil

Using the data collected for surface soil, chemicals of potential concern (COPCs) were identified for the risk assessment. COPCs are those chemicals evaluated in the risk assessment. Consistent with USEPA Region I guidance, COPCs were selected based on frequency of detection and comparison of detected concentrations to risk-based screening criteria. USEPA Regional Screening Levels (RSLs) for residential soil were used in the selection of COPCs for surface soil. In surface soil at the Oxbow Area, the identified COPCs include dioxins and furans, Aroclor-1254, Aroclor-1268, seven PAHs, one phthalate, and seven inorganics/metals.

TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to characterize the relationship between the dose of COPC administered or received and the likelihood of adverse health effects in the exposed population. Toxicity values (e.g., slope factors (SFs), reference doses (RfDs), or reference concentrations (RfCs)) are used to estimate the likelihood of adverse effects as a function of human exposure to an agent. These toxicity values are used in the risk characterization process to estimate the potential for adverse effects occurring in humans at different exposure levels.

The dose-response information may be divided into two major categories:

- toxicity information associated with threshold (non-carcinogenic) health effects.
- toxicity information concerning carcinogenicity, either from human epidemiologic data or from laboratory studies.

All the chemicals selected as COPCs are evaluated for potential non-carcinogenic health effects. In addition, any substance considered to be a known, probable, or possible human carcinogen is also evaluated for its potential carcinogenic effects. The classification of a chemical as a carcinogen does not preclude an evaluation of that same chemical for potential non-carcinogenic health risks, as all potentially carcinogenic chemicals may also exert non-carcinogenic health effects.

Toxicity values were obtained from USEPA recommended sources, including the USEPA's Integrated Risk Information System (IRIS), and the USEPA's National Center for Environmental Assessment (NCEA) publications, and various USEPA reports.

EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the type and magnitude of receptors' exposures to COPCs at or migrating from the site. The exposure assessment is conducted to: 1) characterize the populations of humans potentially exposed via direct contact with surface soil; 2) identify the mechanisms by which receptors may be exposed; and 3) identify the intake, or dose, of COPCs that receptors may receive through the identified exposure pathways.

Identification of Potentially Exposed Human Populations

The potentially exposed human populations identified for evaluation in the Supplemental BHHRA include Passive Recreational Visitors who may or may not live in the immediate vicinity of the Site, but who would visit the Oxbow Area for passive recreational activities. The Oxbow Area is in close proximity to the Woonasquatucket River and to residential properties along the river in the area of the Site. People who visit the Oxbow Area for hiking, bird-watching, picnicking, and other passive recreational activities would most likely live in the area of the Woonasquatucket River. This Supplemental BHHRA focuses only on the potential exposures to surface soils in the Oxbow Area. Potential exposures to surface water and sediment in the river and fish consumption have previously been evaluated in the BHHRA for the Site (MACTEC, 2005). The Oxbow Area has been divided into two exposure areas for the purpose of this Supplemental BHHRA, the human health concern area and the general area.

Identification of Exposure Points

Two exposure points, identified as the human health concern area and the general area, have been identified for quantitative evaluation of surface soil by the Passive Recreational Visitor. The human health concern area health exposure point is represented by ten soil samples that were collected in this area. The human health concern area is an upland area with an elevation above the 100 year flood elevation. Also the human health concern area appears to be more accessible than the general area. The general area is within the 100 year floodplain and more susceptible to flooding throughout the year. The general area exposure point is represented by 22 soil samples that were collected in this area.

Exposure Scenarios and Routes of Exposure

The Passive Recreational Visitor is assumed to be exposed to surface soil via incidental ingestion and dermal contact. It is assumed that Passive Recreational Visitors include young children (ages 1 through 6), adolescents (ages 7 through 18), and adults (assumed ages 19 through 30). Exposures were evaluated based on the reasonable maximum exposure (RME) scenario. The RME is the highest exposure that is reasonably expected to occur at a site. It is assumed that for the RME scenario the Passive Recreational Visitor is exposed to soil 78 days per year in the human health concern area or 26 days per year in the general area. The exposure frequency (EF) of 78 days per year was previously used in the Oxbow Risk Assessment Addendum (MACTEC and Battelle, 2006). The EF of 26 per year for the general area is consistent with an alternative exposure scenario developed in response to comments raised during stakeholders meetings, mainly that the general area is less accessible and less desirable for recreational activities. The RME values assume that a receptor uses the Site for all of his/her outdoor activities (e.g., recreational play/exploration, recreational angling, or subsistence angling) on those days they visit the Oxbow Area.

Exposure Point Concentrations

A single concentration is selected as representative of the actual concentration for each COPC in surface soil for a given exposure point. This value, called the exposure point concentration (EPC), is used in the estimates of health risks at the Site. An EPC is selected for every COPC identified in the screening process described earlier. The lower of 95% Upper Confidence Limit (UCL) on the mean and the maximum concentration is typically used as the EPC.

Identification of Exposure Models and Parameters

Chemical-specific intakes were calculated in a manner consistent with USEPA guidance for risk assessment. Average daily doses (ADD) of COPCs were calculated as the measure of exposure. The ADD's are expressed as milligrams of contaminant per kilogram of bodyweight per day (milligrams per kilogram [mg/kg/day]). For non-cancer health effects calculations, the ADD was averaged over the duration of exposure. For cancer risk calculations, the ADD was averaged over a 70-year lifetime (a lifetime average daily dose or [LADD]). The following exposure parameters are included in the dose calculations:

- Concentrations (C) in surface soil
- Ingestion rate (IR)
- Exposure frequency (EF)

- Fraction ingested (FI) from contaminated source
- Exposure duration (ED)
- Body weight (BW)
- Averaging time (AT) – cancer and non-cancer
- Skin surface area (SA) exposed

RISK CHARACTERIZATION

Using USEPA-approved toxicity values as well as exposure assumptions, potential risks associated with current and future exposure for the Passive Recreational Visitor were evaluated based on exposure to surface soil within the human health concern area and the general area.

Chemical-Specific Excess Lifetime Cancer Risk was calculated using the following equations:

$$Risk_i = CDI_i \times SF_i$$

where:

$Risk_i$	=	unitless probability of an individual developing cancer as the result of exposure to a chemical i
CDI_i	=	chronic daily intake of chemical i averaged over 70 years (mg/kg/day)
SF_i	=	USEPA cancer slope factor for chemical i $(mg/kg/day)^{-1}$

Pathway-Specific Excess Lifetime Cancer Risk:

$$Risk_T = \Sigma\ Risk_i$$

where:

$Risk_T$	=	unitless probability of an individual developing cancer as the result of multiple chemical exposures
$Risk_i$	=	unitless cancer risk estimate for a single chemical associated with surface soil exposure

The results from the carcinogenic risk assessment are compared to acceptable risk ranges established by the USEPA. The USEPA's guidelines, established in the National Hazardous Substances and Pollution Contingency Plan (NCP) identify acceptable exposure levels as those concentration levels "that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} [one in ten thousand] and 10^{-6} [one in one million] using information on the relationship between dose and response" (USEPA, 1990). Where the cumulative site risk to an

individual exceeds the upper end of this range, action is generally warranted at a site. Where the cumulative site risk to an individual is less than 10^{-4}, action is generally not warranted. However, USEPA may also decide that a lower level of risk is unacceptable and that action is warranted, if there are extenuating circumstances, such as uncertainties in the risk assessment.

Following are the equations used to determine the Hazard Quotient (HQs) and Hazard Index (HIs).

The following equation is used to determine the HQ:

$$HQ_i = \frac{I_i}{RfD_i}$$

where:

HQi	=	HQ of chemical i
Ii	=	intake of chemical i averaged over the exposure period (mg/kg/day)
RfDi	=	RfD for chemical i corresponding to the same ED as the intake (mg/kg/day)

The following equation is used to determine the HI:

$$HI = \Sigma\ HQ_i$$

where:

HI	=	potential for noncarcinogenic effects from multiple chemical exposures
HQi	=	HQ for each chemical associated with floodplain soil exposure

An HI of less than 1 indicates that noncarcinogenic toxic effects are unlikely. An HI greater than 1 indicates a greater possibility of a noncarcinogenic toxic effect occurring. USEPA typically considers action if the HI is greater than one.

RISK SUMMARY

Summary of Calculation of Receptor Risks

Table ES-1 summarizes the risks. This table presents the soil route-specific risks for each age-group for the Passive Recreational Visitor for each exposure area.

Human Health Concern Area

As shown in Table ES-1, the total (summed across age groups) soil cancer risk for the Passive Recreational Visitor in the human health concern area is 4×10^{-6}, which is within the Superfund cancer risk range. The highest non-cancer HI among the age groups in the human health concern area is 0.1, for the child Passive Recreational Receptor. This screening HI is below the Superfund HI threshold value. The largest chemical contributor to the HI is ingestion of arsenic. Ingestion of soil by the child receptor contributes the largest cancer risk among exposure pathways. The largest chemical contributor to cancer risk is the dioxin toxic equivalent quotient (dioxin TEQ).

General Area

As shown in Table ES-1, the total (summed across age groups) soil cancer risk for the Passive Recreational Visitor in the general area is 6×10^{-5}, which is within the Superfund cancer risk range. The highest non-cancer HI among the age groups in the general area is 0.2, for the child Passive Recreational Receptor. This screening HI is below to the Superfund HI threshold value. The largest chemical contributor to the HI is ingestion of thallium. Ingestion of soil by the child receptor contributes the largest cancer risk among exposure pathways. The largest chemical contributor to cancer risk is the dioxin TEQ.

UNCERTAINTY ANALYSIS

The uncertainty analysis includes a discussion of major limitations of the analyses, any sources of uncertainties, and, if possible, any indication as to whether these uncertainties and limitations may have resulted in and over- or under-estimation of risk. The uncertainty section may also include unusual site conditions or extenuating circumstances that may be pertinent to risk management decisions.

The values for receptor-specific exposure parameters such as soil contact rates and soil ingestion rates have been identified in a conservative manner. Default USEPA residential values have been applied to this passive recreational scenario. Values have been identified based on available guidance and professional judgment. In risk assessment, when values are assigned in lieu of actual measurements, there is some uncertainty in the values, and that uncertainty may have an impact on the results of the risk assessment. In that context, the exposure estimates and associated risk estimates in this assessment would likely be overestimated rather than underestimated. Some factors that were not specifically addressed in the calculations could result in lower risk estimates.

Non-cancer risk was not quantitatively evaluated for potential exposures to dioxins and furans. There is not currently a published USEPA oral RfD available for 2,3,7,8-TCDD, any other dioxin or furan congener. USEPA has concluded that the current average dioxin exposure to the human population is greater than the RfDs that would be calculated based on available data. USEPA, therefore, concluded that RfD values would not be informative for safety assessment (USEPA, 2000). Non-cancer effects such as effects on reproduction and development, suppression of the immune system, and chloracne (USEPA, 2000) have been associated with these compounds in animal studies and it is likely that similar effects might occur with human exposure. Therefore, the non-cancer risk associated with potential exposure to dioxins and furans are understated in this Supplemental BHHRA.

Overall, the risk characterization provides conservative estimates of non-cancer and cancer risks consistent with USEPA risk assessment guidance (USEPA, 1989).

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MAIN REPORT

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) Region I and U.S. Army Corps of Engineers, New England District (USACE) prepared a Supplemental Baseline Human Health Risk Assessment (BHHRA) for the Oxbow Area at the Centredale Manor Restoration Project Superfund Site located in North Providence, Rhode Island (hereafter referred to as "the Site"). Previously an Interim-Final BHHRA (MACTEC, 2005) was completed in 2005 for the Site. However, the Interim-Final BHHRA did not evaluate the Oxbow Area because data was not available. In 2006 an Addendum to the Interim-Final BHHRA was completed which evaluated the Oxbow Area (MACTEC and Battelle, 2006). The Addendum to the Interim-Final BHHRA was based on a limited data set for the Oxbow Area and evaluated risk to surface soils. This Supplemental BHHRA has been prepared because additional surface soil and sediment data was collected in the Oxbow Area in 2010. A site location map is provided as Figure 1. An aerial photograph of the Oxbow Area and the surrounding areas is provided as Figure 2.

1.1 BACKGROUND AND INVESTIGATION HISTORY

In 2006 an Addendum to the Interim-Final BHHRA was completed for the Oxbow Area. The Addendum was based on a limited dataset (7 floodplain soil and sediment samples collected in 2004) and risks were calculated for a passive recreational visitor exposed to surface soil. Due to the limited size of the data set all samples (soil and sediment) were evaluated as soil. The results of the Addendum showed cancer risks for floodplain soil exposure at the Oxbow Area greater than the Superfund risk range. This Supplemental BHHRA is being conducted because additional data have been collected from the Oxbow Area.

In June 2004 an investigation of floodplain soils and sediments was conducted as described in Section 1.3.1. Additional soil and sediment samples were collected in September through November 2010 as described in Section 1.3.1. Also included in this Supplemental BHHRA are surface soil data collected in November and December 1999 and surface soil data collected in July 2001. The data collected during these investigations are the focus of this Supplemental BHHRA.

This Supplemental BHHRA analyzes potential adverse human health effects for both current and likely future conditions caused by hazardous substance releases from the Site in the absence of any actions to control or mitigate these releases (i.e., under an assumption of no action). Current and

potential future exposure to soils may occur at the Oxbow Area. This Supplemental BHHRA evaluates risks to soils in the Oxbow Area quantitatively.

1.2 ORGANIZATION OF REPORT

This report is divided into seven sections: an introduction is provided in Section 1.0; a hazard identification is presented in Section 2.0; exposure assessment including receptor identification, development of exposure profiles and exposure point concentrations (EPCs) are presented in Section 3.0; the toxicity assessment is presented in Section 4.0, the risk characterization is contained in Section 5.0, the uncertainty analysis is discussed in Section 6.0, and the Conclusions are presented in Section 7.0. Appendix A presents the list of samples used in the risk assessment and Appendix B contains all data used for the risk assessment.

The table numbering in this report is consistent with the numbering of Tables in the USEPA's *Risk Assessment Guidance for Superfund (RAGS): Volume I - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments) Final* (USEPA, 2001a). That guidance includes standardized tables (with a specific numbering scheme) for reporting risk assessment activities. For each group of tables (such as the Table 2s that present the selection of chemicals of potential concern [COPC]), the tables are numbered consecutively.

1.3 DESCRIPTION OF SITE

The main area of the Site, consisting of approximately 9 acres, is located in North Providence, Rhode Island, just south of Route 44 on the eastern bank of the Woonasquatucket River. The main area of the Site is known as 2072 and 2074 Smith Street where currently there are two apartment complexes and three capped areas. The remaining portions of the Site consist of reaches, man-made ponds, and wetlands associated with the Woonasquatucket River.

One of those portions of the Site is the forested wetland floodplain and upland area to the southwest of Allendale Dam, referred to as the Oxbow Area. The Oxbow Area is an undeveloped parcel that is bisected by a former river channel remnant and lies mostly within the 100-year floodplain. Allendale Pond sediments are a reservoir of contamination from the source area and disturbance of those sediments may release sediment associated contaminants into the water column and into downstream areas, including the Oxbow Area. The abandoned channel previously received flow at its eastern end and flowed westward and then in a southerly direction to Lyman Mill Pond. Currently the channel receives flow from flood waters overtopping the bank at the

eastern side of the Oxbow. The channel is typically over a meter deep and contains water throughout the year. Figure 2 shows the abandoned channel, which is the surface water feature running from east to west. For the purpose of this Supplemental BHHRA the Oxbow Area has been divided into two sub areas referred to as the human health concern area and the general area. The human health concern area is comprised of an area mostly above the 100-year floodplain elevation. The human health concern area is mostly upland and can be accessed by an earthen trail. In contrast the general area is within the 100 year floodplain and is more susceptible to flooding throughout the year. The human health concern area and general area are shown on Figure 2. Exposure areas are discussed in more detail in Section 1.4.

Available data indicate that flooding of the Woonasquatucket River may have deposited Site-related contaminants in and on the surficial soils and sediment in the Oxbow Area. Historic surface soil and sediment sampling and analysis at the Site have detected elevated (above typical background) levels of dioxin (particularly 2,3,7,8- tetrachlorodibenzo-p-dioxin (TCDD)), some pesticides and polychlorinated biphenyls (PCBs) (primarily Aroclor-1254), and selected metals (Battelle, 2004a). Recent surface soil sampling and analysis results include similar compounds, and in addition polycyclic aromatic hydrocarbons (PAHs), and Aroclor-1268 have been detected.

1.3.1 Site Investigations and Actions

In November and December 1999 seven surface soil (0-1 ft) samples were collected from the Oxbow Area. The samples were analyzed for semivolatile organic compounds (SVOC), pesticides, PCBs, inorganics and dioxin and furans.

In July 2001 one surface soil (0-0.5 ft) sample was collected from the Oxbow Area and analyzed for SVOCs, pesticides, PCBs, inorganics and dioxins and furans.

In June 2004 floodplain samples (combination of floodplain soils and surface sediment) were collected from the forested wetland referred to as the Oxbow Area which is located southwest of Allendale Dam to investigate the nature and extent of the Site contamination in that area. Sampling targeted low-lying areas and excluded areas of artificial fill or gravel. Two surficial (0 to 0.5 ft) wetland soil samples (LPX-SD-4404 and LPX-SD-4405) were collected north of the channel and two surficial (0 to 0.5 feet) wetland soil samples (LPX-SD-4406 and LPX-SD-4407) were collected south of the abandoned channel. It has been determined that LPX-SD-4404 is not impacted by the Site based on dioxin composition inconsistent with the Site, but, which is consistent with

background. These sample locations are shown in Figure 4-25 of the Remedial Investigation Report. All samples were analyzed for dioxins and furans, and a subset of the samples were analyzed for pesticides, PCBs, inorganics, and total organic carbon content.

In September through November 2010 additional soil were collected from the Oxbow Area. In total 34 surface soil samples (0-1 ft) were collected. Ten of the soil samples were collected from the human health concern area, 20 of the samples were collected from the general area, and four samples were collected from wetland fill areas as shown in Table A-1. All soil samples were analyzed for SVOCs, pesticides, PCBs, metals, and dioxins and furans.

Available data indicate that flooding of the Woonasquatucket River may have deposited Site-related contaminants in and on the surficial soils and sediment in the Oxbow Area. Recreational visitors to the Site could contact these surface soils during passive recreational activities within the Oxbow Area.

A discussion regarding the nature and extent of contamination of Oxbow Area sediment samples is contained in Appendix C of Part II Supplemental Baseline Human Health and Ecological Risk Assessment: Oxbow Area Floodplain Soil and Sediment.

1.4 EXPOSURE AREAS

For the purpose of this Supplemental BHHRA, two exposure areas for soil have been identified, the human health concern area and the general area. The exposure areas and associated samples are shown on Figure 2. Site photographs are included in Appendix C.

The human health concern area is represented by surface soils along a defined path along the west bank of the Woonasquatucket River and soils in an upland area west of the Woonasquatucket River. During Site visits a weather-worn wooden tree-house and other evidence of human activity have been noted in this area. An earthen trail provides access to the human health concern area. Additional signs of human activity in this area include discarded clothing and trash in likely congregation areas. Soil at this exposure area will be evaluated quantitatively in this Supplemental BHHRA. Photos 1 and 2 in Appendix C show sampling locations in the human health concern area.

The general area is represented by surface soils from the low-lying forested area within the 100-year floodplain. This area has limited access by human receptors and is a less desirable area for recreation activities. However, the earthen trail leading to the human health concern area does pass through the general area. This exposure area contains soils from both east and west of the Woonasquatucket River. Soil at this exposure area will be evaluated quantitatively in this Supplemental BHHRA. Photo 3 in Appendix C shows a soil sample location in the general area.

In this Supplemental BHHRA, the term "exposure point" has been used to identify locations or areas of exposure. The exposure points correspond to the exposure areas identified above as follows:

- The human health concern area; and
- The general area.

1.5 CURRENT AND REASONABLY FORESEEABLE USES OF THE SITE

The Oxbow Area is an undeveloped, forested wetland. There are no buildings or other constructed features (with the exception of a weather-worn wooden tree house) other than some earthen dikes located near the eastern end of the abandoned channel, in close proximity to the Woonasquatucket River. Most of the Oxbow Area is within the 100-year floodplain of the river. Currently, local residents and visitors to the area may enter the Oxbow Area and walk along a riverside earthen trail. There is some evidence that adolescents or young adults have at some time been present in the area, because a weather-worn wooden tree-house was observed within the area. There is no evidence that hunting is an activity in the Oxbow Area. It is possible that as the Site and the Woonasquatucket River are restored, the Oxbow Area might become a more attractive area for passive recreation (hiking, bird-watching, picnicking, etc.). Therefore, potential future land use is identified as passive recreation.

1.6 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) identifies potential source areas from which chemicals may have been released, the migration pathways through which oil and/or hazardous materials (OHM) may have been transported and/or translocated to other environmental media, and where possible exposure may occur. The CSM provides a framework for understanding sources of OHM, migration pathways, identification of potential receptors, and development of exposure profiles. The CSM for the Oxbow Area is presented here.

1.6.1 Source Area

Releases of hazardous substances from former industrial operations have occurred at the Site. The source area consists of two parcels located at 2072 and 2074 Smith Street (Lots 200 & 250) that cover approximately 9 acres. Evidence suggests that operations at the former chemical company and drum reconditioning facility resulted in waste disposal onto surface soil and beneath the ground surface. Wastes have also been released directly into the Woonasquatucket River, which runs along the western side of the source area (Tetra Tech NUS Inc., 2000). Dioxins and furans have been detected in soils and sediments as well as in fish tissue collected in 1996 from the Woonasquatucket River. Much of the impacted soils have been stabilized or capped. Other contaminants detected in Site media include PCBs, volatile organic compounds (VOCs), PAHs, hexachloroxanthene (HCX), phthalates, and metals. The sediments on the eastern bank of the river in the source area have been covered with rip rap. Allendale Pond sediments are a reservoir of contamination from the source area and disturbance of those sediments may release sediment associated contaminants into the water column and into downstream areas.

1.6.2 Migration of Oil and/or Hazardous Material

The forested wetland soils of the Oxbow Area are subject to frequent flooding of the Woonasquatucket River. During flood events, suspended sediments from Allendale Pond and even from upstream areas of the Woonasquatucket River are carried with the flood waters that flow over the Allendale Dam into the Oxbow Area where some portion of the suspended sediments is deposited on the ground surface. With the partial breaching of Allendale Dam in 1991 and the more recent breach in 2001, contaminants have migrated downriver, presumably to some extent into the Oxbow Area, and to Lyman Mill Pond. Since the source of contamination in the Oxbow Area is deposition of floodwater-borne suspended river sediments, the 100 year floodplain has been used to delineate the likely spatial extent of impacts. Also since the general area is more susceptible to flooding than the human health concern area, the two areas are evaluated separately.

1.6.3 Potential Human Receptors

Currently, local residents and visitors to the area may enter the Oxbow Area and walk along a riverside earthen trail. As previously discussed, there is some evidence that adolescents or young adults have at some time been present in the area, because a weather-worn wooden tree-house was observed within the area. There is no evidence that hunting is an activity in the Oxbow Area and according to the North Providence Police Department, hunting is prohibited in North Providence. Therefore, hunters have not been identified as potential receptors. It is possible that as the Site and

the Woonasquatucket River are restored, the Oxbow Area might become a more attractive area for passive recreation (hiking, bird-watching, picnicking, etc.). Therefore, potential future land use is identified as passive recreation.

Visiting recreational anglers and residents living along the river who engage in angling would be expected to primarily be present at the river's edge (along the western shore of the river) rather than throughout the forested wetland of the Oxbow Area. The western shore of the river is easily accessible along the Oxbow Area, and there are footpaths that follow the edge of the river in that area.

Human exposure to sediments in the Oxbow Area is very unlikely due to the difficulty to access this area. The sediments in the Oxbow Area are in very dense thickets of wetland shrubs with tangled root structures and branches making progress through it very challenging (Appendix C Photo 4). It is not foreseeable that human receptors would be exposed to these sediments. Therefore human exposure to sediments in the Oxbow Area will not be evaluated as part of this risk assessment.

Table 1.1 indicates which receptors and exposure pathways are evaluated for this Supplemental BHHRA. Other receptors (Visiting Recreational Angler and Resident Living Along the River) and exposure pathways associated with the Woonasquatucket River and surrounding area have previously been evaluated in the Interim-Final BHHRA for the Site (MACTEC, 2005) and are therefore not re-evaluated here.

Consistent with USEPA objectives, the following pathways are evaluated for the Supplemental BHHRA as summarized in Table 1.2:

1) Potential exposure to COPC via surface soil contact. Passive Recreational Visitors (from the surrounding neighborhoods or from other areas) are evaluated in the Supplemental BHHRA, focusing on three age groups that include the child (ages 1 through 6), the older child (ages 7 through 18), and the adult (ages 19 through 30) that might come into contact (ingestion and dermal contact) with surface soil in the Oxbow Area.

1.6.4 Summary of Data

As previously mentioned, this Supplemental BHHRA evaluates soil in the Oxbow Area (human health concern area and general area). Appendix A contains a list of samples evaluated in this risk assessment. Appendix B contains the data evaluated in this risk assessment.

Oxbow Soil Data

Table 2.1 presents a statistical summary of the analytical data collected for the surface soils from the Oxbow Area and evaluated in this assessment. This table presents a summary of the Toxic Equivalent Quotient (TEQ) for dioxins and furans (hereafter referred to as "dioxin TEQ"). Table B-1 presents all of the soil data for the Oxbow Area (human health concern area and general area). This table presents all of the dioxin and furan congener and homolog group data as well as the dioxin TEQ. A total of 32 soil samples are included in the Oxbow Area dataset. The dataset of 32 samples includes four "summary" samples. Each "summary" sample's analytical data represent average concentrations for multiple samples collected in close proximity to each other. The following groups of samples were averaged; RES-11-011-01, RES-11-011-02, RES-11-011-03; RES-11-012-01, RES-11-012-02, RES-11-012-03; SS_G-01, SS_G-01-01, SS_G-01-02, SS_G-01-03; SS_G-29, SS_G-29-01, SS_G-29-02. All 32 soil samples were analyzed for dioxins and furans, 28 of the samples were analyzed for SVOCs, and 30 samples were analyzed for pesticides, PCBs and metals. The dioxin congener 2,3,7,8-TCDD was detected in all 32 samples. Dioxins and furans congeners and homolog groups are well represented in the soil sample data (not limited to a single congener or homolog group). The 2,3,7,8-substituted congeners with the highest concentrations are typically the 1,2,3,4,6,7,8-HpCDD and 2,3,7,8-TCDD and the total octachlorinated dibenzo-p-dioxin (OCDD) concentration is generally in the same order of magnitude as the 1,2,3,4,6,7,8-HpCDD and 2,3,7,8-TCDD concentrations. The 2,3,7,8-TCDD congener is by far the largest contributor to the dioxin TEQ for all samples except three (RES-SS-11-011-03, RES-SS-11-012-02 and RES-SS-11-012-03). The 2,3,7,8-TCDD congener accounts for between 37.7% and 99.7% of the dioxin TEQ for the remainder of the samples. Table B-2 presents the calculation of dioxin TEQs for individual samples in the Oxbow Area.

Among the Aroclors, Aroclor-1254 was detected in 13 of 30 samples with a range of detected concentrations from 0.0077 milligrams per kilogram (mg/kg) to 0.75 mg/kg. Aroclor-1268 was detected in four of 28 samples with a range of detected concentrations from 0.02 mg/kg to 0.11 mg/kg. Aroclor-1260 was detected in two of 30 samples with a range of detected concentrations from 0.062 mg/kg to 0.12 mg/kg. No other Aroclors were detected.

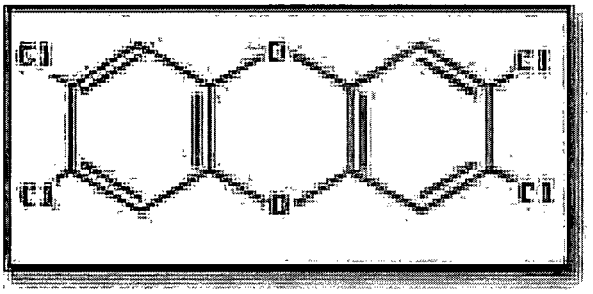
Nineteen pesticides were detected in the 30 soil samples, 4,4'dichlorodiphenyldichloroethylene (DDE) (29 of 30), 4,4'dichlorodiphenyltrichloroethane (DDT) (25 of 30) and gamma-chlordane (20

of 30) were the most frequently detected pesticides. Ten inorganic metals were detected in all 30 soil samples.

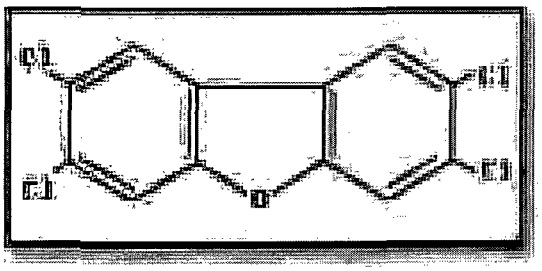
Lead was detected in all 30 soil samples collected in the Oxbow Area. The maximum detected concentration of lead, 2,460 mg/kg, was detected at location RES-11-012. This concentration appears to be an outlier for the general area dataset. The next highest concentration of lead in the Oxbow Area is 334 mg/kg at location SS_G-07. Lead has not been identified as a site contaminant and the concentration reported at location RES-11-012 is unlikely to be related to deposition of sediments during flooding events. Most likely the lead concentration at RES-11-012 is not related to the Site. Therefore the lead concentration of 2,460 mg/kg has not been included in the risk assessment.

The 2010 Oxbow Area investigation results are consistent with the results of historical investigations, the reported releases at the Site, and the nature of contamination in the sediments of the Woonasquatucket River. Results from the June 2004 investigation are documented in a data report (Battelle, 2004).

One of the analytical parameters shown in Table 2.1 is the dioxin TEQ. The TEQs are media-specific concentrations that are normalized to the toxicity of the 2,3,7,8-TCDD congener, generally considered to be the most toxic of the dioxin and furan compounds. The dioxin TEQs are calculated by multiplying the medium-specific concentration of each 2,3,7,8-chlorinated congener or congener group by a Toxicity Equivalent Factor (TEF) and summing those products. The TEF is a measure of the toxicity of a particular congener or congener group relative to toxicity of 2,3,7,8-TCDD. The TEFs used in this assessment are those identified in USEPA's 2010 guidance (USEPA, 2010). In simple terms, the dioxin TEQ indicates the concentration of 2,3,7,8-TCDD that would have the same toxicity as the mixture of dioxins and furans being evaluated.

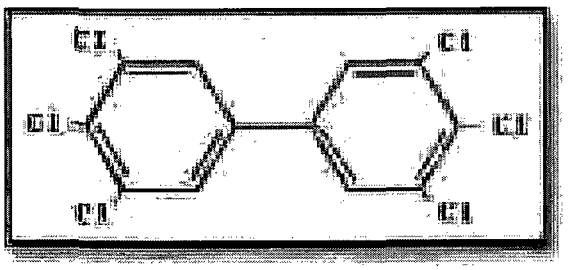


2,3,7,8-Tetrachlorodibenzo-p-dioxin



2,3,7,8-Tetrachlorodibenzofuran

Biphenyl is a dual-ring structure comprised of two six-carbon benzene rings joined by a single carbon-carbon bond. Up to ten chlorine atoms can be substituted for hydrogen atoms in the biphenyl molecule. Each of the carbon atoms in the benzene rings is assigned a location number between 1 and 6. The carbon atoms assigned the location 1 are bonded to each other and are not available for chlorine substitution. Each unique chemical compound within the PCB category is referred to a congener. Therefore, the biphenyl molecule containing two chlorine atoms (each located at the "4" position of one of the benzene rings), would be a PCB congener referred to as 4,4'-Dichlorobiphenyl. A total of 209 PCB congeners have been identified. A biphenyl with one chlorine atom is referred to as a monochlorobiphenyl and a biphenyl with ten chlorine atom is referred to as a decachlorobiphenyl. Homologs are subcategories of PCB congeners having equal numbers of chlorine atoms. For example, there are 12 PCB congeners that have two chlorine atoms. These 12 congeners are included in the dichlorobiphenyl homolog.



3,3',4,4',5,5'-Hexachlorobiphenyl

Commercially produced PCB mixtures were sold under many names. However, the most common naming convention for commercial PCB mixtures was with reference to the Aroclor series. Aroclors are mixtures of various chlorinated biphenyls. The last two digits in the Aroclor identifier indicates the percentage of the mixture represented by chlorine. Aroclor-1242 is a mixture of chlorobiphenyls with a chlorine content of 42%. Aroclor-1254 is a mixture of chlorobiphenyls with a chlorine content of approximately 54%. Typically, the higher the chlorine content, the

greater the abundance of the heavier chlorinated biphenyls (such as pentachlorobiphenyls and hexabiphenyls).

During investigations of the Site, analysis of PCBs has been completed by two different analytical approaches. The first and most frequently applied approach (for the large majority of samples) at the Site is the analysis for Aroclors via Method 8082. In this analysis, the following analytical parameters are typically reported: Aroclor-1016; Aroclor-1221; Aroclor-1232; Aroclor-1242; Aroclor-1248; Aroclor-1254; Aroclor-1260; and Aroclor-1268. The second approach, identification and quantification of individual PCB congeners, was used less frequently, with only a few representative samples per area, at the Site. The identification of individual PCB congeners was accomplished by a modified Method 1668A. Although each of the 209 PCB congeners has a unique chemical name (such as 4,4'-Dichlorobiphenyl), a shorthand means of identifying the individual congeners has been developed. Each of the congeners has been assigned a unique number from 1 to 209 (Ballschmiter, 1992). The numbering scheme assigns lower numbers to lower chlorine content congeners and higher numbers to higher chlorine content congeners. As an example, the PCB congener 3,4',5-trichlorobiphenyl is also referred to as PCB-39.

A total of 12 of the PCB congeners, based on their chemical structure, have been identified as "dioxin-like" or co-planar PCB congeners. These co-planar PCB congeners have been assigned 2,3,7,8-TCDD TEFs in a manner similar to the dioxin and furan congeners (USEPA, 2010a). A TEQ for all co-planar PCBs has been calculated for each floodplain soil sample that has been analyzed for PCB congeners. PCB congener analysis was conducted for only 1 soil sample in the Oxbow Area (LPX-FP-4004-0000-01). The TEFs used in the development of TEQs in this risk assessment are the mammalian TEFs for dioxins, furans, and dioxin-like (coplanar) PCBs as published in the USEPA guidance (USEPA, 2010). Table B-3 presents the calculation of dioxin PCB TEQs.

2.0 HAZARD IDENTIFICATION

The objectives of this section are to present an orderly compilation of the available sampling data for the hazardous substances present at the Site, to identify data sets suitable for use in a quantitative risk evaluation, and to identify contaminants of potential concern upon which the quantitative assessment of risk will be based. Summaries of the sampling data have been generated using Risk Assessment Guidance for Superfund (RAGS) Part D standard Table 2s, for each constituent detected in soil. Table 2s include the minimum and maximum concentrations (including locations of the latter), minimum and maximum data qualifiers, units, frequency of detection, range of detection limits, concentration used for screening, screening toxicity value, potential regulatory criteria (e.g., state standards), whether a contaminant is chosen as a COPC, and the rationale for that choice.

When choosing COPCs, USEPA guidance was followed (USEPA, 1989). Consistent with USEPA's Guidance for *Comparing Background and Chemical Concentrations in Soil for CERCLA Sites*, September 2002, USEPA Region I recommended a baseline risk assessment approach that retains all constituents that exceed risk-based screening concentrations as COPCs for further human health risk evaluation. Per this guidance, background chemical concentrations were not utilized in the selection of COPCs. All chemicals detected during sampling efforts, not just site-related chemicals or those that bioaccumulate, have been considered in the selection of COPCs for the human health evaluation. This will result in a total estimate of risk (including risks associated with background conditions) to the receptors potentially exposed to soils.

Chemicals that are infrequently detected may be artifacts in the data due to sampling, analytical, or other problems, and may not be related to site operations or disposal practices. Based on RAGS Part A (USEPA, 1989), a chemical is considered for elimination from the quantitative risk assessment if: 1) it is detected infrequently in one or perhaps two environmental media, 2) it is not detected in any other sampled media or at high concentrations, and 3) there is no reason to believe that the chemical may be present. In addition, chemicals that are considered essential human nutrients (e.g., iron, magnesium, calcium, potassium, and sodium) will not be considered in the quantitative risk assessment.

2.1 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

This section identifies the chemicals present at the Site and documents the selection of COPCs.

2.1.1 Chemicals of Potential Concern Selection Methods

COPCs are those detected chemicals which may pose more than a *de minimis* health risk and are evaluated in this risk assessment. A risk-based concentration screen is used to identify and eliminate from further consideration those detected chemicals with concentrations below even residential risk-based screening levels. COPCs for surface soil were selected using all available Oxbow surface soil data (combined data set from human health concern area and the general area). The procedure used to select COPCs for the Supplemental BHHRA is summarized as follows, and is consistent with USEPA Region I (USEPA, 1999) methodology:

1) *Comparison to Available Criteria*
   - Selected as a COPC in soils if the maximum detected concentration exceeds the USEPA Regional Screening Level (RSL) for residential soils (USEPA, 2010b).

The RSLs for soil address direct contact (ingestion and dermal contact) exposures, as well as inhalation of constituents that may be released to air. The published RSLs have been derived as the lower of the concentration associated with a cancer risk of 1 in 1 million ($1x10^{-6}$) and the concentration associated with a non-cancer hazard quotient (HQ) of 1. Per USEPA Region I guidance (USEPA, 1995), the published RSLs have been adjusted for use in the risk-based screening step. The adjusted RSL used for that purpose is the lower of the concentration associated with a cancer risk of 1 in 1 million ($1x10^{-6}$) and the concentration associated with a non-cancer HQ of 0.1. This adjustment of the risk based concentrations (RBCs) per the guidance is applied to account for the possible cumulative impacts of having several chemicals that might have similar mechanisms of toxic action.

The use of residential RSLs for selection of COPCs in surface soils ensures that analytes present at concentrations that could potentially pose more than a *de minimus* risk for residential land use exposures are identified. The RSLs are set at *de minimis* risk levels (cancer risk of one in one million and the adjusted RSLs at HQ of 0.1). The use of these RSLs for selection of COPCs in surface soils represents a conservative approach because it is highly unlikely that potential exposure to these media would occur at the frequency or intensity that would be associated with residential land use.

2) Essential Nutrients:

- Eliminated as COPCs because they are considered essential human nutrients. The following inorganic analytes are considered essential human nutrients: calcium, magnesium, iron, potassium, and sodium.

3) Chemicals for which risk-based concentrations were not available were retained as COPCs.

- The results of the COPC selection for surface soil at the Oxbow Area (human health concern area and general area) are summarized in Table 2.1. The following notes are used to denote the reasons for selection or exclusion of analytes as COPCs:

  ASL: The concentration used for COPC screening (the maximum detected concentration) is greater than the risk-based concentration; the analyte is therefore selected as a COPC.

  BSL: The concentration used for COPC screening (the maximum detected concentration) is less than the risk-based concentration; the analyte is therefore not selected as a COPC.

  FOD: The analyte was detected in less than five percent of the samples, and is therefore not selected as a COPC.

  E: The analyte is an essential nutrient, and is therefore not selected as a COPC.

  NSL: No screening level available; analyte is therefore selected as a COPC.

2.1.2 Chemical of Potential Concern Selection Results

Table 2.1 presents the selection of COPCs for surface soil collected from the Oxbow Area. COPCs include dioxins and furans, Aroclor-1254 and Aroclor-1268, six PAHs, two SVOCs, and seven inorganics/metals. A review of the substances eliminated during the COPC selection process did not identify any substance(s) that was likely to pose significant risk despite elimination via the risk-based screening approach.

3.0 EXPOSURE ASSESSMENT

As defined by the USEPA (USEPA, 1989), exposure to a chemical is the contact of that chemical with the outer boundary of the body (i.e., skin and openings such as mouth, nostrils, or punctures and lesions). An exposure assessment is the quantitative or qualitative evaluation of that contact. It describes the intensity, frequency, and duration of contact, as well as the rates at which the chemical crosses the boundary (chemical intake or uptake rates), the route by which it crosses the boundary, and the resulting amount of chemical that actually crosses the boundary (a dose) and the amount absorbed (internal dose).

The objective of the exposure assessment is to estimate the type and magnitude of exposures to COPCs at or migrating from the Site. The exposure assessment is conducted to: 1) characterize the populations of humans potentially exposed via direct contact with surface soil; 2) identify the mechanisms by which receptors may be exposed; and 3) identify the intake, or dose, of COPCs that receptors may receive through the identified exposure pathways. The exposure assessment includes the following components:

- Characterization of the exposure setting (including current and future land use);
- Identification of exposure pathways (including receptor identification and exposure scenarios, and exposure points);
- Identification of EPCs;
- Quantification of exposures; and
- A summary of exposures by receptor and exposure point.

Present and future potential exposures to Site contaminants include direct contact with surface soil. Narrative descriptions and summary tables of exposure scenarios are provided in this section. The exposure scenarios for current and future potential scenarios are summarized in a RAGS Part D Table 4 (Table 4.1).

3.1 CHARACTERIZATION OF EXPOSURE SETTING

The exposure setting has previously been described in Section 1.4.

3.2 IDENTIFICATION OF EXPOSURE PATHWAYS, POTENTIAL RECEPTORS, AND EXPOSURE POINTS

This subsection describes the receptors and activities, exposure pathways, exposure parameters and exposure points for the Passive Recreational Visitor.

This step involves the identification of all relevant exposure pathways through which specific populations may be exposed (current and future) to contaminants at the Site. An exposure pathway consists of four necessary elements: 1) a source or mechanism of chemical release; 2) a transport or retention medium; 3) a point of human contact; and 4) a route of exposure at the point of contact (USEPA, 1989). As discussed in the text below and in Table 1.2 the Passive Recreational Visitor is the receptor population evaluated in this Supplemental BHHRA. The Passive Recreational Visitor is distinguished here from what might be referred to as an Active Recreational Visitor. The distinction is in the nature and intensity of the expected activities that might result in soil exposure. The Passive Recreational activities might include walking, bird watching, and exploring, while Active Recreational activities might include playing baseball, playing in a "tot lot", and other activities with a higher potential for high intensity soil contact.

Exposures were evaluated based on a Reasonable Maximum Exposure (RME) scenario. The RME is the highest exposure that is reasonably expected to occur at a site. The RME scenario is characterized by coupling the contaminant concentrations with conservative exposure parameters developed for the exposure scenario. The RME scenario is summarized in Table 4.1 and is discussed in Sections 3.2.1 and 3.2.2 below. Exposure parameters are obtained from USEPA guidance (USEPA, 1997a) and other USEPA-approved sources. In general, RME parameters represent 95th percentile values.

3.2.1 Receptor Exposure Scenarios for Surface Soil

Using the information summarized in Table 1.2, receptor exposure scenarios were compiled. The following paragraphs discuss the receptor exposure scenarios.

Exposure parameters for the RME scenario were selected from USEPA guidance documents (USEPA, 1989; 1994a; 1997a; 2001b) and were based on professional judgment considering the site-specific exposure conditions. This subsection describes the exposure scenarios and exposure parameters in detail.

Passive Recreational Visitor

In the previous BHHRA for the Site (MACTEC, 2005), an exposure profile was identified for residents living along the river. A resident who lives at the Centredale Manor Apartments, Brook Village Apartments, or a private residence at one of the residential lots along the eastern shore of the Woonasquatucket River may visit water bodies at the Site for recreational angling, recreational walking, exploring the banks of the river and ponds, and wading and swimming (wading and swimming are not applicable to the Oxbow Area). It is assumed that area residents include young children (ages 1 through 6), adolescents (ages 7 through 18), and adults (assumed ages 19 through 30). This exposure profile appears to be an appropriate starting point for evaluating a potential passive recreational visitor for the Oxbow Area. The Oxbow Area is in close proximity to the Woonasquatucket River and to residential properties along the river in the area of the Site. People who visit the Oxbow Area for hiking, bird-watching, picnicking, and other passive recreational activities would most likely live in the general area of the Woonasquatucket River. This Supplemental BHHRA quantitatively evaluates only the potential exposures to surface soils in the Oxbow Area. Potential exposures to surface water and sediment in the river and fish consumption have previously been evaluated in the BHHRA for the Site.

Cancer and non-cancer risk estimates are calculated separately for surface soils at each exposure area. These risks are used in a surface soil-specific evaluation. The risks associated with the Oxbow Area surface soils have not been combined with the previously calculated risks associated with potential exposures associated with fish consumption and contact with surface water and sediment in the river.

The exposure scenarios for the human health concern area and the general area are described below. The exposure parameters for surface soil are presented in Tables 4.1.

Exposure Duration. For both scenarios, it is assumed that a Passive Recreational Visitor is raised at and remains at the same residence over a 30-year period (USEPA, 1994a) in the vicinity of the Oxbow Area. The 30-year duration is segregated into three age periods: young-child (ages 1 through 6) for 6 years; adolescent (ages 7 through 18) for 12 years; and adult (ages 19 through 30) for 12 years.

Exposure Frequency. It is assumed that a Passive Recreational Visitor visits the Oxbow Area for walking/exploring/bird watching May through October. As described previously the human health

concern area and the general area will be evaluated separately. The exposure frequency (EF) differs between these two areas. The human health concern area is a more desirable area for human usage and in addition evidence of human activity has been observed. Therefore the EF is greater in the human health concern area than in the general area. The EF associated with these various activities is broken down as follows.

The EF during the summer months assumes walking/exploring/bird watching within the Oxbow Area (including the river bank). It is assumed that potential exposures to surface soil occur each day that access to the Oxbow Area occurs (78 days per year for the human health concern area and 26 days per year for the general area).

Body Weight. Body weight (BW) values for young children and adults are based on values recommended in USEPA guidance (USEPA, 1994a). BW values for adolescent are based on the average of 50th percentile BW for the male ages 7 through 18 (USEPA, 1997).

Incidental Ingestion Rate and Fraction Ingested. The incidental ingestion rates for surface soil are the default ingestion rate values for soil recommended in USEPA guidance (USEPA, 1994); the ingestion rate for adults is applied to adolescent who are less likely than young children to place soil-covered hands in the mouth. The fraction ingested (FI) parameter for surface soil is 100%. The assumed soil ingestion rates (typically applied to residential scenarios) are considered conservative assumptions for a passive recreational scenario. The dermal surface area (SA) and adherence factor values for surface soil are based on the RAGS Part E (USEPA, 2001b) default values for residential exposures to soil.

3.2.2 Exposure Points

Two exposure points, identified as the human health concern area and the general area, have been identified for quantitative evaluation of surface soil by the Passive Recreational Visitor. The human health exposure point is represented by ten soil samples that were collected in this area. The general area is represented by 22 soil samples that were collected in this area.

Exposure Point Concentrations

A single concentration is selected as representative of the actual concentration for each COPC in a surface soil for a given exposure point. This value, called the EPC, is used in the estimates of

health risks at the Site. An EPC is selected for every COPC identified in the screening process described earlier.

The 95% Upper Confidence Limit (UCL) on the mean is typically used as the EPC. There are two exceptions to this rule. In the case where the 95% UCL is greater than the maximum detected concentration; and/or if there are fewer than five samples in a data set (the UCL is not calculated). For these two situations, the maximum detected concentration is used as the RME EPC.

The 95% UCL values are calculated using the ProUCL software (V. 4.1.00; USEPA, 2010c). The ProUCL software performs a goodness-of-fit test that accounts for data sets without any non-detect observations, as well as data sets with non-detect observations. The software then determines the distribution of the data set for which the EPC is being derived (e.g., normal, lognormal, gamma, or non-discernable), and then calculates a conservative and stable 95 percent UCL value in accordance with the framework described in "Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites" (USEPA, 2002c). The software includes numerous algorithms for calculating 95% UCL values, and provides a recommended UCL value based on the algorithm that is most applicable to the statistical nature of the data set.

EPCs are provided in 'RAGS Part D Table 3s', which are presented as Table 3.1. ProUCL output sheets are provided in Appendix D.

3.3 QUANTIFICATION OF EXPOSURES

The next step is to calculate COPC intakes via direct contact with surface soil for the Passive Recreational Visitor for both exposure points. Population-related variables have been selected that describe the characteristics associated with individual receptors in that population.

3.3.1 Estimation of Chemical-Specific Intakes

The chemical-specific intake, or the average daily dose (ADD), is the amount of COPC taken into the body. When appropriate, it is the product of the average daily exposure and an absorption factor (ABS). Chemical-specific intakes were calculated in a manner consistent with USEPA guidance for risk assessment (USEPA, 1989; 2001b).

A Lifetime Average Daily Dose (LADD) is calculated in order to estimate carcinogenic risk. The Averaging Time (AT) over which the total intake of COPC is averaged is 70 years for carcinogenic effects (USEPA, 1989).

For noncarcinogenic effects, depending on the duration of the exposure period, an ADD, Chronic (ADD_c) for long-term exposure (seven years or longer) or ADD, Subchronic (ADD_s) for exposure periods from a month up to seven years may be calculated.

Soil Direct Contact Exposures

The ADD received by a receptor via direct contact with soil (ADD_{soil}) is the sum of the ADD's for exposure via the routes of dermal contact with the contaminated soil and ingestion of the contaminated soil. Thus,

$$ADD_{soil} = ADD_{dermal} + ADD_{ingestion}$$

Dermal Contact. The ADD due to dermal contact with COPC-contaminated soil ($ADD_{dermal\ absorption}$) may be calculated:

$$ADD_{dermal\ absorption} = \frac{DAevent * SA * EF * ED}{BW * AT}$$

and:

$$DAevent = [COPC]soil * AF * ABS * C$$

Where:

$ADD_{dermal\ absorption}$	=	Average daily dose of COPC received through dermal contact with soil during the period of exposure (dimensions: mass/mass×time, typical units: mg/kg×day)
DAevent	=	Dose of COPC absorbed during each exposure event (dimensions: milligrams per square centimeter [mg/cm^2])
$[COPC]_{soil}$	=	EPC of COPC in the soil at the exposure point during the period of exposure (dimensions: mg/kg)
SA	=	Skin surface area in contact with the soil on days exposed (dimensions: square centimeter per day [cm^2/day])
AF	=	Mass of soil adhered to the unit SA of skin exposed (dimensions: mg/cm^2)
ABS	=	Absorption Factor; represents the fraction of COPC that may be absorbed through the skin from soil (unitless)
EF	=	Exposure Frequency: the number of exposure events during the exposure period divided by the number of days in the exposure period (dimensions: days/year)

ED	=	Exposure Duration: the period of time over which exposure may occur (dimension: years)
BW	=	Body Weight of the receptor of concern during the ED dimension: kg)
AT	=	Averaging Time (dimension: days)
C	=	Appropriate units conversion factor(s)

Ingestion. The ADD due to the incidental ingestion of COPC contaminated soil ($ADD_{ingestion}$) may be calculated:

$$ADD_{ingestion} = \frac{[COPC]_{soil} * IR * EF * ED * C}{BW * AT}$$

Where:

ADDingestion	=	Average daily dose of COPC received through the ingestion of soil during the period of exposure (dimensions: mass/mass×time, typical units: mg/kg×day)
[COPC]soil	=	EPC of the COPC in soil (dimensions: mass/mass, typical units: mg/kg)
IR	=	Daily soil ingestion rate on days exposed during the exposure period (dimensions: mass/time, typical units: mg/day)
EF	=	Number of exposure events during the exposure period divided by the number of days in the exposure period (dimensions: events/time, typical units: days/year)
ED	=	Duration of the exposure period (dimensions: time, typical units: years)
C	=	Appropriate units conversion factor(s)
BW	=	Body weight of the receptor of concern during the averaging period (dimensions: mass, typical units: kg)
AT	=	Averaging Time (dimension: time, typical units: days)

The daily chemical intakes have been calculated separately for non-cancer and cancer endpoints using the EPCs presented in Table 3.1, the exposure parameters and intake equations shown in Table 4.1. The soil daily intakes for the Passive Recreational Visitor in the human health concern area exposure point, all age-groups, are calculated in Tables 7.1 through 7.3. The soil daily intakes for the Passive Recreational Visitor in general area exposure point, all age-groups, are calculated in Tables 7.4 through 7.6. Each of those tables shows all daily intake calculations for surface soils for a receptor group/age-group/exposure point combination.

4.0 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to characterize the relationship between the dose of COPC administered or received and the likelihood of adverse health effects in the exposed population. From this quantitative dose-response relationship, toxicity values (e.g., slope factors (SFs), or reference dose (RfD) values) are derived that can be used to estimate the likelihood of adverse effects as a function of human exposure to an agent. These toxicity values are used in the risk characterization process to estimate the potential for adverse effects occurring in humans at different exposure levels.

The dose-response relationship(s) for each chemical that has been selected as a COPC is presented in this section. The dose-response information may be divided into two major categories:

- Toxicity information associated with threshold (non-carcinogenic) health effects.
- Toxicity information concerning carcinogenicity, either from human epidemiologic data or from laboratory studies.

All the chemicals selected as COPCs are evaluated for potential *non-carcinogenic* health effects. In addition, any substance considered to be a *known*, *probable*, or *possible* human carcinogen is also evaluated for its potential carcinogenic effects. The classification of a chemical as a carcinogen does not preclude an evaluation of that same chemical for potential non-carcinogenic health risks, as all potentially carcinogenic chemicals may also exert non-carcinogenic health effects.

4.1 DOSE-RESPONSE ASSESSMENT FOR CARCINOGENIC EFFECTS

It has historically been assumed that carcinogenic effects are non-threshold effects (IRIS, 2011). This means that any dose, no matter how small, is assumed to pose a finite probability of generating a response. Thus, no dose of a carcinogen is thought to be risk-free. However, USEPA has recently identified some carcinogens for which thresholds appear to exist. For carcinogenic effects, USEPA uses a two-part evaluation in which the substance is first assigned a weight-of-evidence classification, and then a SF or unit risk (UR) is calculated to reflect the carcinogenic potency.

The weight-of-evidence evaluation involves determining the likelihood that the agent is a human carcinogen. USEPA has developed a system for characterizing the overall weight of evidence for a

chemical's carcinogenicity based on the availability of animal, human, and other supportive data (USEPA, 1989). The weight-of-evidence classification rates the likelihood that an agent is a human carcinogen. It qualitatively affects the interpretation of potential health risks. Three major factors are considered in characterizing the overall weight-of-evidence for carcinogenicity: (1) the quality of evidence from human studies, (2) the quality of evidence from animal studies, and (3) other supportive information, such as mutagenicity data and structure-activity data.

USEPA's final classification of the overall weight-of-evidence has the following five categories:

Group A - Human Carcinogen. This category indicates that there is sufficient evidence from epidemiological studies to support a causal association between an agent and human cancer.

Group B - Probable Human Carcinogen. This category generally indicates that there is at least limited evidence from epidemiologic studies of carcinogenicity to humans (Group B1) or that, in the absence of data on humans, there is sufficient evidence of carcinogenicity in animals (Group B2).

Group C - Possible Human Carcinogen. This category indicates that there is limited evidence of carcinogenicity in animals in the absence of data on humans.

Group D - Not Classified. This category indicates that the evidence for carcinogenicity in animals is inadequate.

Group E - No Evidence of Carcinogenicity to Humans. This category indicates that there is evidence of noncarcinogenicity in at least two adequate animal tests in different species or in both epidemiologic and animal studies.

USEPA's revised guidelines for cancer risk assessment (USEPA, 2005a) have been adopted as agency policy for cancer risk assessment. These guidelines contain a revised classification system for carcinogenic effects with the following classifications.

- Carcinogenic to humans
- Likely to be carcinogenic to humans
- Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential

- Data inadequate for an assessment of human carcinogenic potential
- Not likely to be carcinogenic in humans

In the Integrated Risk Information System (IRIS), the weight of evidence classification for a given chemical may reflect either of the two classification schemes identified above.

The ability of a chemical to increase the incidence of cancer in a target population is described by one of two values: the carcinogenic SF or the UR. SFs or URs are typically calculated for chemicals in Groups A, B1, and B2. Cancer dose-response values for chemicals in Group C are calculated on a case-by-case basis.

For some chemicals, human epidemiologic data is the basis of an estimate of the carcinogenic potency, although the most common basis of these values is an animal study. The SF is given in units of $(mg/kg/day)^{-1}$ and is based upon the concept of a LADD. Oral SFs are used to estimate the risks associated with exposure to carcinogens via ingestion. No SFs are available for the dermal route of exposure, but are instead calculated from oral SFs using the methodology described in Section 4.1.4.

The dose-response data used in this Supplemental BHHRA for carcinogenic effects, including SF values, are presented in Table 6.1.

4.2 ADJUSTMENT FOR EARLY LIFE EXPOSURE TO CARCINOGENS WITH A MUTAGENIC MODE OF ACTION

USEPA has developed guidance for characterizing cancer susceptibility associated with early life exposures (e.g., young children) to potentially carcinogenic chemicals (USEPA, 2005b; 2008). The approach developed by USEPA to characterize cancer risks for early life stages includes consideration of differences in physiology and exposure potential between children and adults, as well as differences in susceptibility to tumor development between children and adults. Physiological and behavioral differences are accounted for in the exposure assessment, whereby age-specific exposure parameters (e.g., BWs, ingestion rates, inhalation rates, contact frequencies) are applied to the various age groups evaluated in the risk assessment. Differences in susceptibility to tumor development are accounted for by considering the carcinogenic mode of action (MOA) in accordance with the MOA framework developed by USEPA (USEPA, 2005b).

In accordance with the MOA framework, for chemicals that initiate carcinogenesis by a mutagenic MOA and for which data concerning differential susceptibility for early life stages is available, USEPA may develop SFs that are applicable to specific ages (e.g., infants and young children, adults). The following COPCs at the Site are considered carcinogenic and operate with a mutagenic MOA: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. USEPA has not developed SF for different age groups for these COPCs. Therefore, the SFs for each COPC is adjusted for specific age groups to account for the mutagenic MOA. A 10 fold adjustment is used for the first two years of life (ages 0-2). A 3 fold adjustment is used after two year through <16 years of ages. After 16 years of age no adjustment is made to the SFs (USEPA, 2005b).

This risk assessment evaluates children (ages 1-6), adolescents (ages 7-18) and adults (ages 19-30). The SFs for the previously identified chemicals which have a mutagenic MOA have been adjusted. The SFs for the child receptor have been multiplied by a factor of 4.2 to account for the mutagenic MOA. The value of 4.2 for the child receptor represents a weighted average:

$$\frac{(1\ year \times 10) + (5\ years \times 3)}{6\ years} = 4.2$$

The same process was used for the adolescent receptor as shown below:

$$\frac{(9\ years \times 3) + (3\ years \times 1)}{12\ years} = 2.5$$

As stated previously no SF adjustment is necessary for the adult receptor.

4.3 DOSE-RESPONSE ASSESSMENT FOR NONCARCINOGENIC EFFECTS

In contrast to carcinogens, noncarcinogens are believed to have threshold exposure levels below which adverse effects are not expected. USEPA has derived standards and guidelines based on acceptable levels of exposure for such compounds. Noncarcinogenic effects of concern on which many of the standards and guidelines are based include liver toxicity, reproductive effects, neurotoxicity, teratogenicity, and other chronic toxicities. Various criteria have been developed from experiments that can be used to estimate the dose-response relationship of noncarcinogens. Some of the same uncertainties involved in deriving cancer risk estimates (namely, selection of an appropriate data set and extrapolation of high-dose animal data to low-dose human exposure) are

also involved in deriving noncarcinogenic dose-response criteria. Dose-response values used most often to evaluate noncarcinogenic effects are RfDs.

The RfD, expressed in units of mg/kg/day, is defined as an estimate (with uncertainty spanning perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (USEPA, 1989). When available, the RfD is the dose-response criterion most appropriate for quantitatively estimating noncarcinogenic effects. The RfD is derived from the following equation:

$$RfD\ (mg/kg/day) = \frac{NOAEL\ or\ LOAEL}{UF\ and/or\ MF}$$

The No Observable Adverse Effect Level (NOAEL) represents the dose of a chemical at which there are no statistically or biologically significant differences in the frequency of an adverse effect between the exposed population and its appropriate control. The Lowest Observable Adverse Effect Level (LOAEL) represents the lowest dose at which a statistically significant difference in the frequency of an effect is noted. Both the NOAEL and the LOAEL are reported in terms of mg/kg/day. An uncertainty factor (UF) of ten per type of uncertainty (e.g., extrapolation from animal sensitivity to human sensitivity, relationship between lowest adverse effect level and no adverse effect level) is used to account for interspecies and interspecies differences, severity of the adverse effect, whether the dose was an NOAEL or an LOAEL, and the adequacy of the data. The magnitude of the UF will therefore vary from chemical to chemical, ranging from 10 to 10,000. A modifying factor (MF), ranging from less than 1 to 10 may also be added to reflect qualitative uncertainties not explicitly addressed in the UFs. The toxicity endpoint upon which the RfD is derived and the UF and/or MF used in the calculation are presented in the dose-response tables. No RfDs are available for the dermal route of exposure but are instead calculated from oral RfDs using the methodology described below (USEPA, 2001b).

The use of chronic RfDs to evaluate the potential for adverse health effects resulting from substantially less-than-lifetime exposures may be overly protective. Subchronic reference doses (RfD_ss) have been developed for many chemicals to evaluate the potential noncarcinogenic effects of limited duration exposures. RfD_ss are similar to chronic RfDs; the distinction is the length of ED.

The dose-response data for noncarcinogenic effects (RfDs) and their critical toxic effects are presented in Table 5.1, for both chronic and subchronic effects.

4.4 DERMAL DOSE-RESPONSE VALUES

SFs and non-cancer RfDs were developed to evaluate risk associated with the dermal contact exposure route. In accordance with USEPA guidance (USEPA, 2001b), dermal dose-response values are calculated from oral dose-response values using an oral ABS. The oral ABS represents the amount of substance that is absorbed from the gastrointestinal tract following oral administration of a substance. The absorbed dose represents the amount of substance that is potentially available for biological interaction. It is this dose-response relationship that the toxicity of a dermally absorbed substance is evaluated. Thus, for potentially carcinogenic substances, the dermal dose-response value is calculated as follows:

$$SF_d = SF_{oral} / Oral\ ABS$$

The dermal dose-response value for evaluating non-carcinogenic effects is calculated as follows:

$$RfD_d = RfD_{oral} x\ Oral\ ABS$$

The Oral ABS is the fraction of contaminant absorbed in the gastrointestinal tract (dimensionless) in the critical toxicity study. Chemical-specific Oral ABS values are published by USEPA (USEPA, 2001b). In accordance with USEPA guidance (USEPA, 2001b), oral dose-response values are only adjusted using an Oral ABS value if the COPC has an oral ABS value less than 50%. Otherwise, the oral dose-response value is used as the dermal dose-response value. Dermal SFs and RfDs are presented in Tables 6.1 and 5.1 respectively.

4.5 SOURCES OF DOSE-RESPONSE VALUES

The following hierarchy of sources for dose-response values has been utilized in identifying dose-response values for this Supplemental BHHRA.

Tier 1 - IRIS (http://www.epa.gov/iris/). In accordance with USEPA guidance, the main source of dose-response values is the USEPA IRIS, which is a database established by USEPA containing all validated data on many toxic substances found at hazardous waste sites. This database was used to identify the SFs and RfDs applied in this risk assessment (IRIS, 2011).

Tier 2 - NCEA's peer reviewed toxicity values (PRTVs). National Center for Environmental Assessment (NCEA's) peer reviewed toxicity values (PRTVs) are developed by the Superfund Technical Support Center (STSC) for the USEPA Superfund program. STSC's reassessment of Health Effects Assessment Summary Table (HEAST) toxicity values, as well as development of PRTVs in response to Regional or Headquarters Superfund program requests, are consistent with Agency practices on toxicity value development, use the most recent scientific literature, and are supported by both internal and external peer review, providing a high level of confidence in the use of these values in the Superfund Program. USEPA Region I has provided PRTVs and associated documentation prepared by the STSC for aluminum, copper, 2-methylnapthalene, and 4-nitrophenol (USEPA, 2003b).

Tier 3 - Other toxicity values

- Agency for Toxic Substances and Disease Registry (ATSDR's) method reporting limits (MRLs) address non-cancer effects only, and are available on the ATSDR website at http://www.atsdr.cdc.gov/mrls.html.
- Toxicity values remaining in current versions of HEAST (1997b).
- State and other regulating agencies.

In this Supplemental BHHRA, the majority of dose-response values used are published in IRIS. For some Site-related COPCs required dose-response data are only available as NCEA provisional values. These dose-response values were used in this Supplemental BHHRA in order to provide a more complete evaluation of potential risks.

Uncertainties related to the absence of dose-response data, particularly for COPCs for which the exposure pathway, which represents the only pathway or most significant exposure pathway, has no toxicity criterion, will be discussed in the risk assessment uncertainty analysis.

Evaluation of Dioxin-Like Compounds in Site Media

Due to the limited toxicological data available for many individual dioxin, furan, coplanar PCB congeners, and HCX, and to simplify the risk assessment process, a methodology has been developed that quantifies the toxicities of various dioxin, furan, and coplanar PCB congeners relative to the toxicity of 2,3,7,8-TCDD (USEPA, 2010a). TCDD is widely accepted to be the most toxicologically significant chemical among these groups of chemicals, all of whose toxicological properties are assumed to be regulated by their individual abilities to bind to the cytosolic Ah receptor (AhR).

Based on the potency of 2,3,7,8-TCDD, and the greater amount of research that has been devoted to 2,3,7,8-TCDD, a SF has only been developed for this congener. Other dioxin, furan, and co-planar PCB compounds exert toxicity through the same mechanism of action as 2,3,7,8-TCDD, but the threshold effects levels for the other compounds are directly related to their affinity to interact with the AhR. Therefore, dioxin, furan, and co-planar PCB compounds (dioxin-like compounds) are evaluated using the dose-response data for 2,3,7,8-TCDD, but the concentrations are weighted according to their potency relative to the 2,3,7,8-TCDD using TEFs (USEPA, 2010a).

The procedure for weighting the concentrations of dioxin-like compounds is documented in Appendix B. In summary, because 2,3,7,8-TCDD has the greatest affinity for the AhR, it is arbitrarily assigned a TEF of 1. Other congeners are assigned a TCDD TEF relative to 2,3,7,8-TCDD based on experimental evidence concerning their relative binding potential to the AhR. The potency of the congener is then estimated by multiplying the measured media concentration by the TEF for the particular congener to yield a TEQ. Finally, a TEQ for the entire sample can be determined by summing the calculated TEQs for each AhR binding congener; the resulting concentration is a measure of the potency of the entire mixture represented in terms of 2,3,7,8-TCDD, and is expressed as a TCDD-equivalent concentration. This methodology assumes that the combined effects of the different congeners are dose or concentration additive, and this has been generally supported by results of many studies. This approach fails to consider the toxicological significance of effects that are not mediated by the AhR (e.g., neurotoxicity and various hormonal effects). However, current consensus is that the TEF approach is the best methodology for assessing the impacts associated with exposure to dioxin-like compounds (USEPA, 2010a).

At this time, USEPA has not yet derived an IRIS toxicity value for dioxin. Due to the lack of a Tier 1 (IRIS) and a Tier 2 (PPRTV – Provisional Peer Reviewed Toxicity Value) for dioxin, this risk assessment uses the currently available HEAST cancer toxicity value of 1.5E+05 per mg/kg/day (USEPA, 1997b) as a Tier 3 value to evaluate the potential risks associated with dioxin and dioxin-like compounds. The USEPA's dioxin reassessment has been developed and undergone review over many years with the participation of scientific experts in USEPA and other federal agencies, as well as scientific experts in the private sector and academia. The Agency followed current cancer guidelines and incorporated the latest data and physiological/biochemical research into the assessment. When the USEPA's dioxin reassessment is finalized, the dioxin cancer risks may be re-evaluated. The SF for 2,3,7,8-TCDD of 1.5E+05 per mg/kg/day (USEPA, 1997b) is

used to evaluate the potential risks associated with dioxin-like compounds. This SF has been utilized to be consistent with previous risk assessments for the Site. Specifically, this SF is applied to the calculated intakes for the dioxin TEQ (sum of TEQs for individual dioxin and furan compounds) and the co-planar PCB TEQ (sum of TEQs for individual co-planar PCB congeners). The TEFs for dioxin-like PCBs, polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) identified for mammals (USEPA, 2010a) are applied to the soil EPCs for each of the congeners to identify a TEQ. The TEQ are used in conjunction with the oral SF for 2,3,7,8-TCDD (available in HEAST, USEPA 1997b) to estimate cancer risk for those compounds. The dioxin/furan TEQ has been kept distinct from the co-planar PCB TEQ for purposes of risk calculations.

At this time, USEPA has not yet derived a Tier 1 or a Tier 2 non-cancer toxicity value for dioxin. Due to the lack of a Tier 1 or Tier 2 value and the lack of any endorsable Tier 3 values, non-cancer dioxin risks are not evaluated in this risk assessment. The USEPA's dioxin reassessment has been developed and undergone review over many years with the participation of scientific experts in USEPA and other federal agencies, as well as scientific experts in the private sector and academia. The Agency followed current guidelines and incorporated the latest data and physiological/biochemical research into the assessment. When the USEPA's dioxin reassessment is finalized, the dioxin non-cancer risks may be re-evaluated.

The dioxin-like PCB congeners evaluated in this manner include congeners 105, 114, 118, 123, 156, 157, 167, 189, 81, 77, 126, and 169. The remainder of the reported PCB congeners are not evaluated in a quantitative manner. Rather, they are evaluated, by inclusion, with the Aroclor-1254 or Aroclor-1260 using the High Risk and Persistence, Upper Bound SF, as shown in Table 6.1, for PCBs (IRIS, 2011). Aroclor-1254 and Aroclor-1260 EPCs have not been adjusted (reduced) to account for the twelve co-planar PCB congeners that are evaluated using the dioxin TEF approach. Therefore, there is an overestimation of cancer risk associated with these co-planar PCB congeners. This approach is consistent with the approach used by USEPA for RSLs. The RfDs (Aroclor-1254) obtained from the IRIS database is used to evaluate non-cancer risks associated with Aroclors.

The compound HCX has been identified as a dioxin-like compound. However, there is no formally published USEPA SF, RfD, or dioxin TEF for HCX. The HCX toxicity information in the literature is limited. There are many uncertainties associated with HCX: none of the available

studies documents long-term toxicity of HCX; there is limited information concerning metabolites of HCX; there are many uncertainties associated with the available study reports; and the Hahn study report, which suggests a dioxin TEF, is a preliminary, unpublished report. A TEF of 0.0002 has been applied for HCX in this Supplemental BHHRA (consistent with the previous Oxbow risk assessment).

DIOXIN REASSESSMENT

USEPA has reviewed available toxicity studies on 2,3,7,8-TCDD and other dioxin-like compounds. A preliminary draft document, *Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds*, (USEPA, 2000) presents USEPA's scientific reassessment of the health risks resulting from exposure to these compounds. This draft document has been reviewed by the public and the USEPA's Science Advisory Board (SAB) in its publication, *Dioxin Reassessment – An SAB Review of the Office of Research and Development's Reassessment of Dioxin*, (USEPA-SAB, 2001). At this time, the dioxin reassessment document and its contents remain in draft status. The draft reassessment document draws some important conclusions and makes recommendations concerning health risk assessment for dioxins and furans. The USEPA's dioxin reassessment has been developed and undergone review over many years with the participation of scientific experts in USEPA and other federal agencies, as well as scientific experts in the private sector and academia. The Agency followed current cancer guidelines and incorporated the latest data and physiological/biochemical research into the assessment. When the USEPA's dioxin reassessment is finalized, the dioxin cancer and non-cancer risks may be re-evaluated.

Cancer Effects

In its review of available toxicity studies on 2,3,7,8-TCDD and other dioxin-like compounds (USEPA, 2000), USEPA recommended a revised SF of 1E+06 $(mg/kg/day)^{-1}$ to estimate upper-bound cancer risk for background intakes and incremental intakes above background. This estimate compares well with the published estimates of cancer slope and risk from epidemiological studies by Becher et al., 1998 and Steenland et al., 2001 on the Hamburg and National Institute of Occupational Safety and Health (NIOSH) cohorts. Use of the recommended SF (USEPA, 2000) would result in an approximately 7-fold increase in the cancer risk estimates based on the current upper-bound SF (1.56 E+05) per mg/kg/day associated with 2,3,7,8-TCDD and other dioxin-like compounds. .

The epidemiological literature suggests an association with increases in all cancers combined, in respiratory tumors, and possibly in soft tissue sarcoma. USEPA found that a weight-of-evidence evaluation suggests that mixtures of 2,3,7,8-TCDD and other dioxin-like PCDDs, PCDFs, and PCBs are strong cancer promoters and weak direct or indirect tumor initiators.

Based on the most sensitive cancer responses in animal and human studies, USEPA estimated SFs ranging from approximately 1E+06 to 9E+06 $(mg/kg/day)^{-1}$. USEPA estimated an upper-bound SF of 1E+06 $(mg/kg/day)^{-1}$ based on human data from a meta-analysis of three occupational cohorts, and an upper bound SF of 1.4E+06 $(mg/kg/day)^{-1}$ based on animal data. Other analyses of these data have recently been published (Starr, 2001, 99-1301 and Crump, 2003, 99-1300). The shape of the low-dose exposure response relationship could not be determined from available data. Therefore, USEPA used a linear dose extrapolation model to derive upper-bound SF estimates.

Non-cancer Effects

USEPA (USEPA, 2000) evaluated the "margin-of-exposure" (MOE), for several toxicology studies on non-cancer effects (DeVito et al., 1995; Gray et al., 1997; Mabley et al., 1992 a,b,c; Murray et al., 1979; Narashimhan et al., 1994; Rier et al., 1993; Schantz et al., 1992; Schrenk et al., 1994; Sewall and Lucier, 1995; Smialowicz et al., 1994; Van Birgelen et al., 1995; Vecchi et al., 1983 Vogel et al., 1997; Walker et al., 1999). MOE is defined here as the ratio of the effect level in the comparison species to the current background human body burden. The effect level in the comparison species pertains to the body burden in laboratory species that results in some low level effect, such as a LOAEL, or the ED01 (the effective dose at which 1% of the tested population shows the effect in question). For the most sensitive endpoints identified, MOEs were found to range from, for example, less than one for enzyme induction in mice and rats, less than four for developmental effects and to four for endometriosis in nonhuman primates. In other words, the body burden in the laboratory species that showed a particular effect was only four times (and less) higher than the current body burden in humans. In evaluating MOEs, consideration should be given to uncertainties in distinguishing between adaptive biochemical changes and adverse effects, both on an individual level and as these changes impact whole populations. Children's non-cancer risks from dioxin and related compounds may be greater than for adults, but more data are needed to fully address this issue.

An RfD for dioxin-like compounds has not been developed. Further, USEPA (USEPA, 2000) concluded that an RfD for dioxin calculated in the manner typical of the way USEPA determines

RfDs would result in a dose that is significantly lower than current average background doses. RfDs are used primarily to evaluate increments of exposure from specific sources when background exposures are low and insignificant, and background exposures are not insignificant as indicated by the MOE discussion above.

This assessment quantifies non-cancer effects using RfDs to calculate HQs and hazard indices. Because an RfD has not been developed for PCDDs and PCDFs, the potential for non-cancer effects from exposure to dioxin-like compounds is not quantitatively evaluated in this assessment.

Alternative cancer risk estimates for the surface soil exposure pathway could be calculated in the same manner as discussed above, but using the 2,3,7,8-TCDD SF draft value ($1x10^6$/(mg/kg/day)) presented in the 2000 Dioxin Reassessment Document (USEPA, 2000). Using that SF, the estimated cancer risks associated with dioxin and furan exposure would be approximately 6.4 times higher than calculations presented in this assessment.

Evaluation of Chromium in Site Media

The most common forms of chromium in environmental media are chromium III (trivalent chromium) and chromium VI (hexavalent chromium). Although chromium was detected in Site media, no speciation analyses were performed. To provide a conservative assessment of toxicity and health risks associated with potential exposures to chromium, chromium data was evaluated as hexavalent chromium in this risk assessment.

Exposures to hexavalent chromium have been associated with chronic non-cancer health effects via ingestion, dermal contact, and inhalation, and allergic contact dermatitis via direct dermal contact with hexavalent-chromium containing materials. The chronic oral RfD of 0.003 mg/kg/day (IRIS, 2011) and the subchronic oral RfD of 0.02 mg/kg/day (USEPA, 1997b) have been applied to the estimated daily doses in order to characterize potential non-cancer risks for ingestion and dermal contact with soil. In the current USEPA IRIS file, hexavalent chromium is considered a carcinogen only from inhalation exposure, and since the inhalation exposure pathway is not complete at the Site, hexavalent chromium is only evaluated for non-carcinogenic effects in this risk assessment.

5.0 RISK CHARACTERIZATION

The final step of the risk assessment is the risk characterization. This step involves the integration of the exposure and toxicity assessment into quantitative expressions of potential human health risks associated with COPC exposure. Quantitative estimates of both carcinogenic and noncarcinogenic risks are made for each COPC in surface soil and at each exposure point (human health concern area and the general area).

Cancer Risks

Carcinogenic risks associated with exposure to individual chemicals are estimated by multiplying the chemical intake for each carcinogen by its SF. This value represents an upper bound of the probability of an individual developing cancer over a lifetime as the result of exposure to a chemical. For each receptor and each exposure pathway (exposure to a specific medium) such as dermal exposure to soil, the chemical-specific risks for all carcinogenic compounds will be summed to determine the lifetime cancer risk for that receptor for that medium. The following equations are used to estimate the chemical- and pathway-specific cancer risks.

Chemical-Specific Excess Lifetime Cancer Risk:

$$Risk_i = CDI_i \times SF_i$$

where:

$Risk_i$	=	unitless probability of an individual developing cancer as the result of exposure to a chemical i
CDI_i	=	chronic daily intake of chemical i averaged over 70 years (mg/kg/day)
SF_i	=	USEPA SF for chemical i $(mg/kg/day)^{-1}$

The results from the carcinogenic risk assessment are compared to acceptable risk ranges established by the USEPA. The USEPA's guidelines, established in the National Hazardous Substances and Pollution Contingency Plan (NCP) identify acceptable exposure levels as those concentration levels "that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} using information on the relationship between dose and response" (USEPA, 1990).

Non-cancer Risks

Non-cancer risk estimates are calculated by dividing specific chemical intake by the appropriate RfD. The result is called the HQ. The HQs for individual compounds within an exposure pathway are summed to obtain the hazard index (HI) for that particular pathway.

The following equation is used to determine the HQ:

$$HQ_i = \frac{I_i}{RfD_i}$$

where:

HQ_i	=	HQ of chemical i
I_i	=	intake of chemical i averaged over the exposure period (mg/kg/day)
RfD_i	=	RfD for chemical i corresponding to the same ED as the intake (mg/kg/day)

The following equation is used to determine the HI:

$$HI = \Sigma\ HQ_i$$

where:

HI	=	potential for noncarcinogenic effects from multiple chemical exposures
HQ_i	=	HQ for each chemical associated with exposure

An HI of less than 1 indicates that noncarcinogenic toxic effects are unlikely. An HI greater than 1 indicates a greater possibility of a noncarcinogenic toxic effect occurring, but the circumstances must be evaluated on a case-by-case basis. Generally, as the HI increases, so does the likelihood that adverse effects might be associated with exposure. However, the relationship between increased risk and larger HI values may not be linear.

Calculation of Non-cancer and Cancer Risks

RAGS Part D Table 7s are used to present the risk calculations. In simplistic terms, for a given receptor/age-group, cancer risks are calculated for each chemical in each medium (e.g., soil) and exposure route (e.g., ingestion, dermal contact). Risks across exposure routes are summed to yield the risk for that medium. Cancer risks associated with all exposure media for that receptor/age-group are summed to yield the cumulative receptor cancer risk for that receptor/age-group. For a

given receptor (by age-group), the non-cancer HI is calculated for each chemical, and exposure route for a given medium. HI values associated with all exposure media for each receptor/age-group are summed to yield the screening cumulative HI for that receptor/age-group. This summing of HI values across chemicals and exposure media is a conservative screening approach; because chemicals can have different target organs, non-cancer risks are not necessarily additives.

The calculated cancer risks and HI values for the Passive Recreational Visitor, all age-groups, are calculated in Tables 7.1 through 7.3 and Tables 7.4 through 7.6 for the human health concern area and the general area, respectively. For each receptor group, each of the age groups is presented in a separate table. The RAGS Part D Table 7s document the risk calculations by identifying the COPCs, EPCs, daily chemical intakes by chemical for cancer and non-cancer endpoints, the SFs and RfDs, and the calculated cancer risk and HQ for each chemical in each exposure medium. Further, the Table 7s present summed risks for each medium/exposure route combination and for each medium.

The risk calculation spreadsheets are presented in the following order.

Human Health Concern Area

- Passive Recreational Visitor – child, adolescent, adult – soil. Tables 7.1 through 7.3.

General Area

- Passive Recreational Visitor – child, adolescent, adult – soil. Tables 7.4 through 7.6.

There are no RAGS Part D Table 8s for this Supplemental BHHRA. Table 8s are specifically for the calculation of radiological risks. No radiological COPCs were identified in this assessment. Therefore, no Table 8s are required.

Summary of Non-cancer and Cancer Risks

RAGS Part D Table 9s summarize the information that is documented in the Table 7s. In addition, consistent with USEPA guidance (USEPA, 1989, 2001a), the Table 9s segregate the HI calculations by target organ system, and calculate a HI for each target organ system. This presentation of the HI calculations is an enhancement of the screening HI calculations presented previously in the Table 7s. RAGS Part D Tables 9.1 through 9.6 summarize the risk calculations that are documented in the Table 7s that were discussed previously.

Summary of Calculation of Receptor Risks

Table 11.1 summarizes the risks. This table presents the soil route-specific risks for each age-group for the Passive Recreational Visitor for each exposure area.

Human Health Concern Area

As shown in Table 11.1, the total (summed across age groups) soil cancer risk for the Passive Recreational Visitor in the human health concern area is 4×10^{-6}, which is within the Superfund cancer risk range. The highest non-cancer HI among the age groups in the human health concern area is 0.1, for the child Passive Recreational Receptor. This screening HI is below to the Superfund HI threshold value. The largest chemical contributor to the HI is ingestion of arsenic. Ingestion of soil by the child receptor contributes the largest cancer risk among exposure pathways. The largest chemical contributor to cancer risk is the dioxin TEQ.

General Area

As shown in Table 11.1, the total (summed across age groups) soil cancer risk for the Passive Recreational Visitor in the general area is 6×10^{-5}, which is within the Superfund cancer risk range. The highest non-cancer HI among the age groups in the general area is 0.2, for the child Passive Recreational Receptor. This screening HI is below the Superfund HI threshold value. The largest chemical contributor to the HI is ingestion of thallium. Ingestion of soil by the child receptor contributes the largest cancer risk among exposure pathways. The largest chemical contributor to cancer risk is the dioxin TEQ.

6.0 UNCERTAINTY ANALYSIS

This section includes a discussion of major limitations of the analyses, any sources of uncertainties, and, if possible, any indication as to whether these uncertainties and limitations may have resulted in and over- or under-estimation of risk. The uncertainty section also includes unusual site conditions or extenuating circumstances that may be pertinent to risk management decisions. Other factors such as the inadequacy of toxicity factors to describe all possible COPC-receptor interactions and individual differences within the human population are included in this section. Uncertainties in the quantification of risk associated with the site are identified and their impacts on risk estimates are discussed below.

Hazard Identification

Background conditions have not been specifically considered in the selection or elimination of substances as COPCs. Several of the persistent organic COPCs (such as dioxins, furans, and PCBs), while they are not naturally-occurring substances, are detectable at some concentration almost ubiquitously in environmental samples such as biota and sediments. Therefore, exposure concentrations of those COPCs represent "total" exposure potential from both site-related and non-site-related sources.

The lead concentration of 2,460 mg/kg from sample RES-11-012 was removed from the data set evaluated in the risk assessment because available information indicates it is not related to the Site. The CSM for the Site suggests the Oxbow Area has been impacted by deposition of suspended sediments during flooding. Lead concentrations in river sediments are lower than 2,460 mg/kg, suggesting this soil concentration is unrelated to the Site. Lead was not identified as a COPC in the risk assessment. If the lead concentration at RES-11-012 was included in the risk assessment, lead would have been identified as a COPC and the average lead concentration for the general area would be 247 mg/kg. Consistent with USEPA guidance the average lead concentration should be used to evaluate risks from lead. The average lead concentration for the general area included location RES-11-012 would be below the lead screening value of 400 mg/kg.

Exposure Assessment

The selection of receptors is conservative and health-protective for the conditions identified at the Site. The identification of the Passive Recreational Visitor to be evaluated is conservatively realistic for the current and likely future conditions at the Oxbow Area.

The values for receptor-specific exposure parameters such as soil contact rates and soil ingestion rates have been identified in a conservative manner. Default USEPA residential values have been applied to this passive recreational scenario. Values have been identified based on available guidance and professional judgment. In risk assessment, when values are assigned in lieu of actual measurements, there is some uncertainty in the values, and that uncertainty may have an impact on the results of the risk assessment. In that context, the exposure estimates and associated risk estimates in this assessment would likely be overestimated rather than underestimated. Some factors that were not specifically addressed in the calculations could result in lower risk estimates.

The EF of 26 days per year was used for the general area because it is assumed that the general area is more difficult to access and a less desirable area for recreational activities. There is some uncertainty in this assumption. Recently there appears to be some evidence of a more frequent activity such as deep rutted terrain and freshly exposed soils. Also some soil sample locations (RES-11-011 and RES-11-012) are at residential properties. If these locations are easily accessible from the residential structures, then inclusion of them in the general area exposure area and the use of a 26 day per year EF may underestimate exposure and risk.

Toxicity Assessment

The toxicity assessment has been conducted consistently with available USEPA guidance. Dose-response information has been obtained from the IRIS database, NCEA, and USEPA's HEAST. These sources of dose-response values are commonly used for regulatory risk assessment activities and are generally considered to be conservative in nature. The use of surrogate toxicity values for chemicals lacking USEPA recommended values is conservative because it is likely that the chemical specific toxicity would be lower than those exhibited by their surrogate.

Dioxin and Furan Congeners

Dioxin and furan congeners have been evaluated using the 2,3,7,8-TCDD oral SF of 1.5×10^5 per mg/kg/day (USEPA, 1997b) and the mammalian TEFs (USEPA, 2010a). This approach represents the most recent risk assessment approach for evaluating dioxins and furans. This approach has been employed because there is not adequate toxicity testing for each of the hundreds of dioxin and furan congeners. Although the TEFs do have scientific basis, the use of the TEFs to estimate the cancer potency of each of the congeners does have some uncertainty associated with it. However, the predominant congener in environmental media at the four exposure points is 2,3,7,8-TCDD.

Because 2,3,7,8-TCDD is considered to be the most toxic of the dioxin and furan congeners, the use of the TEFs has less impact on the risk assessment than would be the case where 2,3,7,8-TCDD was not the predominant congener and other congeners without published SFs were the focus of the assessment.

The oral SF for dioxin that was utilized in this assessment is taken from HEAST, 1997. The USEPA's *Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds, Draft* from September 2000 identifies another potential SF of 1 x 10^6 per mg/kg/day. Using the alternative SF, the cancer risk for surface soil exposure would increase by a factor of approximately 6.4.

Non-cancer risk was not quantitatively evaluated for potential exposures to dioxins and furans. There is not currently a published USEPA oral RfD available for 2,3,7,8-TCDD, any other dioxin or furan congener. USEPA has concluded that the current average dioxin exposure to the human population is greater than the RfDs that would be calculated based on available data. USEPA, therefore, concluded that RfD values would not be informative for safety assessment (USEPA, 2000). Non-cancer effects such as effects on reproduction and development, suppression of the immune system, and chloracne (USEPA, 2000) have been associated with these compounds in animal studies and it is likely that similar effects might occur with human exposure. Therefore, the non-cancer risk associated with potential exposure to dioxins and furans are understated in this Supplemental BHHRA.

Risk Characterization

The risks have been compared to Superfund risk management criteria and benchmarks in order to draw conclusions concerning the Site-related risks. More than 99% of the cancer risk for the Passive Recreational Visitor at the Oxbow Area is associated with the dioxin TEQ in soil. Although the dioxin TEQ is clearly the predominant contributor to cancer risk at the Site, it is also clear that the congener 2,3,7,8-TCDD is by far the major risk contributor to the dioxin TEQ.

The data used in the general area for the risk characterization included four sample clusters (RES-11-011, RES-11-012, SS_G-01, and SS_G-29). At each of these samples clusters the concentrations of each compound was averaged to obtain a single concentration to be used in calculating EPCs. To evaluate the impact of averaging concentrations in these clusters an alternate EPC for dioxin-TEQ was calculated using the maximum detected concentration within each

cluster. The EPC used in the risk assessment for the general area for dioxin-TEQ was 0.0028 mg/kg. If the maximum concentration was used for dioxin-TEQ at each of the four sample clusters in calculating the EPC, the revised EPC would be 0.0043 mg/kg. The EPC using maximum concentrations is approximately 1.5 times greater than the EPC using averaged concentrations. Using the revised EPC to calculate cancer risks for the general area would result in a cancer risk of 9×10^{-5} (6×10^{-5} times 1.5). Therefore if the maximum concentration had been used at each sample cluster for dioxin-TEQ the cancer risk would still be within the Superfund cancer risk range.

Overall, the risk characterization provides conservative estimates of non-cancer and cancer risks consistent with USEPA risk assessment guidance (USEPA, 1989).

7.0 CONCLUSIONS

The potential risks associated with current and future soil exposure for Passive Recreational Visitors to the human health concern area and the general area have been characterized. The risk characterization included the evaluation of exposure to soil at the human health concern area and the general area. Risks have been calculated using a RME exposure scenario. The calculated risks have been compared to the Superfund cancer risk range of 10^{-6} to 10^{-4} and to a HI value of 1.

The following conclusions have been drawn.

- The calculated total (all age groups summed) receptor cancer risk for soil exposure at the human health concern and general areas is within the Superfund risk range of 10^{-6} to 10^{-4}.
- Ingestion of soil is the pathway that is the largest contributor to cancer risk in both areas.
- Dioxins and furans (particularly 2,3,7,8-TCDD) are the largest contributors to cancer risk for the soil exposure scenario in both areas.
- The non-cancer HI is less than one for each age group for the Passive Recreational Visitor for both the human health concern area and the general area.

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TABLES

Table ES-1
Risk Assessment Summary

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Scenario	Receptor	Exposure Point	Exposure Route	Excess Lifetime Cancer Risk	Hazard Index
Current/Future - Human Health Concern Area					
Passive Recreational Visitor	Child (ages 1 through 6)	Soil	Incidental ingestion	2.4E-06	0.1
			Dermal contact	3.6E-07	0.004
			Total Risk:	**2.7E-06**	**0.1**
	Adolescent (ages 7 through 18)	Soil	Incidental ingestion	7.0E-07	0.02
			Dermal contact	3.1E-07	0.002
			Total Risk:	**1.0E-06**	**0.02**
	Adult (ages 19 and above)	Soil	Incidental ingestion	4.1E-07	0.01
			Dermal contact	6.1E-08	0.0005
			Total Risk:	**4.8E-07**	**0.01**
			Total Receptor Risk:	**4E-06**	**NC**
Current/Future - General Area					
Passive Recreational Visitor	Child (ages 1 through 6)	Soil	Incidental ingestion	3.9E-05	0.1
			Dermal contact	1.5E-06	0.006
			Total Risk:	**4.1E-05**	**0.2**
	Adolescent (ages 7 through 18)	Soil	Incidental ingestion	1.2E-05	0.02
			Dermal contact	1.1E-06	0.003
			Total Risk:	**1.4E-05**	**0.03**
	Adult (ages 19 and above)	Soil	Incidental ingestion	7.7E-06	0.02
			Dermal contact	1.3E-07	0.0009
			Total Risk:	**7.9E-06**	**0.02**
			Total Receptor Risk:	**6E-05**	**NC**

Prepared by: BJR 4/1/11
Checked by: KJC 4/1/11

Table 1.1
Baseline Human Health Risk Assessment Approach

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Timeframe	Receptor	Exposure Point	Activity	Exposure Medium	Exposure Route	Previous Evaluations	RI/FS Approach
Current/Future	Recreational Visitor	Human Health Concern Area	Passive Recreation	Surface Soil	Direct contact (ingestion and dermal contact	None	Will be considered in the FS.
				Surface soil	Inhalation of particulates and vapors	None	Because the area is a forested wetland and soils would typically have high moisture content, evaluation of dust exposure for passive recreational activities is not necessary.
Current/Future	Recreational Visitor	General Area	Passive Recreation	Floodplain Surface Soil	Direct contact (ingestion and dermal contact	Screening risk assessment (limited data set)	Will be considered in the FS.
				Surface soil	Inhalation of particulates and vapors	None	Because the area is a forested wetland and soils would typically have high moisture content, evaluation of dust exposure for passive recreational activities is not necessary.

Prepared by: BJR
Checked by: MJM

Table 1.2
Exposure Pathway Summary

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point and Receptor Population	Receptor Age	Scenario Timeframe	Potential Exposure Medium And Relevant Pathways			
			Sediment	Surface Water	Flood Plain Surface Soil	Fish
Human Health Concern Area						
Passive Recreational Visitor	Child, Adolescent, Adult	C/F	--	--	ING, DERM	--
General Area						
Passive Recreational Visitor	Child, Adolescent, Adult	C/F	-	--	ING, DERM	--

Notes:
Timeframe:
C - current land use
F - future land use
Pathways:
DERM - exposure via dermal contact
ING - exposure via incidental ingestion
Quan - exposure pathway will be evaluated quantitatively
"--" indicates that the pathway is not evaluated .

Prepared by: BJR
Checked by: MJM

Table 2.1
Data Summary of Detected Parameters and Selection of Chemicals of Potential Concern - Oxbow Area - Surface Soil (0-1 ft bgs)
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)		Maximum (1) Concentration (Qualifier)		Units	Location of Maximum Concentration	Frequency of Detection	Range of Reporting Limits for Non Detects	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value (5)	Potential ARAR/TBC Source	Retain as COPC? (6)	Rationale for Contaminant Deletion or Selection
	Semivolatile Organics																
95-95-4	2,4,5-Trichlorophenol	0.0016	J	0.013	J	mg/Kg	SS_G-01	3 / 28	0.0015 : 2.6	0.013		610	n			No	BSL
88-06-2	2,4,6-Trichlorophenol	0.0052	J	0.0052	J	mg/Kg	SS_G-02	1 / 27	0.0014 : 0.65	0.0052		6.1	n[a]			No	BSL
121-14-2	2,4-Dinitrotoluene	0.034		0.034		mg/Kg	SS_H-19	1 / 27	0.0015 : 0.65	0.034		1.6	c*			No	BSL
91-57-6	2-Methylnaphthalene	0.0025	J	0.029	J	mg/Kg	SS_G-29	9 / 28	0.0022 : 0.65	0.029		31	n			No	BSL
83-32-9	Acenaphthene	0.0018	J	0.12	J	mg/Kg	RES-11-012 SS_G-29	16 / 28	0.0014 : 0.53	0.12		340	n			No	BSL
208-96-8	Acenaphthylene	0.0044	J	0.72		mg/Kg	SS_G-23	28 / 28		0.72		170	n			No	BSL
120-12-7	Anthracene	0.0042	J	0.62		mg/Kg	SS_G-29	25 / 28	0.008 : 0.016	0.62		1700	n			No	BSL
56-55-3	Benz(a)anthracene	0.016		2.4		mg/Kg	SS_G-29	28 / 28		2.4		0.15	c			Yes	ASL
100-52-7	Benzaldehyde	0.0087	J	0.018	J	mg/Kg	SS_G-14	7 / 28	0.0077 : 0.65	0.018		780	ns			No	BSL
50-32-8	Benzo(a)pyrene	0.015		2.8		mg/Kg	SS_G-29	22 / 28	0.03 : 0.088	2.8		0.015	c			Yes	ASL
205-99-2	Benzo(b)fluoranthene	0.024		3.6		mg/Kg	SS_G-29	28 / 28		3.6		0.15	c			Yes	ASL
191-24-2	Benzo(g,h,i)perylene	0.015		2.3		mg/Kg	SS_G-23	28 / 28		2.3		170	n			No	BSL
207-08-9	Benzo(k)fluoranthene	0.011		2.7	J	mg/Kg	RES-11-012	28 / 28		2.7		1.5	c			Yes	ASL
65-85-0	Benzoic Acid	0.11	J	0.8		mg/Kg	SS_G-06	9 / 18	0.096 : 2	0.8		24000	nm			No	BSL
100-51-6	Benzyl Alcohol	0.0039	J	0.058	J	mg/Kg	SS_G-04	8 / 25	0.0021 : 0.077	0.058		610	n			No	BSL
92-52-4	Biphenyl	0.0024	J	0.00328	J	mg/Kg	LPX-FP-4004	2 / 28	0.0019 : 0.65	0.00328		390	ns			No	BSL
117-81-7	Bis(2-ethylhexyl) Phthalate	0.0073	J	2.9		mg/Kg	RES-11-012	24 / 28	0.035 : 0.18	2.9		35	c*			No	BSL
85-68-7	Butyl Benzyl Phthalate	0.0052	J	0.62	J	mg/Kg	RES-11-012	23 / 28	0.016 : 0.53	0.62		260	c*			No	BSL
86-74-8	Carbazole	0.0034	J	0.36	J	mg/Kg	SS_G-29	25 / 28	0.0065 : 0.013	0.36						Yes	NSL
218-01-9	Chrysene	0.024		2.9		mg/Kg	SS_G-29	28 / 28		2.9		15	c			No	BSL
53-70-3	Dibenz(a,h)anthracene	0.0025	J	0.49		mg/Kg	SS_G-23	23 / 28	0.0015 : 0.015	0.49		0.015	c			Yes	ASL
132-64-9	Dibenzofuran	0.0013	J	0.093	J	mg/Kg	RES-11-012	16 / 28	0.0012 : 0.53	0.093		7.8	n			No	BSL
131-11-3	Dimethyl Phthalate	0.025	J	0.13	J	mg/Kg	SS_G-23	10 / 27	0.001 : 0.65	0.13						Yes	NSL
84-74-2	Di-n-butyl Phthalate	0.0084	J	0.093	JEB	mg/Kg	RES-11-012	4 / 28	0.0079 : 0.53	0.093		610	n			No	BSL
206-44-0	Fluoranthene	0.037		5		mg/Kg	SS_G-29	28 / 28		5		230	n			No	BSL
86-73-7	Fluorene	0.0011	J	0.2	J	mg/Kg	SS_G-29	22 / 28	0.0011 : 0.015	0.2		230	n			No	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	0.014		2.1		mg/Kg	SS_G-23	28 / 28		2.1		0.15	c			Yes	ASL
91-20-3	Naphthalene	0.0026	J	0.05	J	mg/Kg	SS_G-29	13 / 28	0.0023 : 0.65	0.05		3.6	c*			No	BSL
98-95-3	Nitrobenzene	0.01	J	0.01	J	mg/Kg	SS_G-01	1 / 27	0.0022 : 0.65	0.01		4.8	c*			No	BSL
85-01-8	Phenanthrene	0.018		2.8		mg/Kg	SS_G-29	28 / 28		2.8		170	n			No	BSL
108-95-2	Phenol	0.0029	J	0.033	J	mg/Kg	SS_G-04	4 / 28	0.002 : 0.65	0.033		1800	n			No	BSL
129-00-0	Pyrene	0.037		5		mg/Kg	RES-11-012	28 / 28		5		170	n			No	BSL
	Pesticides/PCBs																
72-54-8	4,4'-DDD	0.00013	J	0.02658		mg/Kg	LPX-SD-4407	11 / 30	0.00011 : 0.0054	0.02658		2	c			No	BSL
72-55-9	4,4'-DDE	0.0004	J	0.04236		mg/Kg	LPX-SD-4407	29 / 30	0.0054 : 0.0054	0.04236		1.4	c			No	BSL
50-29-3	4,4'-DDT	0.00053	J	0.033	J	mg/Kg	SS_G-01	25 / 30	0.00058 : 0.0059	0.033		1.7	c*			No	BSL
309-00-2	Aldrin	0.00097		0.0034	P	mg/Kg	RES-11-012	2 / 30	0.00016 : 0.00526	0.0034		0.029	c*			No	BSL
319-84-6	alpha-BHC	0.00011	J	0.00027	J	mg/Kg	SS_G-23	4 / 30	0.00011 : 0.00526	0.00027		0.077	c			No	BSL
5103-71-9	alpha-Chlordane	0.00012	J	0.03		mg/Kg	SS_G-23	17 / 30	0.0001 : 0.0028	0.03		1.6	c*			No	BSL
57-74-9	Chlordane	0.0061	J	0.54		mg/Kg	SS_G-23	10 / 28	0.0019 : 0.031	0.54		1.6	c*			No	BSL
319-86-8	delta-BHC	0.00024	J	0.00024	J	mg/Kg	SS_G-29	1 / 30	0.000074 : 0.00526	0.00024						No	FOD
60-57-1	Dieldrin	0.00022	J	0.01313	J	mg/Kg	LPX-FP-4004	9 / 30	0.00014 : 0.0066	0.01313		0.03	c			No	BSL
959-98-8	Endosulfan I	0.00013	J	0.0016	J	mg/Kg	SS_G-01	2 / 30	0.000063 : 0.00526	0.0016		37	n			No	BSL
33213-65-9	Endosulfan II	0.00034	J	0.0039	J	mg/Kg	SS_G-29	4 / 30	0.00014 : 0.0066	0.0039		37	n			No	BSL
1031-07-8	Endosulfan Sulfate	0.00028	J	0.0103	J	mg/Kg	LPX-FP-4004	7 / 30	0.00011 : 0.034	0.0103		37	n			No	BSL
72-20-8	Endrin	0.00021	J	0.0011		mg/Kg	SS_G-18	6 / 30	0.000094 : 0.0066	0.0011		1.8	n			No	BSL
7421-93-4	Endrin Aldehyde	0.00023	J	0.0019		mg/Kg	LPX-SD-4407	7 / 30	0.00012 : 0.0066	0.0019		1.8	n			No	BSL
53494-70-5	Endrin Ketone	0.00032	J	0.016		mg/Kg	RES-11-012	5 / 30	0.000093 : 0.0054	0.016		1.8	n			No	BSL
58-89-9	gamma-BHC (Lindane)	0.00018	J	0.0011		mg/Kg	SS_G-01	4 / 30	0.00008 : 0.00526	0.0011		0.52	c*			No	BSL
5103-74-2	gamma-Chlordane	0.000098	J	0.045		mg/Kg	SS_G-23	20 / 30	0.00009 : 0.00526	0.045		1.6	c*			No	BSL
76-44-8	Heptachlor	0.0062		0.0062		mg/Kg	SS_G-23	1 / 30	0.00012 : 0.00526	0.0062		0.11	c			No	BSL
1024-57-3	Heptachlor Epoxide	0.000085	J	0.026		mg/Kg	RES-11-012	9 / 30	0.000084 : 0.00526	0.026		0.053	c*			No	BSL
11097-69-1	Aroclor 1254	0.0077	J	0.74614	J	mg/Kg	LPX-FP-4004	13 / 30	0.0021 : 0.055	0.74614		0.11	n[a]			Yes	ASL
11096-82-5	Aroclor 1260	0.062		0.12		mg/Kg	SS_G-09	2 / 30	0.0021 : 0.067	0.12		0.22	c			No	BSL
11100-14-4	Aroclor 1268	0.02		0.1131	J	mg/Kg	LPX-FP-4004	4 / 28	0.0021 : 0.02028	0.1131						Yes	NSL
	Inorganics																
7429-90-5	Aluminum	3520		14791	J	mg/Kg	LPX-FP-4004	3 / 3		14791		7700	n			Yes	ASL

Table 2.1
Data Summary of Detected Parameters and Selection of Chemicals of Potential Concern - Oxbow Area - Surface Soil (0-1 ft bgs)
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

CAS Number	Chemical	Minimum (1) Concentration (Qualifier)		Maximum (1) Concentration (Qualifier)		Units	Location of Maximum Concentration	Frequency of Detection	Range of Reporting Limits for Non Detects	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (4)		Potential ARAR/TBC Value (5)	Potential ARAR/TBC Source	Retain as COPC? (6)	Rationale for Contaminant Deletion or Selection
7440-36-0	Antimony	0.086		2.8		mg/Kg	LPX-SD-4407	23 / 30	0.08 : 1.2	2.8		3.1	n			No	BSL
7440-38-2	Arsenic	1.7	J	13.3		mg/Kg	SS_G-02	30 / 30		13.3		0.39	c*			Yes	ASL
7440-39-3	Barium	13		288		mg/Kg	LPX-SD-4407	30 / 30		288		1500	n			No	BSL
7440-41-7	Beryllium	0.24	J	3.46		mg/Kg	LPX-SD-4407	28 / 30	0.24 : 0.35	3.46		16	n			No	BSL
7440-43-9	Cadmium	0.04	J	3.77		mg/Kg	LPX-SD-4407	26 / 30	0.04 : 0.05	3.77		7	n			No	BSL
7440-70-2	Calcium	2700		3860		mg/Kg	RES-11-012	2 / 2		3860						No	E
7440-47-3	Chromium	3.88	J	52		mg/Kg	SS_G-29	30 / 30		52		0.29	c			Yes	ASL
7440-48-4	Cobalt	0.75		10		mg/Kg	SS_G-03	30 / 30		10		2.3	n			Yes	ASL
7440-50-8	Copper	4.8		251		mg/Kg	RES-11-012	30 / 30		251		310	n			No	BSL
7439-89-6	Iron	7790		18264		mg/Kg	LPX-FP-4004	3 / 3		18264		5500	n			No	E
7439-92-1	Lead	21.7		334		mg/Kg	SS_G-07	29 / 29		334		400	nL			No	BSL
7439-95-4	Magnesium	955		2560		mg/Kg	RES-11-012	2 / 2		2560						No	E
7439-96-5	Manganese	40.5		2440		mg/Kg	SS_G-03	30 / 30		2440		180	n			Yes	ASL
7439-97-6	Mercury	0.209		0.209		mg/Kg	LPX-FP-4004	1 / 3	0.12 : 0.18	0.209		2.3	n			No	BSL
22967-92-6	Methyl Mercury	0.000767	J	0.000767	J	mg/Kg	LPX-FP-4004	1 / 1		0.000767		0.78	n			No	BSL
7439-98-7	Molybdenum	1.05		11.1		mg/Kg	SS_G-01	21 / 28	0.63 : 1.07	11.1		39	n			No	BSL
7440-02-0	Nickel	2.05	J	148	J	mg/Kg	SS_G-04	30 / 30		148		150	n			No	BSL
7440-09-7	Potassium	316		792		mg/Kg	RES-11-012	2 / 2		792						No	E
7782-49-2	Selenium	0.1	J	1.78		mg/Kg	LPX-SD-4407	27 / 30	0.1 : 1.8	1.78		39	n			No	BSL
7440-22-4	Silver	0.2	J	5.7	J	mg/Kg	RES-11-012	11 / 30	0.2 : 0.9	5.7		39	n			No	BSL
7440-23-5	Sodium	112		234		mg/Kg	RES-11-012	2 / 2		234						No	E
7440-28-0	Thallium	0.279		0.7		mg/Kg	SS_G-04	4 / 30	0.4 : 2.5	0.7						Yes	NSL
7440-62-2	Vanadium	12		62.7		mg/Kg	LPX-SD-4407	30 / 30		62.7		39	n			Yes	ASL
7440-66-6	Zinc	11.5		574		mg/Kg	RES-11-012	30 / 30		574		2300	n			No	BSL
	Dioxin TEQs																
1746-01-6	Dioxin TEQ - Mammal	0.0000015		0.0064		mg/Kg	SS_G-01	32 / 32		0.0064		0.0000045	c*			Yes	ASL
	HCX	0.00000077	J	0.00026	J	mg/Kg	LPX-FP-4004	4 / 4		0.00026		0.0000045	c*			Yes	ASL
	PCB TEQ USEPA, 2010	0.0000050		0.0000050		mg/Kg	LPX-FP-4004	1 / 1		0.0000050		0.000034	c*			No	BSL

(1) Minimum or maximum concentration detected in data set. Samples included in data set are identified in Appendix B.
(2) The concentration used for screening is the maximum detected concentration.
(3) There are no background values associated with this site.
(4) Values are the Regional Screening Levels (RSLs) obtained from USEPA November 11, 2010.
Values used for screening are the residential soil RSLs for the lesser of cancer risks equal to 1E-06 or non-cancer risks equal to a hazard index of 0.1.
RSL for pyrene used for phenanthrene, acenaphthylene, benzo(ghi)perylene.
RSL for chlordane used for alpha-chlordane and gamma-chlordane
RSL for endosulfan used for endosulfan sulfate, endosulfan I and endosulfan II.
RSL for endrin used for endrin ketone and endrin aldehye.
RSL for chromium (VI) used for chromium.
RSL for mercuric chloride used for mercury.
RSL for vanadium and compounds used for vanadium.
RSL for 2,3,7,8-TCDD used for dioxin TEQ - mammal and HCX
n - RSL is based on a non-cancer hazard quotient of 0.1.
c - RSL is based on an excess lifetime cancer risk of 1 in 1 million.
c* - where n RSL < 100X c RSL.
n[a] - Value is based on a non-cancer endpoint because RSL at a hazard index of 0.1 is lower than RSL at cancer risk equal to 1E-06.
ns - RSL is based on a non-cancer hazard quotient of 0.1; concentration may exceed Csat.
nm - RSL is based on a non-cancer hazard quotient of 0.1; concentration may exceed ceiling limit.
(5) There are no Applicable or Relevant and Appropriate Requirements / To Be Considered (ARAR/TBC) for soil.
(6) Analyte is selected as a COPC if the concentration used for screening exceeds the RSL or if no screening value is available.
ASL - Concentration used for screening is greater than the screening toxicity value; the analyte was selected as a COPC.
BSL - Concentration used for screening is less than the screening toxicity value; the analyte was not selected as a COPC.
NSL - No screening level available; the anlayte was selected as a COPC.
FOD - Analyte detected in less than 5% of the samples.
E - Compound is an essential nutrient.
mg/Kg - milligrams per kilogram.
COPC - Chemical of potential concern.
EB - Compound detected in the associated equipment rinsate blank.
J - Value is estimated.

Prepared by / Date: BJR 3/30/11
Checked by / Date: KASK 3/31/11

Table 3.1
Exposure Point Concentrations - Surface Soil (0-1 ft)
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Potential Concern (1)	Units	Arithmetic Mean	95% UCL (2) (calculation)		Maximum Detected Concentration (qualifier)		Exposure Point Concentration			
								EPC	Units	Statistic	Rationale
Human Health Concern Area	**Semivolatile Organics**										
	Benz(a)anthracene	mg/Kg	0.027	0.033	G [a]	0.04		0.033	mg/Kg	UCL - G [a]	(3)
	Benzo(a)pyrene	mg/Kg	0.031	0.056	NP [c]	0.072		0.056	mg/Kg	UCL - NP [c]	(3)
	Benzo(b)fluoranthene	mg/Kg	0.051	0.062	N [h]	0.08		0.062	mg/Kg	UCL - N [h]	(3)
	Benzo(k)fluoranthene	mg/Kg	0.017	0.019	N [h]	0.025		0.019	mg/Kg	UCL - N [h]	(3)
	Carbazole	mg/Kg	0.0049	0.0060	NP [d]	0.0081		0.0060	mg/Kg	UCL - NP [d]	(3)
	Dibenz(a,h)anthracene	mg/Kg	0.0042	0.0061	NP [c]	0.0083		0.0061	mg/Kg	UCL - NP [c]	(3)
	Dimethyl Phthalate	mg/Kg	0.0039		NC [j]	0.030	J	0.030	mg/Kg	Maximum	(4)
	Indeno(1,2,3-cd)pyrene	mg/Kg	0.032	0.039	N [h]	0.053		0.039	mg/Kg	UCL - N [h]	(3)
	Inorganics										
	Arsenic	mg/Kg	3.0	4.4	N [i]	8.9		4.4	mg/Kg	UCL - N [i]	(3)
	Chromium	mg/Kg	5.4	6.1	N [h]	7.8		6.1	mg/Kg	UCL - N [h]	(3)
	Cobalt	mg/Kg	1.5	1.7	N [h]	2.2		1.7	mg/Kg	UCL - N [h]	(3)
	Manganese	mg/Kg	222	391	G [a]	721	J	391	mg/Kg	UCL - G [a]	(3)
	Vanadium	mg/Kg	18.0	20	N [h]	26		20	mg/Kg	UCL - N [h]	(3)
	Dioxin TEQs										
	Dioxin-TEQ Mammal	mg/Kg	0.0000039	0.0000051	N [h]	0.0000087		0.0000051	mg/Kg	UCL - N [h]	(3)
General Area	**Semivolatile Organics**										
	Benz(a)anthracene	mg/Kg	0.50	0.88	G [a]	2.4		0.88	mg/Kg	UCL - G [a]	(3)
	Benzo(a)pyrene	mg/Kg	0.65	1.1	G [a]	2.8		1.1	mg/Kg	UCL - G [a]	(3)
	Benzo(b)fluoranthene	mg/Kg	0.93	1.6	G [a]	3.6		1.6	mg/Kg	UCL - G [a]	(3)
	Benzo(k)fluoranthene	mg/Kg	0.48	0.89	G [a]	2.7	J	0.89	mg/Kg	UCL - G [a]	(3)
	Carbazole	mg/Kg	0.083	0.14	G [a]	0.36	J	0.14	mg/Kg	UCL - G [a]	(3)
	Dibenz(a,h)anthracene	mg/Kg	0.11	0.18	G [a]	0.49		0.18	mg/Kg	UCL - G [a]	(3)
	Dimethyl Phthalate	mg/Kg	0.073	0.073	NP [c]	0.13	J	0.073	mg/Kg	UCL - NP [c]	(3)
	Indeno(1,2,3-cd)pyrene	mg/Kg	0.45	0.75	G [a]	2.1		0.75	mg/Kg	UCL - G [a]	(3)
	Pesticides/PCBs										
	Aroclor 1254	mg/Kg	0.14	0.18	NP [f]	0.75		0.18	mg/Kg	UCL - NP [f]	(3)
	Aroclor 1268	mg/Kg	0.012	0.026	NP [c]	0.11		0.026	mg/Kg	UCL - NP [c]	(3)

Table 3.1
Exposure Point Concentrations - Surface Soil (0-1 ft)
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Point	Chemical of Potential Concern (1)	Units	Arithmetic Mean	95% UCL (2) (calculation)		Maximum Detected Concentration (qualifier)		Exposure Point Concentration			
								EPC	Units	Statistic	Rationale
	Inorganics										
	Aluminum	mg/Kg	9,637		NC [k]	14,791	J	14,791	mg/Kg	Maximum	(4)
	Arsenic	mg/Kg	5.8	7.0	G [a]	13.3		7.0	mg/Kg	UCL - G [a]	(3)
	Chromium	mg/Kg	26	32	N [h]	52		32	mg/Kg	UCL - N [h]	(3)
	Cobalt	mg/Kg	5.0	6.2	N [h]	10.0		6.2	mg/Kg	UCL - N [h]	(3)
	Manganese	mg/Kg	721	1,026	G [a]	2,440		1,026	mg/Kg	UCL - G [a]	(3)
	Thallium	mg/Kg	0.36	0.45	NP [c]	0.70		0.45	mg/Kg	UCL - NP [c]	(3)
	Vanadium	mg/Kg	28	33	G [a]	62.7		33	mg/Kg	UCL - G [a]	(3)
	Dioxin TEQs										
	HCX	mg/Kg	0.000000022		NC [k]	0.000000052		0.000000052	mg/Kg	Adjusted	(6)
	Dioxin-TEQ Mammal	mg/Kg	0.0014	0.0028	G [b]	0.0064		0.0028	mg/Kg	UCL - G [b]	(3)

Prepared by / Date: BJR 3/31/11
Checked by / Date: KASK 3/31/11

NOTES:
(1) Chemicals of potential concern (COPCs) are identified in Table 2.1.
(2) 95% UCL is calculated using ProUCL software (V. 4.1.00); calculations presented in Appendix D.

G - Gamma distribution
[a] 95% Approximate Gamma UCL
[b] 95% Adjusted Gamma UCL

NP - Non-Parametric distribution
[c] 95% KM (Percentile Bootstrap) UCL
[d] 95% KM (t) UCL
[e] 95% KM (Chebyshev) UCL
[f] 95% KM (BCA) UCL
[g] 95% Chebyshev (Mean, Sd) UCL

N - Normal distribution
[h] 95% Student's-t UCL
[i] 95% Modified-t UCL

NC - Not Calculated
[j] Only one distinct data value was detected
[k] Dataset too small to calculate UCL

(3) The 95% UCL is used as the EPC because the calculated 95% UCL is less than the maximum detected concentration.
(4) The maximum detected concentration is used as the EPC because it is lower than the calculated 95% UCL, or no 95% UCL is calculated.
(5) In accordance with USEPA guidance for evaluating lead exposure, the arithmetic mean concentration is used as the EPC.
(6) HCX EPC has been adjusted using a TEF of 0.0002.
EPC = Exposure Point Concentration
UCL = Upper Confidence Limit on the arithmetic mean
J = Value is estimated
mg/Kg = milligrams per kilogram

Table 4.1
Values Used For Daily Intake Calculations

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SOIL
EXPOSURE MEDIUM: SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	PASSIVE RECREATIONAL VISITOR	ADULT (ages 19 and above)	HUMAN HEALTH CONCERN AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION = CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994	
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[1]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[2,3]	
				BW	BODY WEIGHT	70	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	*CONVERSION FACTOR*	*0.000001*	kg/mg		
		ADOLESCENT (ages 7 - 18)	HUMAN HEALTH CONCERN AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION = CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994	
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[1]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	45	kg	USEPA, 1997[4]	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		CHILD (ages 1 - 6)	HUMAN HEALTH CONCERN AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION = CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				IR-S	INGESTION RATE OF SOIL	200	mg/day	USEPA, 1994	
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[1]	
				ED	EXPOSURE DURATION	6	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	15	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		ADULT (ages 19 and above)	GENERAL AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION = CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994	
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	26	day/yr	Professional Judgement[5]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[2,3]	
				BW	BODY WEIGHT	70	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		ADOLESCENT (ages 7 - 18)	GENERAL AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION = CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				IR-S	INGESTION RATE OF SOIL	100	mg/day	USEPA, 1994	
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	26	day/yr	Professional Judgement[5]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	45	kg	USEPA, 1997[4]	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		

Table 4.1
Values Used For Daily Intake Calculations

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SOIL
EXPOSURE MEDIUM: SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION (cont)	PASSIVE RECREATIONAL VISITOR (cont)	CHILD (ages 1 - 6)	GENERAL AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-INGESTION =
				IR-S	INGESTION RATE OF SOIL	200	mg/day	USEPA, 1994	CS x IR-S x FI x EF x ED x CF x 1/BW x 1/AT
				FI	FRACTION INGESTED	1	unitless	Professional Judgement	
				EF	EXPOSURE FREQUENCY	26	day/yr	Professional Judgement[5]	
				ED	EXPOSURE DURATION	6	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	15	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
DERMAL	PASSIVE RECREATIONAL VISITOR	ADULT (ages 19 and above)	HUMAN HEALTH CONCERN AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
				AF	ADHERENCE FACTOR	0.07	mg/cm2	USEPA, 2001[6]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]	
				SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	5700	cm2/day	USEPA, 2001[8]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[1]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[2,3]	
				BW	BODY WEIGHT	70	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		ADOLESCENT (ages 7 - 18)	HUMAN HEALTH CONCERN AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
				AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[6]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]	
				SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	4800	cm2/day	USEPA, 1997[9]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[1]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	45	kg	USEPA, 1997[4]	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		CHILD (ages 1 - 6)	HUMAN HEALTH CONCERN AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
				AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[6]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]	
				SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	2800	cm2/day	USEPA, 2001[8]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	78	day/yr	Professional Judgement[1]	
				ED	EXPOSURE DURATION	6	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	15	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		

Table 4.1
Values Used For Daily Intake Calculations

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: CURRENT/FUTURE
MEDIUM: SOIL
EXPOSURE MEDIUM: SOIL

EXPOSURE ROUTE	RECEPTOR POPULATION	RECEPTOR AGE	EXPOSURE POINT	PARAMETER CODE	PARAMETER DEFINITION	VALUE	UNITS	RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
DERMAL		ADULT	GENERAL AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
(cont)	PASSIVE RECREATIONAL VISITOR	(ages 19 and above)		AF	ADHERENCE FACTOR	0.07	mg/cm2	USEPA, 2001[6]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
	(cont)			AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]	
				SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	5700	cm2/day	USEPA, 2001[8]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	26	day/yr	Professional Judgement[5]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[2,3]	
				BW	BODY WEIGHT	70	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		ADOLESCENT	GENERAL AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
		(ages 7 - 18)		AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[6]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]	
				SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	4800	cm2/day	USEPA, 1997[9]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	26	day/yr	Professional Judgement[5]	
				ED	EXPOSURE DURATION	12	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	45	kg	USEPA, 1997[4]	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	4380	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		
		CHILD	GENERAL AREA	CS	CHEMICAL CONCENTRATION IN SOIL	chemical-specific	mg/kg	EPC Table	INTAKE-DERMAL =
		(ages 1 - 6)		AF	ADHERENCE FACTOR	0.2	mg/cm2	USEPA, 2001[6]	DAevent x SA x EV x EF x ED x 1/BW x 1/AT
				AbF	ABSORPTION FACTOR	chemical-specific	unitless	USEPA, 2001[7]	
				SA	SKIN SURFACE AREA AVAILABLE FOR CONTACT	2800	cm2/day	USEPA, 2001[8]	Where DAevent =
				EV	EVENT DAY	1	unitless	Professional Judgement	CS x AF x AbF x CF
				EF	EXPOSURE FREQUENCY	26	day/yr	Professional Judgement[5]	
				ED	EXPOSURE DURATION	6	yr	USEPA, 1994[3]	
				BW	BODY WEIGHT	15	kg	USEPA, 1994	
				AT-C	AVERAGING TIME (CANCER)	25550	day	USEPA, 1989	
				AT-N	AVERAGING TIME (NONCANCER)	2190	day	USEPA, 1989	
				CF	CONVERSION FACTOR	0.000001	kg/mg		

USEPA, 1989. "Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)"; Office of Emergency and Remedial Response; EPA-540/1-89/002 (interim final); Washington, D.C., December.
USEPA, 1994. "Risk Updates No. 2"; USEPA Region I, Waste Management Division; August. Values from "Attachment 2" to Risk Updates No. 2.
USEPA, 1997. "Exposure Factors Handbook, Volume 1"; Office of Research and Development; EPA-600/P-95/002Fa; Washington, D.C.; August.
USEPA, 2001. "Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
1 - Value based on exposure during wading, swimming, and walking/exploring banks (4 days per week June - August), and walking/exploring banks (2 days per week May, Sept, Oct).
2 - Representing ages 19 and above of a 30-year residential exposure duration.
3 - The total RME exposure duration is 30 years, consistent with USEPA, 1994. The allocation of exposure duration for the three age groups is based on professional judgement.
4 - Values are the average of 50th percentile body weights for males and females ages 7 through 18.
5 - Value based on exposure during wading, swimming, and walking/exploring banks (1 days per week May - October).
6 - Values for residential exposure to soil used as conservative estimate of potential soil adherence associated with recreational walking/exploring.
7 - Values are provided (Table 3-4 of USEPA, 2001) for arsenic, cadmium, chlordane, 2,4-D, DDT (used for DDD, DDE), TCDD, lindane (used for other BHC isomers), PAHs, PCBs, and pentachlorophenol. A single value is listed for all other SVOCs.
No values are listed for VOCs, other pesticides, or other inorganics and, subsequently, no value will be assigned to the ABSd term for COPCs falling into those categories.
8 - Values for residential exposure to soil used as conservative estimate of potential surface area exposed to soil during recreational walking/exploring.
9 - Values are the average of 50th percentile body surface areas (sum of areas for face, hands, forearms, lower legs, and feet) for males in the various age groups indicated.
mg - milligrams
cm^2 - square centimeters
kg - kilograms

Prepared by: BJR 3/28/11
Checked by: MJM 4/5/11

Table 5.1
Non-Cancer Toxicity Data -- Oral/Dermal
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Adjusted Dermal RfD (2)		Primary Target Organ or System / Critical Effect	Combined Uncertainty/Modifying Factors	RfD: Target Organ(s)	
		Value	Units		Value	Units			Source	Date Verified
SEMIVOLATILES										
Benzo(a)anthracene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney; renal tubular pathology	3,000/1	Surrogate (1)	December-10
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney; renal tubular pathology	300/1	Surrogate (1)	February-11
Benzo(a)pyrene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney; renal tubular pathology	3,000/1	Surrogate (1)	December-10
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney; renal tubular pathology	300/1	Surrogate (1)	February-11
Benzo(b)fluoranthene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney; renal tubular pathology	3,000/1	Surrogate (1)	December-10
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney; renal tubular pathology	300/1	Surrogate (1)	February-11
Benzo(k)fluoranthene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney; renal tubular pathology	3,000/1	Surrogate (1)	December-10
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney; renal tubular pathology	300/1	Surrogate (1)	February-11
Carbazole	chronic	ND			ND				PPRTV	March-11
	subchronic	ND			ND				PPRTV	March-11
Dibenzo(a,h)anthracene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney; renal tubular pathology	3,000/1	Surrogate (1)	December-10
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney; renal tubular pathology	300/1	Surrogate (1)	February-11
Dimethylphthalate	chronic	ND			ND				IRIS	December-10
	subchronic	1.0E-01	mg/kg/day	100%	1.0E-01	mg/kg/day	Increased liver weight; decreased serum and testosterone	3,000	PPRTV SL	February-11
Indeno(1,2,3-cd)pyrene	chronic	3.0E-02	mg/kg/day	89%	3.0E-02	mg/kg/day	Kidney; renal tubular pathology	3,000/1	Surrogate (1)	December-10
	subchronic	3.0E-01	mg/kg/day	89%	3.0E-01	mg/kg/day	Kidney; renal tubular pathology	300/1	Surrogate (1)	February-11
PESTICIDES/PCBs										
Aroclor-1254	chronic	2.0E-05	mg/kg/day	80%	2.0E-05	mg/kg/day	Immune system; immunotoxicity	300/1	IRIS	February-11
	subchronic	3.0E-05	mg/kg/day	80%	3.0E-05	mg/kg/day	Immune system; immunotoxicity	1,000	MRL	February-11
Aroclor 1268	chronic	2.0E-05	mg/kg/day	80%	2.0E-05	mg/kg/day	Immune system; immunotoxicity	300/1	Surrogate (2)	
	subchronic	5.0E-05	mg/kg/day	80%	5.0E-05	mg/kg/day	Immune system; immunotoxicity	300/1	Surrogate (2)	
INORGANICS/METALS										
Aluminum	chronic	1.0E+00	mg/kg/day	100%	1.0E+00	mg/kg/day	LOAEL / CNS	100	PPRTV	February-11
	subchronic	1.0E+00	mg/kg/day	100%	1.0E+00	mg/kg/day	CNS	30	MRL	February-11
Arsenic	chronic	3.0E-04	mg/kg/day	95%	3.0E-04	mg/kg/day	Skin; keratosis, hyperpigmentation and vascular complication	3/1	IRIS	December-10
	subchronic	3.0E-04	mg/kg/day	95%	3.0E-04	mg/kg/day	Skin; keratosis and hyperpigmentation	3/1	HEAST	February-11
Chromium VI	chronic	3.0E-03	mg/kg/day	2.5%	7.5E-05	mg/kg/day	No effects reported	300/3	IRIS	December-10
	subchronic	2.0E-02	mg/kg/day	2.5%	5.0E-04	mg/kg/day	No effects reported	100/1	HEAST	February-11
Cobalt	chronic	3.0E-04	mg/kg/day	100%	3.0E-04	mg/kg/day	LOAEL / Thyroid	3,000	PPRTV	February-11
	subchronic	3.0E-03	mg/kg/day	100%	3.0E-03	mg/kg/day	LOAEL / Thyroid	300	PPRTV	February-11
Manganese (soil)	chronic	4.7E-02	mg/kg/day	4%	1.9E-03	mg/kg/day	CNS; Impairment of neurobehavioral function	3/1	IRIS	December-10
	subchronic	4.7E-02	mg/kg/day	4%	1.9E-03	mg/kg/day	CNS; Impairment of neurobehavioral function	3/1	chronic	December-10
Thallium	chronic	1.0E-05	mg/kg/day	100%	1.0E-05	mg/kg/day	No effects observed	3,000	PPRTV SL	March-11
	subchronic	8.0E-04	mg/kg/day	100%	8.0E-04	mg/kg/day	No effects observed	300/1	HEAST	March-11
Vanadium - Region 1	chronic	4.9E-03	mg/kg/day	2.6%	1.3E-04	mg/kg/day	Kidney	100/1	IRIS	
	subchronic	1.0E-02	mg/kg/day	2.6%	2.6E-04	mg/kg/day	Hematological	10/1	MRL	
DIOXINS/FURANS										
2,3,7,8-tetrachlorobenzo-p-dioxin (TCDD)	chronic	ND			ND					
	subchronic	ND			ND					
HCX	chronic	ND			ND					
	subchronic	ND			ND					

Table 5.1
Non-Cancer Toxicity Data -- Oral/Dermal
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Adjusted Dermal RfD (2)		Primary Target Organ or System / Critical Effect	Combined Uncertainty/Modifying Factors	RfD: Target Organ(s)	
		Value	Units		Value	Units			Source	Date Verified

Prepared by/ Date: kask 03/08/11
Checked by/ Date: BJR 04/01/11

Notes:
In accordance with OSWER 9285.7-53, chronic RfDs are identified from the following heirarchy of sources:
Tier 1:
IRIS = Integrated Risk Information System: Obtained from: http://www.epa.gov/IRIS/
Tier 2:
PPRTV = Preliminary Peer-Reviewed Toxicity Value: Obtained from: http://hhpprtv.ornl.gov/
Tier 3:
HEAST= Health Effects Assessment Summary Tables Obtained from: USEPA Solid Waste and Emergency Response, FY 1997 Update. EPA-540-R-97-036. July 1997.
MRL = Minimum Risk Level (ATSDR: chronic MRLs):
CalEPA = California Environmental Protection Agency Toxicity Criteria Database Obtained from: http://www.oehha.ca.gov/risk/chemicalDB/
In addition, provisional RfDs developed by NCEA are presented for informational purposes and to be used on a case-by-case basis:
NCEA = National Center for Environmental Assessment: Obtained from Region III RSL Table November 2010.
MassDEP = Massachusetts Department of Environmental Protection Obtained from *Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach. Final Policy. 2002.*
PPRTV SL = Preliminary Peer-Reviewed Toxicity Value Screening Level Obtained from: http://hhpprtv.ornl.gov/

Subchronic RfDs are obtained from:
- PPRTV: provisional value
- ATSDR: Intermitent MRLs
- HEAST: subchronic RfDs
- Equal to chronic RfDs when no PPRTV, ATSDR or HEAST value is available

mg = milligram
kg = kilogram
NA = not listed in hierarchy sources
ND = no data available
chronic = the chronic value is used as the subchronic RfD

(1) Values obtained from RAGS Volume 1 (Part E, Supplemental Guidance for Dermal Risk Assessment, Final) (EPA, 2004)
Per this guidance, a value of 100% is used for analytes without published values.
(2) Adjusted Dermal RfD = Oral RfD x Oral to Dermal Adjustment Factor. Per RAGS Part E (USEPA, 2004), adjustments are only performed for chemicals that have an oral absorption efficiency of less than 50%.

Per USEPA Region I "Risk Updates, No. 5", (August, 1999), Non-carcinogenic PAHs without published RfDs should be evaluated using the published RfD for a structurally similar PAH.
Surrogate (1) - Value for pyrene used as a surrogate
Surrogate (2) - RfD for Aroclor 1254 used as surrogate for other PCB congeners with no published RfDs
For manganese in non-drinking water media: As recommended by USEPA Region I Risk Update, a non-dietary RfD is obtained by subtracting typical dietary intake of manganese (5 mg/day) from critical dose (10 mg/day). A modifying factor of 1 is then applied, per USEPA Region 1.

Table 6.1
Cancer Toxicity Data -- Oral/Dermal
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal (2)		Weight of Evidence/ Cancer Guideline Description	Oral Cancer Slope Factor	
	Value	Units		Value	Units		Source	Date Verified
SEMIVOLATILES								
Benzo(a)anthracene (ages >16) [a], [b]	7.3E-01	$(mg/kg/day)^{-1}$	89%	7.3E-01	$(mg/kg/day)^{-1}$	B2	NCEA	
Benzo(a)pyrene	7.3E+00	$(mg/kg/day)^{-1}$	89%	7.3E+00	$(mg/kg/day)^{-1}$	B2	IRIS	December-10
Benzo(b)fluoranthene [a], [b]	7.3E-01	$(mg/kg/day)^{-1}$	89%	7.3E-01	$(mg/kg/day)^{-1}$	B2	NCEA	December-10
Benzo(k)fluoranthene [a], [b]	7.3E-02	$(mg/kg/day)^{-1}$	89%	7.3E-02	$(mg/kg/day)^{-1}$	B2	NCEA	December-10
Carbazole	2.0E-02	$(mg/kg/day)^{-1}$	100%	2.0E-02	$(mg/kg/day)^{-1}$	B2	HEAST	February-11
Dibenzo(a,h)anthracene [a], [b]	7.3E+00	$(mg/kg/day)^{-1}$	89%	7.3E+00	$(mg/kg/day)^{-1}$	B2	NCEA	December-10
Dimethylphthalate	ND			ND		D	IRIS	December-10
Indeno(1,2,3-cd)pyrene [a], [b]	7.3E-01	$(mg/kg/day)^{-1}$	89%	7.3E-01	$(mg/kg/day)^{-1}$	B2	NCEA	February-11
PESTICIDES/PCBs								
Aroclor-1254	2.0E+00	$(mg/kg/day)^{-1}$	80%	2.0E+00	$(mg/kg/day)^{-1}$	See PCBs		
Aroclor 1268	2.0E+00	$(mg/kg/day)^{-1}$	80%	2.0E+00	$(mg/kg/day)^{-1}$	See PCBs		
Polychlorinated Biphenyls (PCBs)	See Below ***					B2	IRIS	February-11
high risk and persistence-upper bound	2.0E+00	$(mg/kg/day)^{-1}$	80%	2.0E+00	$(mg/kg/day)^{-1}$			
INORGANICS/METALS								
Aluminum	ND			ND		Inadequate evidence	PPRTV	February-11
Arsenic	1.5E+00	$(mg/kg/day)^{-1}$	95%	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	December-10
Chromium VI	ND			ND		Inadequate evidence	IRIS	December-10
Cobalt	ND			ND			PPRTV	February-11
Manganese	ND			ND		D	IRIS	December-10
Thallium	ND			ND		Inadequate evidence	IRIS	December-10
Vanadium	ND			ND		ND		
DIOXINS/FURANS								
2,3,7,8-tetrachlorobenzo-p-dioxin (TCDD)	1.5E+05	$(mg/kg/day)^{-1}$	70%	1.5E+05	$(mg/kg/day)^{-1}$	B2	HEAST	January-00
HCX [c]	1.5E+05	$(mg/kg/day)^{-1}$	70%	1.5E+05	$(mg/kg/day)^{-1}$	B2	HEAST	January-00

Table 6.1
Cancer Toxicity Data -- Oral/Dermal
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal (2)		Weight of Evidence/ Cancer Guideline Description	Oral Cancer Slope Factor	
	Value	Units		Value	Units		Source	Date Verified

Notes:

Prepared by/ Date: kask 03/08/11
Checked by/ Date: BJR 04/01/11

In accordance with OSWER 9285.7-53, slope factors are identified from the following heirarchy of sources:

Tier 1:
IRIS = Integrated Risk Information System: Obtained from: http://www.epa.gov/IRIS/

Tier 2:
PPRTV = Preliminary Peer-Reviewed Toxicity Value: Obtained from: http://hhpprtv.ornl.gov/

Tier 3:
HEAST= Health Effects Assessment Summary Tables Obtained from: USEPA Solid Waste and Emergency Response, FY 1997 Update. EPA-540-R-97-036. July 1997.
MRL = Minimum Risk Level (ATSDR: chronic MRLs):
CalEPA = California Environmental Protection Agency Toxicity Criteria Database Obtained from: http://www.oehha.ca.gov/risk/chemicalDB/

In addition, provisional RfDs developed by NCEA are presented for informational purposes and to be used on a case-by-case basis:
NCEA = National Center for Environmental Assessment: Obtained from Region III RSL Table November 2010.
PPRTV SL = Preliminary Peer-Reviewed Toxicity Value Screening Level Obtained from: http://hhpprtv.ornl.gov/

(1) Values obtained from RAGS Volume 1 (Part E, Supplemental Guidance for Dermal Risk Assessment, Final) (EPA, 2004)
Per this guidance, a value of 100% is used for analytes without published values.
(2) Adjusted Dermal SF = Oral SF / Oral to Dermal Adjustment Factor. Per RAGS Part E (USEPA, 2004), adjustments are only performed for chemicals that have an oral absorption efficiency of less than 50%.
[a] - Slope Factor for Benzo(a)Pyrene used for other carcinogenic PAHs, adjusted by Relative Potency Factors of 1.0 [benzo(a)pyrene,dibenz(a,h)anthracene]; 0.1 [benzo(a)anthracene, benzo(b)flouoranthene, indeno(1,2,3-c,d)pyrene]; 0.01 [benzo(k)fluoranthene]; 0.001 [chrysene].
[b] - Slope factors are developed in accordance with the EPA Memorandum: "Implementation of the Cancer Guidelines and Accompanying Supplemental Guidance - Science Policy Council Cancer Guidelines Implementation Workgroup Communication II: Performing Risk Assessments that include Carcinogens Described in the Supplemental Guidance as having a Mutagenic Mode of Actio
The EPA-published slope factor is multiplied by generic age-dependant adjustment factors (ADAFs) as follows:
Young children (1-6 yrs of age): ADAF of 4.2 calculated as an age-weighted ADAF for children 0<2 (ADAF=10) and children 2<6 (ADAF=3), as follows: [(1 yrs x 10) + (5 yrs x 3)] / 6 yrs = 4.2
Adults (>16 yrs of age): ADAF of 1 is the applicable value for this age range.
Adolescent (Age 7-18): ADAF of 2.5 calculated as an age-weighted ADAF for older children >6 - <16 (ADAF=3) and adults >16 (ADAF=1), as follows: [(9 yrs x 3) + (3 yrs x 1)] / 12 yrs = 2.5
[c] - HCX is evaluated by utilizing the cancer slope factor for TCDD and a Toxicity Equivalence Factor of 0.0002
PCB slope factors are applicable to Aroclors 1016, 1248, 1254, and 1260.

Weight of Evidence:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen

kg = kilogram
mg = milligram
NA = not listed in hierarchy sources
ND = no data available

TABLE 7.1
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS -- REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD (AGES 1-6)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD (AGES 1-6)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	
SOIL	SOIL	HUMAN HEALTH CONCERN ARE	INGESTION	Benz(a)anthracene	0.033	mg/kg	3.4E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-08	9.4E-08	mg/kg/day	3.0E-02	mg/kg/day	3.E-06
				Benzo(a)pyrene	0.056	mg/kg	5.7E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	4.E-07	1.6E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Benzo(b)fluoranthene	0.062	mg/kg	6.4E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-08	1.8E-07	mg/kg/day	3.0E-02	mg/kg/day	6.E-06
				Benzo(k)fluoranthene	0.019	mg/kg	1.9E-08	mg/kg/day	7.3E-02	(mg/kg/day)-1	1.E-09	5.4E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Carbazole	0.006	mg/kg	1.5E-09	mg/kg/day	2.0E-02	(mg/kg/day)-1	3.E-11	1.7E-08	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.0061	mg/kg	6.3E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	5.E-08	1.7E-08	mg/kg/day	3.0E-02	mg/kg/day	6.E-07
				Dimethyl Phthalate	0.03	mg/kg	NC		NC			8.5E-08	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.039	mg/kg	4.0E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	3.E-08	1.1E-07	mg/kg/day	3.0E-02	mg/kg/day	4.E-06
				Arsenic	4.4	mg/kg	1.1E-06	mg/kg/day	1.5E+00	(mg/kg/day)-1	2.E-06	1.3E-05	mg/kg/day	3.0E-04	mg/kg/day	4.E-02
				Chromium	6.1	mg/kg	NC		NC			1.7E-05	mg/kg/day	3.0E-03	mg/kg/day	6.E-03
				Cobalt	1.7	mg/kg	NC		NC			4.8E-06	mg/kg/day	3.0E-04	mg/kg/day	2.E-02
				Manganese	391	mg/kg	NC		NC			1.1E-03	mg/kg/day	4.7E-02	mg/kg/day	2.E-02
				Vanadium	20	mg/kg	NC		NC			5.7E-05	mg/kg/day	4.9E-03	mg/kg/day	1.E-02
				Dioxin-TEQ Mammal	0.0000051	mg/kg	1.2E-12	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-07	1.5E-11	mg/kg/day	ND		
			EXPOSURE ROUTE TOTAL								2.E-06					1.E-01
			DERMAL	Benz(a)anthracene	0.033	mg/kg	1.2E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	9.E-09	3.4E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(a)pyrene	0.056	mg/kg	2.1E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-07	5.8E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Benzo(b)fluoranthene	0.062	mg/kg	2.3E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-08	6.4E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Benzo(k)fluoranthene	0.019	mg/kg	7.1E-09	mg/kg/day	7.3E-02	(mg/kg/day)-1	5.E-10	2.0E-08	mg/kg/day	3.0E-02	mg/kg/day	7.E-07
				Carbazole	0.006	mg/kg	4.1E-10	mg/kg/day	2.0E-02	(mg/kg/day)-1	8.E-12	4.8E-09	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.0061	mg/kg	2.3E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-08	6.3E-09	mg/kg/day	3.0E-02	mg/kg/day	2.E-07
				Dimethyl Phthalate	0.03	mg/kg	NC		NC			2.4E-08	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.039	mg/kg	1.5E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-08	4.0E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Arsenic	4.4	mg/kg	9.0E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	1.E-07	1.1E-06	mg/kg/day	3.0E-04	mg/kg/day	4.E-03
				Chromium	6.1	mg/kg	NC		NC			--		7.5E-05	mg/kg/day	
				Cobalt	1.7	mg/kg	NC		NC			--		3.0E-04	mg/kg/day	
				Manganese	391	mg/kg	NC		NC			--		1.9E-03	mg/kg/day	
				Vanadium	20	mg/kg	NC		NC			--		1.3E-04	mg/kg/day	
				Dioxin-TEQ Mammal	0.0000051	mg/kg	1.0E-13	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-08	1.2E-12	mg/kg/day	ND		
												--				
												--				
			EXPOSURE ROUTE TOTAL								4.E-07					4.E-03
		EXPOSURE POINT TOTAL									3.E-06					1.E-01
	EXPOSURE MEDIUM TOTAL										3.E-06					1.E-01
SOIL TOTAL											3.E-06					1.E-01
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	3.E-06	TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA				1.E-01

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not avalailable from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
NV - Not volatile; exposure route not complete for this chemical.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

TABLE 7.2
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS – REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADOLESCENT (AGES 7-18)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADOLESCENT (AGES 7-18)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	
SOIL	SOIL	HUMAN HEALTH CONCERN ARE	INGESTION	Benz(a)anthracene	0.033	mg/kg	6.2E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-09	1.6E-08	mg/kg/day	3.0E-02	mg/kg/day	5.E-07
				Benzo(a)pyrene	0.056	mg/kg	1.0E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	8.E-08	2.7E-08	mg/kg/day	3.0E-02	mg/kg/day	9.E-07
				Benzo(b)fluoranthene	0.062	mg/kg	1.2E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	8.E-09	2.9E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(k)fluoranthene	0.019	mg/kg	3.6E-09	mg/kg/day	7.3E-02	(mg/kg/day)-1	3.E-10	9.0E-09	mg/kg/day	3.0E-02	mg/kg/day	3.E-07
				Carbazole	0.006	mg/kg	4.9E-10	mg/kg/day	2.0E-02	(mg/kg/day)-1	1.E-11	2.8E-09	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.0061	mg/kg	1.1E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	8.E-09	2.9E-09	mg/kg/day	3.0E-02	mg/kg/day	1.E-07
				Dimethyl Phthalate	0.03	mg/kg	NC		NC			1.4E-08	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.039	mg/kg	7.3E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-09	1.9E-08	mg/kg/day	3.0E-02	mg/kg/day	6.E-07
				Arsenic	4.4	mg/kg	3.6E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	5.E-07	2.1E-06	mg/kg/day	3.0E-04	mg/kg/day	7.E-03
				Chromium	6.1	mg/kg	NC		NC			2.9E-06	mg/kg/day	3.0E-03	mg/kg/day	1.E-03
				Cobalt	1.7	mg/kg	NC		NC			8.1E-07	mg/kg/day	3.0E-04	mg/kg/day	3.E-03
				Manganese	391	mg/kg	NC		NC			1.9E-04	mg/kg/day	4.7E-02	mg/kg/day	4.E-03
				Vanadium	20	mg/kg	NC		NC			9.5E-06	mg/kg/day	4.9E-03	mg/kg/day	2.E-03
				Dioxin-TEQ Mammal	0.0000051	mg/kg	4.2E-13	mg/kg/day	1.5E+05	(mg/kg/day)-1	6.E-08	2.4E-12	mg/kg/day	ND		
			EXPOSURE ROUTE TOTAL								7.E-07					2.E-02
			DERMAL	Benz(a)anthracene	0.033	mg/kg	8.4E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	6.E-09	2.0E-08	mg/kg/day	3.0E-02	mg/kg/day	7.E-07
				Benzo(a)pyrene	0.056	mg/kg	1.4E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-07	3.3E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(b)fluoranthene	0.062	mg/kg	1.6E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-08	3.7E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Benzo(k)fluoranthene	0.019	mg/kg	4.8E-09	mg/kg/day	7.3E-02	(mg/kg/day)-1	4.E-10	1.1E-08	mg/kg/day	3.0E-02	mg/kg/day	4.E-07
				Carbazole	0.006	mg/kg	4.7E-10	mg/kg/day	2.0E-02	(mg/kg/day)-1	9.E-12	2.7E-09	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.0061	mg/kg	1.5E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-08	3.6E-09	mg/kg/day	3.0E-02	mg/kg/day	1.E-07
				Dimethyl Phthalate	0.03	mg/kg	NC		NC			1.4E-08	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.039	mg/kg	9.9E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	7.E-09	2.3E-08	mg/kg/day	3.0E-02	mg/kg/day	8.E-07
				Arsenic	4.4	mg/kg	1.0E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	2.E-07	6.0E-07	mg/kg/day	3.0E-04	mg/kg/day	2.E-03
				Chromium	6.1	mg/kg	NC		NC			--		7.5E-05	mg/kg/day	
				Cobalt	1.7	mg/kg	NC		NC			--		3.0E-04	mg/kg/day	
				Manganese	391	mg/kg	NC		NC			--		1.9E-03	mg/kg/day	
				Vanadium	20	mg/kg	NC		NC			--		1.3E-04	mg/kg/day	
				Dioxin-TEQ Mammal	0.0000051	mg/kg	1.2E-13	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-08	7.0E-13	mg/kg/day	ND		
												--				
												--				
			EXPOSURE ROUTE TOTAL								3.E-07					2.E-03
		EXPOSURE POINT TOTAL									1.E-06					2.E-02
	EXPOSURE MEDIUM TOTAL										1.E-06					2.E-02
SOIL TOTAL											1.E-06					2.E-02
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	1.E-06	TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA				2.E-02

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not avalailable from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
NV - Not volatile; exposure route not complete for this chemical.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

TABLE 7.3
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT (AGES 19-30)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT (AGES 19-30)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	
SOIL	SOIL	HUMAN HEALTH CONCERN AREA	INGESTION	Benz(a)anthracene	0.033	mg/kg	1.7E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-09	1.0E-08	mg/kg/day	3.0E-02	mg/kg/day	3.E-07
				Benzo(a)pyrene	0.056	mg/kg	2.9E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-08	1.7E-08	mg/kg/day	3.0E-02	mg/kg/day	6.E-07
				Benzo(b)fluoranthene	0.062	mg/kg	3.2E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-09	1.9E-08	mg/kg/day	3.0E-02	mg/kg/day	6.E-07
				Benzo(k)fluoranthene	0.019	mg/kg	9.9E-10	mg/kg/day	7.3E-02	(mg/kg/day)-1	7.E-11	5.8E-09	mg/kg/day	3.0E-02	mg/kg/day	2.E-07
				Carbazole	0.006	mg/kg	3.1E-10	mg/kg/day	2.0E-02	(mg/kg/day)-1	6.E-12	1.8E-09	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.0061	mg/kg	3.2E-10	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-09	1.9E-09	mg/kg/day	3.0E-02	mg/kg/day	6.E-08
				Dimethyl Phthalate	0.03	mg/kg	NC		NC			9.2E-09	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.039	mg/kg	2.0E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-09	1.2E-08	mg/kg/day	3.0E-02	mg/kg/day	4.E-07
				Arsenic	4.4	mg/kg	2.3E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	3.E-07	1.3E-06	mg/kg/day	3.0E-04	mg/kg/day	4.E-03
				Chromium	6.1	mg/kg	NC		NC			1.9E-06	mg/kg/day	3.0E-03	mg/kg/day	6.E-04
				Cobalt	1.7	mg/kg	NC		NC			5.2E-07	mg/kg/day	3.0E-04	mg/kg/day	2.E-03
				Manganese	391	mg/kg	NC		NC			1.2E-04	mg/kg/day	4.7E-02	mg/kg/day	3.E-03
				Vanadium	20	mg/kg	NC		NC			6.1E-06	mg/kg/day	4.9E-03	mg/kg/day	1.E-03
				Dioxin-TEQ Mammal	0.0000051	mg/kg	2.7E-13	mg/kg/day	1.5E+05	(mg/kg/day)-1	4.E-08	1.6E-12	mg/kg/day	ND		
			EXPOSURE ROUTE TOTAL								4.E-07					1.E-02
			DERMAL	Benz(a)anthracene	0.033	mg/kg	9.0E-10	mg/kg/day	7.3E-01	(mg/kg/day)-1	7.E-10	5.2E-09	mg/kg/day	3.0E-02	mg/kg/day	2.E-07
				Benzo(a)pyrene	0.056	mg/kg	1.5E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-08	8.9E-09	mg/kg/day	3.0E-02	mg/kg/day	3.E-07
				Benzo(b)fluoranthene	0.062	mg/kg	1.7E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-09	9.8E-09	mg/kg/day	3.0E-02	mg/kg/day	3.E-07
				Benzo(k)fluoranthene	0.019	mg/kg	5.2E-10	mg/kg/day	7.3E-02	(mg/kg/day)-1	4.E-11	3.0E-09	mg/kg/day	3.0E-02	mg/kg/day	1.E-07
				Carbazole	0.006	mg/kg	1.3E-10	mg/kg/day	2.0E-02	(mg/kg/day)-1	3.E-12	7.3E-10	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.0061	mg/kg	1.7E-10	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-09	9.7E-10	mg/kg/day	3.0E-02	mg/kg/day	3.E-08
				Dimethyl Phthalate	0.03	mg/kg	NC		NC			3.7E-09	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.039	mg/kg	1.1E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	8.E-10	6.2E-09	mg/kg/day	3.0E-02	mg/kg/day	2.E-07
				Arsenic	4.4	mg/kg	2.8E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	4.E-08	1.6E-07	mg/kg/day	3.0E-04	mg/kg/day	5.E-04
				Chromium	6.1	mg/kg	NC		NC			--		7.5E-05	mg/kg/day	
				Cobalt	1.7	mg/kg	NC		NC			--		3.0E-04	mg/kg/day	
				Manganese	391	mg/kg	NC		NC			--		1.9E-03	mg/kg/day	
				Vanadium	20	mg/kg	NC		NC			--		1.3E-04	mg/kg/day	
				Dioxin-TEQ Mammal	0.0000051	mg/kg	3.2E-14	mg/kg/day	1.5E+05	(mg/kg/day)-1	5.E-09	1.9E-13	mg/kg/day	ND		
												--				
												--				
			EXPOSURE ROUTE TOTAL								6.E-08					5.E-04
		EXPOSURE POINT TOTAL									5.E-07					1.E-02
	EXPOSURE MEDIUM TOTAL										5.E-07					1.E-02
SOIL TOTAL											5.E-07					1.E-02
									TOTAL RECEPTOR RISK ACROSS ALL MEDIA		5.E-07	TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA				1.E-02

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not avalailable from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
NV - Not volatile; exposure route not complete for this chemical.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

TABLE 7.4
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS – REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD (AGES 1-6)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD (AGES 1-6)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	
SOIL	SOIL	GENERAL AREA	INGESTION	Benz(a)anthracene	0.88	mg/kg	3.0E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-07	8.4E-07	mg/kg/day	3.0E-02	mg/kg/day	3.E-05
				Benzo(a)pyrene	1.1	mg/kg	3.8E-07	mg/kg/day	7.3E+00	(mg/kg/day)-1	3.E-06	1.0E-06	mg/kg/day	3.0E-02	mg/kg/day	3.E-05
				Benzo(b)fluoranthene	1.6	mg/kg	5.5E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	4.E-07	1.5E-06	mg/kg/day	3.0E-02	mg/kg/day	5.E-05
				Benzo(k)fluoranthene	0.89	mg/kg	3.0E-07	mg/kg/day	7.3E-02	(mg/kg/day)-1	2.E-08	8.5E-07	mg/kg/day	3.0E-02	mg/kg/day	3.E-05
				Carbazole	0.14	mg/kg	1.1E-08	mg/kg/day	2.0E-02	(mg/kg/day)-1	2.E-10	1.3E-07	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.18	mg/kg	6.2E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	4.E-07	1.7E-07	mg/kg/day	3.0E-02	mg/kg/day	6.E-06
				Dimethyl Phthalate	0.073	mg/kg	NC		NC			6.9E-08	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.75	mg/kg	2.6E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-07	7.1E-07	mg/kg/day	3.0E-02	mg/kg/day	2.E-05
				Aroclor 1254	0.18	mg/kg	1.5E-08	mg/kg/day	2.0E+00	(mg/kg/day)-1	3.E-08	1.7E-07	mg/kg/day	2.0E-05	mg/kg/day	9.E-03
				Aroclor 1268	0.026	mg/kg	2.1E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	4.E-09	2.5E-08	mg/kg/day	2.0E-05	mg/kg/day	1.E-03
				Aluminum	14791	mg/kg	NC		NC			1.4E-02	mg/kg/day	1.0E+00	mg/kg/day	1.E-02
				Arsenic	7	mg/kg	5.7E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	9.E-07	6.6E-06	mg/kg/day	3.0E-04	mg/kg/day	2.E-02
				Chromium	32	mg/kg	NC		NC			3.0E-05	mg/kg/day	3.0E-03	mg/kg/day	1.E-02
				Cobalt	6.2	mg/kg	NC		NC			5.9E-06	mg/kg/day	3.0E-04	mg/kg/day	2.E-02
				Manganese	1026	mg/kg	NC		NC			9.7E-04	mg/kg/day	4.7E-02	mg/kg/day	2.E-02
				Thallium	0.45	mg/kg	NC		NC			4.3E-07	mg/kg/day	1.0E-05	mg/kg/day	4.E-02
				Vanadium	33	mg/kg	NC		NC			3.1E-05	mg/kg/day	4.9E-03	mg/kg/day	6.E-03
				HCX-TEQ	0.000000052	mg/kg	4.2E-15	mg/kg/day	1.5E+05	(mg/kg/day)-1	6.E-10	4.9E-14	mg/kg/day	ND		
				Dioxin-TEQ Mammal	0.0028	mg/kg	2.3E-10	mg/kg/day	1.5E+05	(mg/kg/day)-1	3.E-05	2.7E-09	mg/kg/day	ND		
			EXPOSURE ROUTE TOTAL								4.E-05					1.E-01
			DERMAL	Benz(a)anthracene	0.88	mg/kg	1.1E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	8.E-08	3.0E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Benzo(a)pyrene	1.1	mg/kg	1.4E-07	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-06	3.8E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Benzo(b)fluoranthene	1.6	mg/kg	2.0E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-07	5.5E-07	mg/kg/day	3.0E-02	mg/kg/day	2.E-05
				Benzo(k)fluoranthene	0.89	mg/kg	1.1E-07	mg/kg/day	7.3E-02	(mg/kg/day)-1	8.E-09	3.1E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Carbazole	0.14	mg/kg	3.2E-09	mg/kg/day	2.0E-02	(mg/kg/day)-1	6.E-11	3.7E-08	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.18	mg/kg	2.2E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-07	6.2E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Dimethyl Phthalate	0.073	mg/kg	NC		NC			1.9E-08	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.75	mg/kg	9.3E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	7.E-08	2.6E-07	mg/kg/day	3.0E-02	mg/kg/day	9.E-06
				Aroclor 1254	0.18	mg/kg	5.7E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	1.E-08	6.7E-08	mg/kg/day	2.0E-05	mg/kg/day	3.E-03
				Aroclor 1268	0.026	mg/kg	8.3E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	2.E-09	9.7E-09	mg/kg/day	2.0E-05	mg/kg/day	5.E-04
				Aluminum	14791	mg/kg	NC		NC			--		1.0E+00	mg/kg/day	
				Arsenic	7	mg/kg	4.8E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	7.E-08	5.6E-07	mg/kg/day	3.0E-04	mg/kg/day	2.E-03
				Chromium	32	mg/kg	NC		NC			--		7.5E-05	mg/kg/day	
				Cobalt	6.2	mg/kg	NC		NC			--		3.0E-04	mg/kg/day	
				Manganese	1026	mg/kg	NC		NC			--		1.9E-03	mg/kg/day	
				Thallium	0.45	mg/kg	NC		NC			--		1.0E-05	mg/kg/day	
				Vanadium	33	mg/kg	NC		NC			--		1.3E-04	mg/kg/day	
				HCX-TEQ	0.000000052	mg/kg	--		1.5E+05	(mg/kg/day)-1		--		ND		
				Dioxin-TEQ Mammal	0.0028	mg/kg	--		1.5E+05	(mg/kg/day)-1		--		ND		
												--				
												--				
			EXPOSURE ROUTE TOTAL								2.E-06					6.E-03
		EXPOSURE POINT TOTAL									4.E-05					2.E-01
	EXPOSURE MEDIUM TOTAL										4.E-05					2.E-01
SOIL TOTAL											4.E-05					2.E-01
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	4.E-05	TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA				2.E-01

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not avalailable from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
NV - Not volatile; exposure route not complete for this chemical.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

TABLE 7.5
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS – REASONABLE MAXIMUM EXPOSURE- CURRENT/FUTURE- PASSIVE RECREATIONAL VISITOR- ADOLESCENT (AGES 7-18)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADOLESCENT (AGES 7-18)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	
SOIL	SOIL	GENERAL AREA	INGESTION	Benz(a)anthracene	0.88	mg/kg	5.5E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	4.E-08	1.4E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Benzo(a)pyrene	1.1	mg/kg	6.9E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	5.E-07	1.7E-07	mg/kg/day	3.0E-02	mg/kg/day	6.E-06
				Benzo(b)fluoranthene	1.6	mg/kg	1.0E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	7.E-08	2.5E-07	mg/kg/day	3.0E-02	mg/kg/day	8.E-06
				Benzo(k)fluoranthene	0.89	mg/kg	5.6E-08	mg/kg/day	7.3E-02	(mg/kg/day)-1	4.E-09	1.4E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Carbazole	0.14	mg/kg	3.8E-09	mg/kg/day	2.0E-02	(mg/kg/day)-1	8.E-11	2.2E-08	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.18	mg/kg	1.1E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	8.E-08	2.8E-08	mg/kg/day	3.0E-02	mg/kg/day	9.E-07
				Dimethyl Phthalate	0.073	mg/kg	NC		NC			1.2E-08	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.75	mg/kg	4.7E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	3.E-08	1.2E-07	mg/kg/day	3.0E-02	mg/kg/day	4.E-06
				Aroclor 1254	0.18	mg/kg	4.9E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	1.E-08	2.8E-08	mg/kg/day	2.0E-05	mg/kg/day	1.E-03
				Aroclor 1268	0.026	mg/kg	7.1E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	1.E-09	4.1E-09	mg/kg/day	2.0E-05	mg/kg/day	2.E-04
				Aluminum	14791	mg/kg	NC		NC			2.3E-03	mg/kg/day	1.0E+00	mg/kg/day	2.E-03
				Arsenic	7	mg/kg	1.9E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	3.E-07	1.1E-06	mg/kg/day	3.0E-04	mg/kg/day	4.E-03
				Chromium	32	mg/kg	NC		NC			5.1E-06	mg/kg/day	3.0E-03	mg/kg/day	2.E-03
				Cobalt	6.2	mg/kg	NC		NC			9.8E-07	mg/kg/day	3.0E-04	mg/kg/day	3.E-03
				Manganese	1026	mg/kg	NC		NC			1.6E-04	mg/kg/day	4.7E-02	mg/kg/day	3.E-03
				Thallium	0.45	mg/kg	NC		NC			7.1E-08	mg/kg/day	1.0E-05	mg/kg/day	7.E-03
				Vanadium	33	mg/kg	NC		NC			5.2E-06	mg/kg/day	4.9E-03	mg/kg/day	1.E-03
				HCX-TEQ	0.000000052	mg/kg	1.4E-15	mg/kg/day	1.5E+05	(mg/kg/day)-1	2.E-10	8.2E-15	mg/kg/day	ND		
				Dioxin-TEQ Mammal	0.0028	mg/kg	7.6E-11	mg/kg/day	1.5E+05	(mg/kg/day)-1	1.E-05	4.4E-10	mg/kg/day	ND		
			EXPOSURE ROUTE TOTAL								1.E-05					2.E-02
			DERMAL	Benz(a)anthracene	0.88	mg/kg	7.5E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-08	1.7E-07	mg/kg/day	3.0E-02	mg/kg/day	6.E-06
				Benzo(a)pyrene	1.1	mg/kg	9.3E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	7.E-07	2.2E-07	mg/kg/day	3.0E-02	mg/kg/day	7.E-06
				Benzo(b)fluoranthene	1.6	mg/kg	1.4E-07	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-07	3.2E-07	mg/kg/day	3.0E-02	mg/kg/day	1.E-05
				Benzo(k)fluoranthene	0.89	mg/kg	7.5E-08	mg/kg/day	7.3E-02	(mg/kg/day)-1	6.E-09	1.8E-07	mg/kg/day	3.0E-02	mg/kg/day	6.E-06
				Carbazole	0.14	mg/kg	3.6E-09	mg/kg/day	2.0E-02	(mg/kg/day)-1	7.E-11	2.1E-08	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.18	mg/kg	1.5E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-07	3.6E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Dimethyl Phthalate	0.073	mg/kg	NC		NC			1.1E-08	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.75	mg/kg	6.3E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-08	1.5E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Aroclor 1254	0.18	mg/kg	6.6E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	1.E-08	3.8E-08	mg/kg/day	2.0E-05	mg/kg/day	2.E-03
				Aroclor 1268	0.026	mg/kg	9.5E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	2.E-09	5.5E-09	mg/kg/day	2.0E-05	mg/kg/day	3.E-04
				Aluminum	14791	mg/kg	NC		NC			--		1.0E+00	mg/kg/day	
				Arsenic	7	mg/kg	5.5E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	8.E-08	3.2E-07	mg/kg/day	3.0E-04	mg/kg/day	1.E-03
				Chromium	32	mg/kg	NC		NC			--		7.5E-05	mg/kg/day	
				Cobalt	6.2	mg/kg	NC		NC			--		3.0E-04	mg/kg/day	
				Manganese	1026	mg/kg	NC		NC			--		1.9E-03	mg/kg/day	
				Thallium	0.45	mg/kg	NC		NC			--		1.0E-05	mg/kg/day	
				Vanadium	33	mg/kg	NC		NC			--		1.3E-04	mg/kg/day	
				HCX-TEQ	0.000000052	mg/kg	--		1.5E+05	(mg/kg/day)-1		--		ND		
				Dioxin-TEQ Mammal	0.0028	mg/kg	--		1.5E+05	(mg/kg/day)-1		--		ND		
			EXPOSURE ROUTE TOTAL								1.E-06					3.E-03
		EXPOSURE POINT TOTAL									1.E-05					3.E-02
	EXPOSURE MEDIUM TOTAL										1.E-05					3.E-02
SOIL TOTAL											1.E-05					3.E-02
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	1.E-05	TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA				3.E-02

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not avalailable from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
NV - Not volatile; exposure route not complete for this chemical.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

TABLE 7.6
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS – REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT (AGES 19-30)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT (AGES 19-30)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	EXPOSURE ROUTE	CHEMICAL	EPC		CANCER RISK CALCULATIONS					NON-CANCER HAZARD CALCULATIONS				
					VALUE	UNITS	INTAKE/EXPOSURE CONCENTRATION		CSF/UNIT RISK		CANCER RISK	INTAKE/EXPOSURE CONCENTRATION		RfD/RfC (1)		HAZARD QUOTIENT
							VALUE	UNITS	VALUE	UNITS		VALUE	UNITS	VALUE	UNITS	
SOIL	SOIL	GENERAL AREA	INGESTION	Benz(a)anthracene	0.88	mg/kg	1.5E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-08	9.0E-08	mg/kg/day	3.0E-02	mg/kg/day	3.E-06
				Benzo(a)pyrene	1.1	mg/kg	1.9E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-07	1.1E-07	mg/kg/day	3.0E-02	mg/kg/day	4.E-06
				Benzo(b)fluoranthene	1.6	mg/kg	2.8E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	2.E-08	1.6E-07	mg/kg/day	3.0E-02	mg/kg/day	5.E-06
				Benzo(k)fluoranthene	0.89	mg/kg	1.6E-08	mg/kg/day	7.3E-02	(mg/kg/day)-1	1.E-09	9.1E-08	mg/kg/day	3.0E-02	mg/kg/day	3.E-06
				Carbazole	0.14	mg/kg	2.4E-09	mg/kg/day	2.0E-02	(mg/kg/day)-1	5.E-11	1.4E-08	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.18	mg/kg	3.1E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	2.E-08	1.8E-08	mg/kg/day	3.0E-02	mg/kg/day	6.E-07
				Dimethyl Phthalate	0.073	mg/kg	NC		NC			7.4E-09	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.75	mg/kg	1.3E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-08	7.6E-08	mg/kg/day	3.0E-02	mg/kg/day	3.E-06
				Aroclor 1254	0.18	mg/kg	3.1E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	6.E-09	1.8E-08	mg/kg/day	2.0E-05	mg/kg/day	9.E-04
				Aroclor 1268	0.026	mg/kg	4.5E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	9.E-10	2.6E-09	mg/kg/day	2.0E-05	mg/kg/day	1.E-04
				Aluminum	14791	mg/kg	NC		NC			1.5E-03	mg/kg/day	1.0E+00	mg/kg/day	2.E-03
				Arsenic	7	mg/kg	1.2E-07	mg/kg/day	1.5E+00	(mg/kg/day)-1	2.E-07	7.1E-07	mg/kg/day	3.0E-04	mg/kg/day	2.E-03
				Chromium	32	mg/kg	NC		NC			3.3E-06	mg/kg/day	3.0E-03	mg/kg/day	1.E-03
				Cobalt	6.2	mg/kg	NC		NC			6.3E-07	mg/kg/day	3.0E-04	mg/kg/day	2.E-03
				Manganese	1026	mg/kg	NC		NC			1.0E-04	mg/kg/day	4.7E-02	mg/kg/day	2.E-03
				Thallium	0.45	mg/kg	NC		NC			4.6E-08	mg/kg/day	1.0E-05	mg/kg/day	5.E-03
				Vanadium	33	mg/kg	NC		NC			3.4E-06	mg/kg/day	4.9E-03	mg/kg/day	7.E-04
				HCX-TEQ	0.000000052	mg/kg	9.1E-16	mg/kg/day	1.5E+05	(mg/kg/day)-1	1.E-10	5.3E-15	mg/kg/day	ND		
				Dioxin-TEQ Mammal	*0.0028*	*mg/kg*	*4.9E-11*	*mg/kg/day*	*1.5E+05*	*(mg/kg/day)-1*	*7.E-06*	*2.8E-10*	*mg/kg/day*	ND		
			EXPOSURE ROUTE TOTAL								8.E-06					2.E-02
			DERMAL	Benz(a)anthracene	0.88	mg/kg	8.0E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	6.E-09	4.6E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Benzo(a)pyrene	1.1	mg/kg	1.0E-08	mg/kg/day	7.3E+00	(mg/kg/day)-1	7.E-08	5.8E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Benzo(b)fluoranthene	1.6	mg/kg	1.4E-08	mg/kg/day	7.3E-01	(mg/kg/day)-1	1.E-08	8.4E-08	mg/kg/day	3.0E-02	mg/kg/day	3.E-06
				Benzo(k)fluoranthene	0.89	mg/kg	8.1E-09	mg/kg/day	7.3E-02	(mg/kg/day)-1	6.E-10	4.7E-08	mg/kg/day	3.0E-02	mg/kg/day	2.E-06
				Carbazole	0.14	mg/kg	9.7E-10	mg/kg/day	2.0E-02	(mg/kg/day)-1	2.E-11	5.7E-09	mg/kg/day	ND		
				Dibenz(a,h)anthracene	0.18	mg/kg	1.6E-09	mg/kg/day	7.3E+00	(mg/kg/day)-1	1.E-08	9.5E-09	mg/kg/day	3.0E-02	mg/kg/day	3.E-07
				Dimethyl Phthalate	0.073	mg/kg	NC		NC			3.0E-09	mg/kg/day	ND		
				Indeno(1,2,3-cd)pyrene	0.75	mg/kg	6.8E-09	mg/kg/day	7.3E-01	(mg/kg/day)-1	5.E-09	4.0E-08	mg/kg/day	3.0E-02	mg/kg/day	1.E-06
				Aroclor 1254	0.18	mg/kg	1.8E-09	mg/kg/day	2.0E+00	(mg/kg/day)-1	4.E-09	1.0E-08	mg/kg/day	2.0E-05	mg/kg/day	5.E-04
				Aroclor 1268	0.026	mg/kg	2.5E-10	mg/kg/day	2.0E+00	(mg/kg/day)-1	5.E-10	1.5E-09	mg/kg/day	2.0E-05	mg/kg/day	7.E-05
				Aluminum	14791	mg/kg	NC		NC			--		1.0E+00	mg/kg/day	
				Arsenic	7	mg/kg	1.5E-08	mg/kg/day	1.5E+00	(mg/kg/day)-1	2.E-08	8.5E-08	mg/kg/day	3.0E-04	mg/kg/day	3.E-04
				Chromium	32	mg/kg	NC		NC			--		7.5E-05	mg/kg/day	
				Cobalt	6.2	mg/kg	NC		NC			--		3.0E-04	mg/kg/day	
				Manganese	1026	mg/kg	NC		NC			--		1.9E-03	mg/kg/day	
				Thallium	0.45	mg/kg	NC		NC			--		1.0E-05	mg/kg/day	
				Vanadium	33	mg/kg	NC		NC			--		1.3E-04	mg/kg/day	
				HCX-TEQ	0.000000052	mg/kg	--		1.5E+05	(mg/kg/day)-1		--		ND		
				Dioxin-TEQ Mammal	0.0028	mg/kg	--		1.5E+05	(mg/kg/day)-1		--		ND		
												--				
												--				
			EXPOSURE ROUTE TOTAL								1.E-07					9.E-04
		EXPOSURE POINT TOTAL									8.E-06					2.E-02
	EXPOSURE MEDIUM TOTAL										8.E-06					2.E-02
SOIL TOTAL											8.E-06					2.E-02
										TOTAL RECEPTOR RISK ACROSS ALL MEDIA	8.E-06				TOTAL RECEPTOR HAZARD ACROSS ALL MEDIA	2.E-02

NOTES:
(1) - Blank cells indicate that an RfD or RfC is not avalailable from the sources used to obtain dose-response data for this risk assessment.
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
NV - Not volatile; exposure route not complete for this chemical.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

TABLE 9.1
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD (AGES 1-6)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD (AGES 1-6)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK (1)					NON-CARCINOGENIC HAZARD QUOTIENT (1)				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	SOIL	HUMAN HEALTH CONCERN AREA	Benz(a)anthracene	2.5E-08	NA	9.0E-09	NA	3.4E-08	Kidney	3.1E-06	NA	1.1E-06	4.3E-06
			Benzo(a)pyrene	4.2E-07	NA	1.5E-07	NA	5.7E-07	Kidney	5.3E-06	NA	1.9E-06	7.3E-06
			Benzo(b)fluoranthene	4.6E-08	NA	1.7E-08	NA	6.3E-08	Kidney	5.9E-06	NA	2.1E-06	8.0E-06
			Benzo(k)fluoranthene	1.4E-09	NA	5.2E-10	NA	1.9E-09	Kidney	1.8E-06	NA	6.6E-07	2.5E-06
			Carbazole	2.9E-11	NA	8.2E-12	NA	3.8E-11		--	NA	--	
			Dibenz(a,h)anthracene	4.6E-08	NA	1.7E-08	NA	6.2E-08	Kidney	5.8E-07	NA	2.1E-07	7.9E-07
			Dimethyl Phthalate	NC	NA	NC	NA			--	NA	--	
			Indeno(1,2,3-cd)pyrene	2.9E-08	NA	1.1E-08	NA	4.0E-08	Kidney	3.7E-06	NA	1.3E-06	5.1E-06
			Arsenic	1.6E-06	NA	1.4E-07	NA	1.7E-06	Skin	4.2E-02	NA	3.5E-03	4.5E-02
			Chromium	NC	NA	NC	NA		NOAEL	5.8E-03	NA	--	5.8E-03
			Cobalt	NC	NA	NC	NA		Endocrine	1.6E-02	NA	--	1.6E-02
			Manganese	NC	NA	NC	NA		Nervous System	2.4E-02	NA	--	2.4E-02
			Vanadium	NC	NA	NC	NA		Kidney	1.2E-02	NA	--	1.2E-02
			Dioxin-TEQ Mammal	1.9E-07	NA	1.6E-08	NA	2.0E-07		--	NA	--	
												--	
												--	
			CHEMICAL TOTAL	2.4E-06	--	3.6E-07	--	3E-06		9.9E-02	--	3.5E-03	1E-01
		EXPOSURE POINT TOTAL						3E-06					1E-01
	EXPOSURE MEDIUM TOTAL							3E-06					1E-01

RECEPTOR TOTAL	3E-06		1E-01
TOTAL RISK ACROSS ALL MEDIA	3E-06	TOTAL HAZARD ACROSS ALL MEDIA	1E-01

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

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TOTAL ENDOCRINE HI =	1.6E-02
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	--
TOTAL KIDNEY HI =	1.2E-02
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	--
TOTAL NERVOUS SYSTEM HI =	2.4E-02
TOTAL NOAEL HI =	5.8E-03
	--
TOTAL SKIN HI =	4.5E-02
	--

TABLE 9.2
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADOLESCENT (AGES 7-18)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADOLESCENT (AGES 7-18)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK (1)					NON-CARCINOGENIC HAZARD QUOTIENT (1)				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	SOIL	HUMAN HEALTH CONCERN AREA	Benz(a)anthracene	4.5E-09	NA	6.1E-09	NA	1.1E-08	Kidney	5.2E-07	NA	6.5E-07	1.2E-06
			Benzo(a)pyrene	7.7E-08	NA	1.0E-07	NA	1.8E-07	Kidney	8.9E-07	NA	1.1E-06	2.0E-06
			Benzo(b)fluoranthene	8.5E-09	NA	1.1E-08	NA	2.0E-08	Kidney	9.8E-07	NA	1.2E-06	2.2E-06
			Benzo(k)fluoranthene	2.6E-10	NA	3.5E-10	NA	6.1E-10	Kidney	3.0E-07	NA	3.8E-07	6.8E-07
			Carbazole	9.8E-12	NA	9.4E-12	NA	1.9E-11		--	NA	--	
			Dibenz(a,h)anthracene	8.3E-09	NA	1.1E-08	NA	2.0E-08	Kidney	9.7E-08	NA	1.2E-07	2.2E-07
			Dimethyl Phthalate	NC	NA	NC	NA			--	NA	--	
			Indeno(1,2,3-cd)pyrene	5.3E-09	NA	7.2E-09	NA	1.3E-08	Kidney	6.2E-07	NA	7.7E-07	1.4E-06
			Arsenic	5.4E-07	NA	1.5E-07	NA	6.9E-07	Skin	7.0E-03	NA	2.0E-03	9.0E-03
			Chromium	NC	NA	NC	NA		NOAEL	9.7E-04	NA	--	9.7E-04
			Cobalt	NC	NA	NC	NA		Endocrine	2.7E-03	NA	--	2.7E-03
			Manganese	NC	NA	NC	NA		Nervous System	4.0E-03	NA	--	4.0E-03
			Vanadium	NC	NA	NC	NA		Kidney	1.9E-03	NA	--	1.9E-03
			Dioxin-TEQ Mammal	6.2E-08	NA	1.8E-08	NA	8.0E-08		--	NA	--	
												--	
												--	
			CHEMICAL TOTAL	7.0E-07	--	3.1E-07	--	1E-06		1.7E-02	--	2.0E-03	2E-02
		EXPOSURE POINT TOTAL						1E-06					2E-02
	EXPOSURE MEDIUM TOTAL							1E-06					2E-02

RECEPTOR TOTAL	**1E-06**		**2E-02**
TOTAL RISK ACROSS ALL MEDIA	**1E-06**	**TOTAL HAZARD ACROSS ALL MEDIA**	**2E-02**

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

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	--
TOTAL ENDOCRINE HI =	2.7E-03
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	--
	--
TOTAL KIDNEY HI =	1.9E-03
	--
	--
TOTAL NERVOUS SYSTEM HI =	4.0E-03
TOTAL NOAEL HI =	9.7E-04
	--
TOTAL SKIN HI =	9.0E-03
	--

TABLE 9.3
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT (AGES 19-30)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT (AGES 19-30)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK (1)					NON-CARCINOGENIC HAZARD QUOTIENT (1)				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	SOIL	HUMAN HEALTH CONCERN ARE	Benz(a)anthracene	1.3E-09	NA	6.5E-10	NA	1.9E-09	Kidney	3.4E-07	NA	1.7E-07	5.1E-07
			Benzo(a)pyrene	2.1E-08	NA	1.1E-08	NA	3.2E-08	Kidney	5.7E-07	NA	3.0E-07	8.7E-07
			Benzo(b)fluoranthene	2.4E-09	NA	1.2E-09	NA	3.6E-09	Kidney	6.3E-07	NA	3.3E-07	9.6E-07
			Benzo(k)fluoranthene	7.3E-11	NA	3.8E-11	NA	1.1E-10	Kidney	1.9E-07	NA	1.0E-07	2.9E-07
			Carbazole	6.3E-12	NA	2.5E-12	NA	8.8E-12		--	NA	--	
			Dibenz(a,h)anthracene	2.3E-09	NA	1.2E-09	NA	3.5E-09	Kidney	6.2E-08	NA	3.2E-08	9.4E-08
			Dimethyl Phthalate	NC	NA	NC	NA			--	NA	--	
			Indeno(1,2,3-cd)pyrene	1.5E-09	NA	7.7E-10	NA	2.3E-09	Kidney	4.0E-07	NA	2.1E-07	6.0E-07
			Arsenic	3.5E-07	NA	4.1E-08	NA	3.9E-07	Skin	4.5E-03	NA	5.4E-04	5.0E-03
			Chromium	NC	NA	NC	NA		NOAEL	6.2E-04	NA	--	6.2E-04
			Cobalt	NC	NA	NC	NA		Endocrine	1.7E-03	NA	--	1.7E-03
			Manganese	NC	NA	NC	NA		Nervous System	2.6E-03	NA	--	2.6E-03
			Vanadium	NC	NA	NC	NA		Kidney	1.2E-03	NA	--	1.2E-03
			Dioxin-TEQ Mammal	4.0E-08	NA	4.8E-09	NA	4.5E-08		--	NA	--	
												--	
												--	
			CHEMICAL TOTAL	4.1E-07	--	6.1E-08	--	5E-07		1.1E-02	--	5.4E-04	1E-02
		EXPOSURE POINT TOTAL						5E-07					1E-02
	EXPOSURE MEDIUM TOTAL							5E-07					1E-02

RECEPTOR TOTAL	**5E-07**		**1E-02**
TOTAL RISK ACROSS ALL MEDIA	**5E-07**	**TOTAL HAZARD ACROSS ALL MEDIA**	**1E-02**

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

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	--
TOTAL ENDOCRINE HI =	**1.7E-03**
	--
	--
	--
	--
TOTAL KIDNEY HI =	**1.2E-03**
	--
	--
TOTAL NERVOUS SYSTEM HI =	**2.6E-03**
TOTAL NOAEL HI =	**6.2E-04**
	--
TOTAL SKIN HI =	**5.0E-03**
	--

TABLE 9.4
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - CHILD (AGES 1-6)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: CHILD (AGES 1-6)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK (1)					NON-CARCINOGENIC HAZARD QUOTIENT (1)				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	SOIL	GENERAL AREA	Benz(a)anthracene	2.2E-07	NA	8.0E-08	NA	3.0E-07	Kidney	2.8E-05	NA	1.0E-05	3.8E-05
			Benzo(a)pyrene	2.7E-06	NA	1.0E-06	NA	3.7E-06	Kidney	3.5E-05	NA	1.3E-05	4.8E-05
			Benzo(b)fluoranthene	4.0E-07	NA	1.5E-07	NA	5.4E-07	Kidney	5.1E-05	NA	1.8E-05	6.9E-05
			Benzo(k)fluoranthene	2.2E-08	NA	8.1E-09	NA	3.0E-08	Kidney	2.8E-05	NA	1.0E-05	3.8E-05
			Carbazole	2.3E-10	NA	6.4E-11	NA	2.9E-10		--	NA	--	
			Dibenz(a,h)anthracene	4.5E-07	NA	1.6E-07	NA	6.1E-07	Kidney	5.7E-06	NA	2.1E-06	7.8E-06
			Dimethyl Phthalate	NC	NA	NC	NA			--	NA	--	
			Indeno(1,2,3-cd)pyrene	1.9E-07	NA	6.8E-08	NA	2.6E-07	Kidney	2.4E-05	NA	8.6E-06	3.2E-05
			Aroclor 1254	2.9E-08	NA	1.1E-08	NA	4.1E-08	Immune system	8.5E-03	NA	3.4E-03	1.2E-02
			Aroclor 1268	4.2E-09	NA	1.7E-09	NA	5.9E-09	Immune system	1.2E-03	NA	4.8E-04	1.7E-03
			Aluminum	NC	NA	NC	NA		Nervous System	1.4E-02	NA	--	1.4E-02
			Arsenic	8.5E-07	NA	7.2E-08	NA	9.3E-07	Skin	2.2E-02	NA	1.9E-03	2.4E-02
			Chromium	NC	NA	NC	NA		NOAEL	1.0E-02	NA	--	1.0E-02
			Cobalt	NC	NA	NC	NA		Endocrine	2.0E-02	NA	--	2.0E-02
			Manganese	NC	NA	NC	NA		Nervous System	2.1E-02	NA	--	2.1E-02
			Thallium	NC	NA	NC	NA		NOAEL	4.3E-02	NA	--	4.3E-02
			Vanadium	NC	NA	NC	NA		Kidney	6.4E-03	NA	--	6.4E-03
			HCX-TEQ	6.3E-10	NA	--	NA	6.3E-10		--	NA	--	
			Dioxin-TEQ Mammal	3.4E-05	NA	--	NA	3.4E-05		--	NA	--	
												--	
												--	
			CHEMICAL TOTAL	3.9E-05	--	1.5E-06	--	4E-05		1.5E-01	--	5.8E-03	2E-01
		EXPOSURE POINT TOTAL						4E-05					2E-01
	EXPOSURE MEDIUM TOTAL							4E-05					2E-01
RECEPTOR TOTAL								**4E-05**					**2E-01**
							TOTAL RISK ACROSS ALL MEDIA	**4E-05**	**TOTAL HAZARD ACROSS ALL MEDIA**				**2E-01**

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

	--
	--
	--
TOTAL ENDOCRINE HI =	2.0E-02
	--
	--
	--
TOTAL IMMUNE SYSTEM HI =	1.4E-02
TOTAL KIDNEY HI =	6.6E-03
	--
	--
TOTAL NERVOUS SYSTEM HI =	3.5E-02
TOTAL NOAEL HI =	5.3E-02
	--
TOTAL SKIN HI =	2.4E-02
	--

TABLE 9.5
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADOLESCENT (AGES 7-18)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADOLESCENT (AGES 7-18)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK (1)					NON-CARCINOGENIC HAZARD QUOTIENT (1)				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	SOIL	GENERAL AREA	Benz(a)anthracene	4.0E-08	NA	5.4E-08	NA	9.4E-08	Kidney	4.6E-06	NA	5.8E-06	1.0E-05
			Benzo(a)pyrene	5.0E-07	NA	6.8E-07	NA	1.2E-06	Kidney	5.8E-06	NA	7.2E-06	1.3E-05
			Benzo(b)fluoranthene	7.3E-08	NA	9.9E-08	NA	1.7E-07	Kidney	8.4E-06	NA	1.1E-05	1.9E-05
			Benzo(k)fluoranthene	4.1E-09	NA	5.5E-09	NA	9.6E-09	Kidney	4.7E-06	NA	5.9E-06	1.1E-05
			Carbazole	7.6E-11	NA	7.3E-11	NA	1.5E-10		--	NA	--	
			Dibenz(a,h)anthracene	8.2E-08	NA	1.1E-07	NA	1.9E-07	Kidney	9.5E-07	NA	1.2E-06	2.1E-06
			Dimethyl Phthalate	NC	NA	NC	NA			--	NA	--	
			Indeno(1,2,3-cd)pyrene	3.4E-08	NA	4.6E-08	NA	8.1E-08	Kidney	4.0E-06	NA	4.9E-06	8.9E-06
			Aroclor 1254	9.8E-09	NA	1.3E-08	NA	2.3E-08	Immune system	1.4E-03	NA	1.9E-03	3.3E-03
			Aroclor 1268	1.4E-09	NA	1.9E-09	NA	3.3E-09	Immune system	2.1E-04	NA	2.8E-04	4.8E-04
			Aluminum	NC	NA	NC	NA		Nervous System	2.3E-03	NA	--	2.3E-03
			Arsenic	2.8E-07	NA	8.2E-08	NA	3.7E-07	Skin	3.7E-03	NA	1.1E-03	4.8E-03
			Chromium	NC	NA	NC	NA		NOAEL	1.7E-03	NA	--	1.7E-03
			Cobalt	NC	NA	NC	NA		Endocrine	3.3E-03	NA	--	3.3E-03
			Manganese	NC	NA	NC	NA		Nervous System	3.5E-03	NA	--	3.5E-03
			Thallium	NC	NA	NC	NA		NOAEL	7.1E-03	NA	--	7.1E-03
			Vanadium	NC	NA	NC	NA		Kidney	1.1E-03	NA	--	1.1E-03
			HCX-TEQ	2.1E-10	NA	--	NA	2.1E-10		--	NA	--	
			Dioxin-TEQ Mammal	1.1E-05	NA	--	NA	1.1E-05		--	NA	--	
												--	
												--	
												--	
			CHEMICAL TOTAL	1.2E-05	--	1.1E-06	--	1E-05		2.4E-02	--	3.3E-03	3E-02
		EXPOSURE POINT TOTAL						1E-05					3E-02
	EXPOSURE MEDIUM TOTAL							1E-05					3E-02

RECEPTOR TOTAL	**1E-05**		**3E-02**
TOTAL RISK ACROSS ALL MEDIA	**1E-05**	**TOTAL HAZARD ACROSS ALL MEDIA**	**3E-02**

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

	--
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	--
TOTAL ENDOCRINE HI =	**3.3E-03**
	--
	--
	--
TOTAL IMMUNE SYSTEM HI =	**3.8E-03**
TOTAL KIDNEY HI =	**1.1E-03**
	--
	--
TOTAL NERVOUS SYSTEM HI =	**5.8E-03**
TOTAL NOAEL HI =	**8.8E-03**
	--
TOTAL SKIN HI =	**4.8E-03**
	--

TABLE 9.6
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - REASONABLE MAXIMUM EXPOSURE - CURRENT/FUTURE - PASSIVE RECREATIONAL VISITOR - ADULT (AGES 19-30)
CENTREDALE MANOR RESTORATION PROJECT SUPERFUND SITE
NORTH PROVIDENCE, RHODE ISLAND

SCENARIO TIMEFRAME: CURRENT/FUTURE
RECEPTOR POPULATION: PASSIVE RECREATIONAL VISITOR
RECEPTOR AGE: ADULT (AGES 19-30)

MEDIUM	EXPOSURE MEDIUM	EXPOSURE POINT	CHEMICAL	CARCINOGENIC RISK (1)					NON-CARCINOGENIC HAZARD QUOTIENT (1)				
				INGESTION	INHALATION	DERMAL	EXTERNAL (RADIATION)	EXPOSURE ROUTES TOTAL	PRIMARY TARGET ORGAN	INGESTION	INHALATION	DERMAL	EXPOSURE ROUTES TOTAL
SOIL	SOIL	GENERAL AREA	Benz(a)anthracene	1.1E-08	NA	5.8E-09	NA	1.7E-08	Kidney	3.0E-06	NA	1.5E-06	4.5E-06
			Benzo(a)pyrene	1.4E-07	NA	7.3E-08	NA	2.1E-07	Kidney	3.7E-06	NA	1.9E-06	5.7E-06
			Benzo(b)fluoranthene	2.0E-08	NA	1.1E-08	NA	3.1E-08	Kidney	5.4E-06	NA	2.8E-06	8.2E-06
			Benzo(k)fluoranthene	1.1E-09	NA	5.9E-10	NA	1.7E-09	Kidney	3.0E-06	NA	1.6E-06	4.6E-06
			Carbazole	4.9E-11	NA	1.9E-11	NA	6.8E-11		--	NA	--	
			Dibenz(a,h)anthracene	2.3E-08	NA	1.2E-08	NA	3.5E-08	Kidney	6.1E-07	NA	3.2E-07	9.3E-07
			Dimethyl Phthalate	NC	NA	NC	NA			--	NA	--	
			Indeno(1,2,3-cd)pyrene	9.6E-09	NA	5.0E-09	NA	1.5E-08	Kidney	2.5E-06	NA	1.3E-06	3.9E-06
			Aroclor 1254	6.3E-09	NA	3.5E-09	NA	9.8E-09	Immune system	9.2E-04	NA	5.1E-04	1.4E-03
			Aroclor 1268	9.1E-10	NA	5.1E-10	NA	1.4E-09	Immune system	1.3E-04	NA	7.4E-05	2.1E-04
			Aluminum	NC	NA	NC	NA		Nervous System	1.5E-03	NA	--	1.5E-03
			Arsenic	1.8E-07	NA	2.2E-08	NA	2.1E-07	Skin	2.4E-03	NA	2.8E-04	2.7E-03
			Chromium	NC	NA	NC	NA		NOAEL	1.1E-03	NA	--	1.1E-03
			Cobalt	NC	NA	NC	NA		Endocrine	2.1E-03	NA	--	2.1E-03
			Manganese	NC	NA	NC	NA		Nervous System	2.2E-03	NA	--	2.2E-03
			Thallium	NC	NA	NC	NA		NOAEL	4.6E-03	NA	--	4.6E-03
			Vanadium	NC	NA	NC	NA		Kidney	6.9E-04	NA	--	6.9E-04
			HCX-TEQ	1.4E-10	NA	--	NA	1.4E-10		--	NA	--	
			Dioxin-TEQ Mammal	7.3E-06	NA	--	NA	7.3E-06		--	NA	--	
												--	
												--	
			CHEMICAL TOTAL	7.7E-06	--	1.3E-07	--	8E-06		1.6E-02	--	8.8E-04	2E-02
		EXPOSURE POINT TOTAL						8E-06					2E-02
	EXPOSURE MEDIUM TOTAL							8E-06					2E-02

RECEPTOR TOTAL	**8E-06**		**2E-02**
TOTAL RISK ACROSS ALL MEDIA	**8E-06**	**TOTAL HAZARD ACROSS ALL MEDIA**	**2E-02**

NOTES:
NC - Not carcinogenic by this exposure route.
NA - Not applicable; exposure route not applicable for this chemical/exposure medium.
-- - Not calculated; dose-response data and/or dermal absorption values are not available.

Prepared by: BJR 03/31/11
Checked by: KJC 04/01/11

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	--
TOTAL ENDOCRINE HI =	2.1E-03
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	--
	--
TOTAL IMMUNE SYSTEM HI =	1.6E-03
TOTAL KIDNEY HI =	7.1E-04
	--
	--
TOTAL NERVOUS SYSTEM HI =	3.7E-03
TOTAL NOAEL HI =	5.7E-03
	--
TOTAL SKIN HI =	2.7E-03
	--

Table 11.1
Risk Assessment Summary

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Exposure Scenario	Receptor	Exposure Point	Exposure Route	Excess Lifetime Cancer Risk	Hazard Index
Current/Future - Human Health Concern Area					
Passive Recreational Visitor	Child (ages 1 through 6)	Soil	Incidental ingestion	2.4E-06	0.1
			Dermal contact	3.6E-07	0.004
			Total Risk:	**2.7E-06**	**0.1**
	Adolescent (ages 7 through 18)	Soil	Incidental ingestion	7.0E-07	0.02
			Dermal contact	3.1E-07	0.002
			Total Risk:	**1.0E-06**	**0.02**
	Adult (ages 19 and above)	Soil	Incidental ingestion	4.1E-07	0.01
			Dermal contact	6.1E-08	0.0005
			Total Risk:	**4.8E-07**	**0.01**
			Total Receptor Risk:	**4E-06**	**NC**
Current/Future - General Area					
Passive Recreational Visitor	Child (ages 1 through 6)	Soil	Incidental ingestion	3.9E-05	0.1
			Dermal contact	1.5E-06	0.006
			Total Risk:	**4.1E-05**	**0.2**
	Adolescent (ages 7 through 18)	Soil	Incidental ingestion	1.2E-05	0.02
			Dermal contact	1.1E-06	0.003
			Total Risk:	**1.4E-05**	**0.03**
	Adult (ages 19 and above)	Soil	Incidental ingestion	7.7E-06	0.02
			Dermal contact	1.3E-07	0.0009
			Total Risk:	**7.9E-06**	**0.02**
			Total Receptor Risk:	**6E-05**	**NC**

Prepared by: BJR 4/1/11
Checked by: KJC 4/1/11

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FIGURES

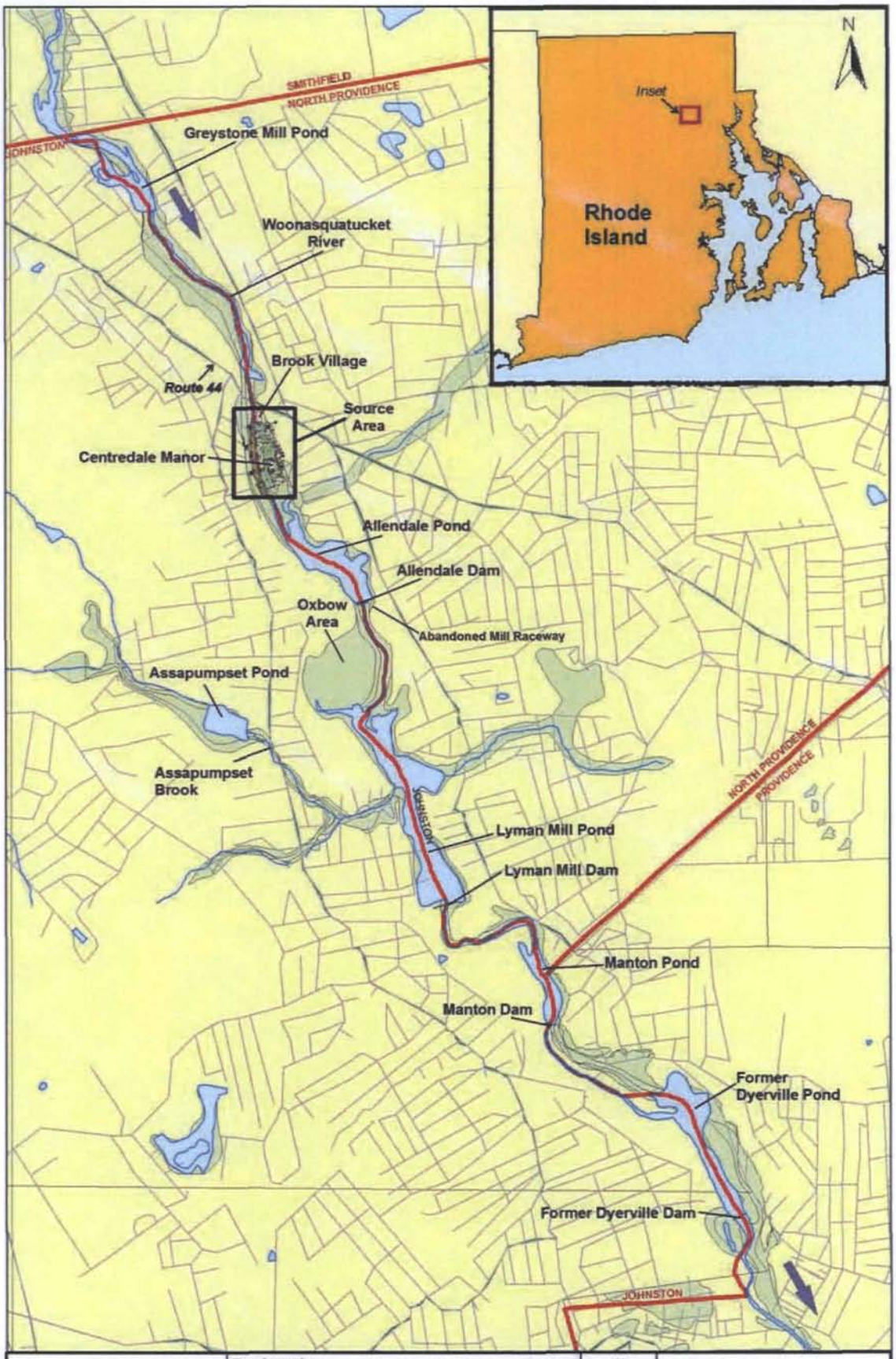

Figure 1
Site Map

Explanation:

- Roads
- Town Boundary
- 100 Year Flood Zone
- Outside of 100 Year Flood Zone
- River Flow Direction

0 500 1,000 2,000
Feet

N

Date: 10/16/07

Document: sitemap_battelle_final*.mxd
Drawn By: Jim Hicks (Battelle)
Checked by: Deirdre Dahlen (Battelle)
Projection: Rhode Island State Plane (NAD 83 Feet)

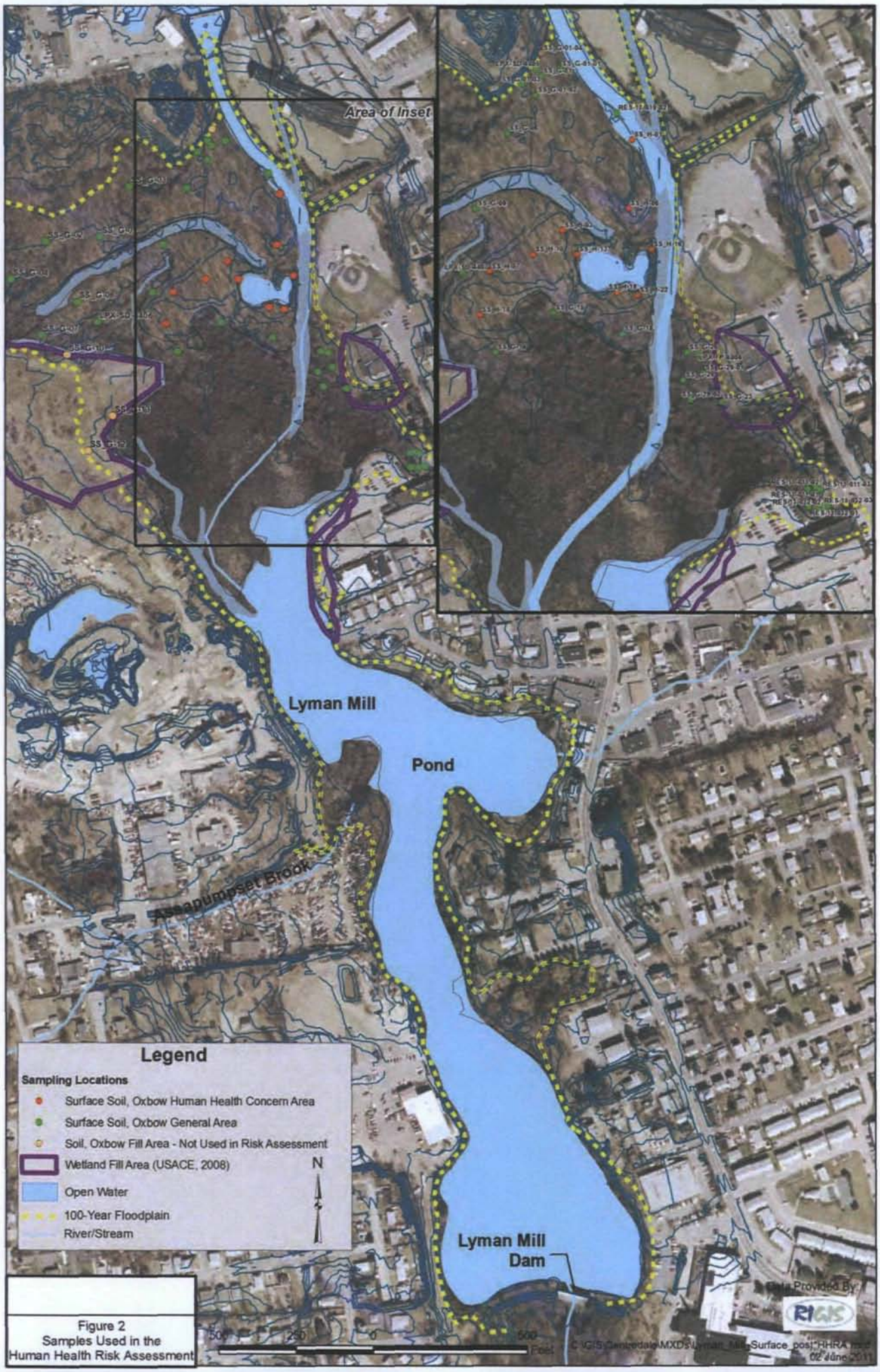

Figure 2
Samples Used in the
Human Health Risk Assessment

APPENDICES

APPENDIX A

Samples Used in Human Health Risk Assessment

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Table A-1
Samples Used in Human Health Risk Assessment

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Media	Exposure Area	Location ID	Sample ID	Sample Date	Top Depth	Bottom Depth
Surface Soil	Human Health Concern Area	SS_H-01	SS_H-01-SS1	9/28/2010	0	1
		SS_H-03	SS_H-03-SS1	9/29/2010	0	1
		SS_H-06	SS_H-06-SS1	9/28/2010	0	1
		SS_H-07	SS_H-07-SS1	9/29/2010	0	1
		SS_H-10	SS_H-10-SS1	9/29/2010	0	1
		SS_H-13	SS_H-13-SS1	9/29/2010	0	1
		SS_H-16	SS_H-16-SS1	9/28/2010	0	1
		SS_H-18	SS_H-18-SS1	9/29/2010	0	1
		SS_H-19	SS_H-19-SS1	9/30/2010	0	1
		SS_H-22	SS_H-22-SS1	9/28/2010	0	1
	General Area	LPX-FP-4004	LPX-FP-4004-0000-01	7/19/2001	0	0.5
		LPX-SD-4405	LPX-SD-4405-0005-01	6/21/2004	0	0.5
		LPX-SD-4406	LPX-SD-4406-0005-01	6/21/2004	0	0.5
		LPX-SD-4407	LPX-SD-4407-0005-01	6/21/2004	0	0.5
		RES-11-011	RES-SS-11-011-AVG	12/2/1999	0	1
		RES-11-011-01	RES-SS-11-011-01	12/2/1999	0	1
		RES-11-011-02	RES-SS-11-011-02	12/2/1999	0	1
		RES-11-011-03	RES-SS-11-011-03	12/2/1999	0	1
		RES-11-012	RES-SS-11-012-AVG	12/2/1999	0	1
		RES-11-012-01	RES-SS-11-012-01	12/2/1999	0	1
		RES-11-012-02	RES-SS-11-012-02	12/2/1999	0	1
		RES-11-012-03	RES-SS-11-012-03	12/2/1999	0	1
		RES-11-419-02	RES-SS-11-419-02	11/19/1999	0	1
		SS_G-01	SS_G-01-AVG	9/28/2010	0	1
		SS_G-01	SS_G-01-SS1	9/28/2010	0	1
		SS_G-01-01	SS_G-01-SS5	11/18/2010	0	1
		SS_G-01-02	SS_G-01-SS2	11/18/2010	0	1
		SS_G-01-03	SS_G-01-SS3	11/18/2010	0	1
		SS_G-02	SS_G-02-SS1	9/29/2010	0	1
		SS_G-03	SS_G-03-SS1	9/28/2010	0	1
		SS_G-04	SS_G-04-SS1	9/29/2010	0	1
		SS_G-05	SS_G-05-SS1	9/30/2010	0	1
		SS_G-06	SS_G-06-SS1	9/28/2010	0	1
		SS_G-07	SS_G-07-SS1	9/29/2010	0	1
		SS_G-08	SS_G-08-SS1	9/29/2010	0	1
		SS_G-09	SS_G-09-SS1	9/29/2010	0	1
		SS_G-14	SS_G-14-SS1	10/1/2010	0	1
		SS_G-15	SS_G-15-SS1	10/1/2010	0	1
		SS_G-18	SS_G-18-SS1	10/1/2010	0	1
		SS_G-23	SS_G-23-SS1	9/30/2010	0	1
		SS_G-26	SS_G-26-SS1	9/30/2010	0	1
		SS_G-29	SS_G-29-AVG	9/30/2010	0	1
		SS_G-29	SS_G-29-SS1	9/30/2010	0	1
		SS_G-29-01	SS_G-29-SS3	11/18/2010	0	1
		SS_G-29-02	SS_G-29-SS2	11/18/2010	0	1

Shaded samples have been replaced in the risk assessment calculations by the associated "AVG" summary sample (average concentrations).

Prepared by: KJC 03/28/11
Checked by: BJR 03/29/11

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APPENDIX B

Data Used in Human Health Risk Assessment

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Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	LPX-FP-4004-0000-01 7/19/2001	LPX-SD-4405-0005-01 6/21/2004	LPX-SD-4406-0005-01 6/21/2004	LPX-SD-4407-0005-01 6/21/2004	RES-SS-11-011-AVG 12/2/1999	RES-SS-11-012-AVG 12/2/1999	RES-SS-11-419-02 11/19/1999	SS_G-01-AVG 9/28/2010	SS_G-02-SS1 9/29/2010	SS_G-03-SS1 9/28/2010	SS_G-04-SS1 9/29/2010
Semivolatile Organics (mg/Kg)											
1,2,4-Trichlorobenzene								0.016 U	0.0026 U	0.0026 U	0.035 UJ
1,2-Dichlorobenzene								0.019 U	0.0029 U	0.0029 U	0.039 UJ
1,3-Dichlorobenzene								0.019 U	0.003 U	0.003 U	0.04 UJ
1,4-Dichlorobenzene								0.019 U	0.0029 U	0.0029 U	0.039 UJ
2,2'-oxybis(1-chloropropane)					0.53 U	0.65 U					
2,4,5-Trichlorophenol	2.6 U				1.3 U	1.6 U		0.013 J	0.0015 U	0.0015 U	0.02 UJ
2,4,6-Trichlorophenol					0.53 U	0.65 U		0.0088 U	0.0052 J	0.0014 U	0.019 UJ
2,4-Dichlorophenol					0.53 U	0.65 U		0.0063 U	0.001 U	0.001 U	0.014 UJ
2,4-Dimethylphenol					0.53 U	0.65 U		0.035 U	0.0055 UJ	0.0055 U	0.073 UJ
2,4-Dinitrophenol	2.6 UJ				1.3 U	1.6 U		0.085 U	0.017 UJ	0.017 U	0.23 UJ
2,4-Dinitrotoluene					0.53 U	0.65 U		0.0094 U	0.0015 U	0.0015 U	0.02 UJ
2,6-Dinitrotoluene					0.53 U	0.65 U		0.013 U	0.002 U	0.002 U	0.027 UJ
2-Chloronaphthalene					0.53 U	0.65 U		0.01 U	0.0016 U	0.0016 U	0.022 UJ
2-Chlorophenol					0.53 U	0.65 U		0.013 U	0.002 U	0.002 U	0.027 UJ
2-Methyl-4,6-dinitrophenol					1.3 U	1.6 U		0.0088 U	0.0014 U	0.0014 U	0.019 UJ
2-Methylnaphthalene	0.00782 J				0.53 U	0.65 U		0.013 J	0.0032 J	0.0022 U	0.029 UJ
2-Methylphenol					0.53 U	0.65 U		0.0094 U	0.0015 U	0.0015 U	0.02 UJ
2-Nitroaniline					1.3 U	1.6 U		0.02 U	0.0032 U	0.0032 U	0.043 UJ
2-Nitrophenol	0.51 U				0.53 U	0.65 U		0.0094 U	0.0015 U	0.0015 U	0.02 UJ
3,3'-Dichlorobenzidine					0.53 U	0.65 U		0.024 U	0.0037 U	0.0037 U	0.049 UJ
3-Nitroaniline					1.3 U	1.6 U		0.016 U	0.0025 U	0.0025 U	0.033 UJ
4-Bromophenyl Phenyl Ether					0.53 U	0.65 U		0.01 U	0.0016 U	0.0016 U	0.022 UJ
4-Chloro-3-methylphenol					0.53 U	0.65 U		0.0088 U	0.0014 U	0.0014 U	0.019 UJ
4-Chloroaniline					0.53 U	0.65 U		0.012 U	0.0019 U	0.0019 U	0.025 UJ
4-Chlorophenyl Phenyl Ether					0.53 U	0.65 U		0.0088 U	0.0014 U	0.0014 U	0.019 UJ
4-Methylphenol	0.51 U				0.53 U	0.65 U		0.0094 U	0.0015 U	0.0015 U	0.02 UJ
4-Nitroaniline					1.3 U	1.6 U		0.011 U	0.0018 U	0.0018 U	0.024 UJ
4-Nitrophenol	2.6 U				1.3 U	1.6 U		0.11 U	0.018 U	0.018 U	0.24 UJ
Acenaphthene	0.01054 J				0.53 U	0.12 J		0.033 J	0.0029 J	0.0014 U	0.019 UJ
Acenaphthylene	0.02823 J				0.3 J	0.16 J		0.097	0.012	0.0092	0.047 J
Acetophenone					0.53 U	0.65 U					
Anthracene	0.04475 J				0.22 J	0.35 J		0.13	0.014	0.0074 J	0.043 J
Atrazine					0.53 U	0.65 U					
Benz(a)anthracene	0.29695 J				0.76	1.3 J		0.56	0.078	0.028	0.19 J
Benzaldehyde	0.02951 U				0.53 U	0.65 U		0.049 U	0.012 J	0.0077 U	0.11 UJ
Benzo(a)pyrene	0.34967 J				0.96	1.7 J		0.71	0.13	0.042	0.37 J
Benzo(b)fluoranthene	0.419 J				1.5	3.1 J		0.88	0.23	0.052	0.59 J
Benzo(g,h,i)perylene	0.29644 J				0.31 J	0.47 J		0.44	0.13	0.032	0.35 J
Benzo(k)fluoranthene	0.37161 J				1.6	2.7 J		0.31	0.081	0.018	0.2 J
Benzoic Acid								0.48 U	R	0.096 U	R
Benzyl Alcohol								0.014 U	0.007 J	0.0021 U	0.058 J
Biphenyl	0.00328 J				0.53 U	0.65 U		0.012 U	0.0019 U	0.0019 U	0.025 UJ
Bis(2-chloroethoxy)methane					0.53 U	0.65 U		0.0094 U	0.0015 U	0.0015 U	0.02 UJ
Bis(2-chloroethyl) Ether					0.53 U	0.65 U		0.012 U	0.0019 U	0.0019 U	0.025 UJ
Bis(2-chloroisopropyl) Ether								0.016 U	0.0026 U	0.0026 U	0.035 UJ
Bis(2-ethylhexyl) Phthalate	0.31 J				0.13 J	2.9		0.38 J	0.031 J	0.012 J	0.11 J
Butyl Benzyl Phthalate	0.07 J				0.53 U	0.62 J		0.099 J	0.024	0.0071 J	0.11 J
Caprolactam					0.53 U	0.65 U					
Carbazole	0.072 J				0.11 J	0.26 J		0.076	0.019	0.0046 J	0.043 J
Chrysene	0.45735 J				1.2	2.1		0.73	0.17	0.043	0.32 J
Dibenz(a,h)anthracene	0.07375 J				0.14 J	0.17 J		0.12	0.023	0.0076 J	0.057 J
Dibenzofuran	0.01111 J				0.53 U	0.093 J		0.021 J	0.0025 J	0.0012 U	0.016 UJ
Diethyl Phthalate					0.53 U	0.65 U		0.0081 U	0.0013 U	0.0013 U	0.018 UJ
Dimethyl Phthalate					0.53 U	0.65 U		0.079 J	0.001 U	0.001 U	0.12 J

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Di-n-butyl Phthalate	0.51 UJ				0.53 U	0.093 JEB		0.05 U	0.0079 U	0.0079 U	0.11 UJ
Di-n-octyl Phthalate	0.51 U				0.53 U	0.65 UJ		0.011 U	0.0017 U	0.0017 U	0.023 UJ
Fluoranthene	0.79252 J				2	3.4		1.2	0.28	0.061	0.58 J
Fluorene	0.01638 J				0.073 J	0.14 J		0.04 J	0.0036 J	0.0026 J	0.015 UJ
Hexachlorobenzene					0.53 U	0.65 U		0.0075 U	0.0012 U	0.0012 U	0.016 UJ
Hexachlorobutadiene					0.53 U	0.65 U		0.016 U	0.0025 U	0.0025 U	0.033 UJ
Hexachlorocyclopentadiene					0.53 U	0.65 U		0.19 U	0.029 U	0.029 U	0.39 UJ
Hexachloroethane					0.53 U	0.65 U		0.02 U	0.0031 U	0.0031 U	0.041 UJ
Indeno(1,2,3-cd)pyrene	0.32296 J				0.38 J	0.47 J		0.46	0.13	0.031	0.37 J
Isophorone					0.53 U	0.65 U		0.0063 U	0.001 U	0.001 U	0.014 UJ
Naphthalene	0.01275 J				0.53 U	0.65 U		0.018 J	0.0037 J	0.0033 J	0.031 UJ
Nitrobenzene					0.53 U	0.65 U		0.01 J	0.0022 U	0.0022 U	0.029 UJ
N-Nitrosodi-n-propylamine					0.53 U	0.65 U		0.015 U	0.0024 U	0.0024 U	0.032 UJ
N-Nitrosodiphenylamine					0.53 U	0.65 U		0.01 U	0.0016 U	0.0016 U	0.022 UJ
Pentachlorophenol	2.6 U				1.3 U	1.6 U		0.13 U	0.02 U	0.02 U	0.27 UJ
Phenanthrene	0.33152 J				1.1	2.2		0.53	0.084	0.028	0.18 J
Phenol	0.51 U				0.53 U	0.65 U		0.013 U	0.0049 J	0.002 U	0.033 J
Pyrene	0.62517 J				2.4	5		1.2	0.23	0.059	0.5 J
Pesticides/PCBs (mg/Kg)											
4,4'-DDD	0.00144			0.02658	0.0054 U	0.0082		0.00054 J	0.00011 U	0.00011 U	0.003 J
4,4'-DDE	0.00505			0.04236	0.0054 U	0.021 P		0.0043	0.0018	0.0017	0.0058 J
4,4'-DDT	0.00304			0.00276 J	0.0054 U	0.027		0.033 J	0.0012 U	0.0018	0.0059 UJ
Aldrin	0.00114 U			0.00097	0.0028 U	0.0034 P		0.00044 U	0.00016 U	0.00016 U	0.00043 UJ
alpha-BHC	0.00114 U			0.00019 U	0.0028 U	0.0034 U		0.00011 J	0.00088 U	0.00011 U	0.00031 UJ
alpha-Chlordane	0.00284			0.00768 J	0.0028 U	0.015		0.0013 J	0.00028 J	0.0001 U	0.0036 J
beta-BHC	0.00114 U			0.00016 U	0.0028 U	0.0034 U		0.00045 U	0.00018 U	0.00019 U	0.00048 UJ
Chlordane	0.07963 J			0.02034 U				0.041 J	0.0061 J	0.0046 U	0.058 J
delta-BHC	0.00114 U			0.0002 U	0.0028 U	0.0034 U		0.00013 U	0.000074 U	0.000074 U	0.0003 UJ
Dieldrin	0.0022			0.00251	0.0054 U	0.0066 U		0.007 J	0.00014 U	0.00045 U	0.00037 UJ
Endosulfan I	0.00114 U			0.00021 U	0.0028 U	0.0034 U		0.0016 J	0.00088 U	0.000063 U	0.0027 UJ
Endosulfan II	0.00114 U			0.0002 U	0.0054 U	0.0066 U		0.0019 J	0.00088 U	0.00034 J	0.0027 UJ
Endosulfan Sulfate	0.00137			0.00024 U	0.0054 U	0.0066 U		0.00044 J	0.00011 U	0.00019 U	0.00029 UJ
Endrin	0.00114 U			0.0002 U	0.0054 U	0.0066 U		0.001	0.000094 U	0.00024 U	0.00045 UJ
Endrin Aldehyde	0.00114 U			0.0019	0.0054 U	0.0066 U		0.0013 J	0.00012 U	0.00023 J	0.00055 J
Endrin Ketone	0.00114 U			0.0002 U	0.0054 U	0.016		0.0014	0.000093 U	0.000093 U	0.00032 J
gamma-BHC (Lindane)	0.00114 U			0.00018 U	0.0028 U	0.0034 U		0.0011	0.00018 U	0.00008 U	0.00052 J
gamma-Chlordane	0.00114 U			0.00694	0.0028 U	0.011		0.0089 J	0.00028 J	0.00035 J	0.0044 J
Heptachlor	0.00114 U			0.00019 U	0.0028 U	0.0034 U		0.00042 U	0.00012 U	0.00012 U	0.00032 UJ
Heptachlor Epoxide	0.00039 J			0.00017 U	0.0076 P	0.026		0.00074 U	0.000084 U	0.000084 U	0.00025 J
Methoxychlor	0.00114 U			0.00028 U	0.028 U	0.034 U		0.00073 U	0.00019 U	0.00019 U	0.0005 UJ
Toxaphene	0.02845 U			0.02033 U	0.28 U	0.34 U		0.23 U	0.019 U	0.024 U	0.14 UJ
Aroclor 1016	0.01423 U			0.02032 U	0.054 U	0.066 U		0.008 U	0.0021 U	0.0021 U	0.0056 UJ
Aroclor 1221	0.01423 U			0.02028 U	0.11 U	0.13 U		0.008 U	0.0021 U	0.0021 U	0.0056 UJ
Aroclor 1232	0.01423 U			0.02028 U	0.054 U	0.066 U		0.008 U	0.0021 U	0.0021 U	0.0056 UJ
Aroclor 1242	0.01423 U			0.02028 U	0.054 U	0.066 U		0.008 U	0.0021 U	0.0021 U	0.0056 UJ
Aroclor 1248	0.01423 U			0.02028 U	0.054 U	0.066 U		0.008 U	0.0021 U	0.0021 U	0.0056 UJ
Aroclor 1254	0.12002			0.63783	0.054 U	0.15		0.28 J	0.0021 U	0.0077 J	0.049 J
Aroclor 1260	0.01423 U			0.02032 U	0.054 U	0.066 U		0.008 U	0.0049 U	0.0021 U	0.0056 UJ
Aroclor 1262								0.008 U	0.0021 U	0.0021 U	0.0056 UJ
Aroclor 1268	0.02249			0.02028 U				0.026 J	0.0021 U	0.0021 U	0.0056 UJ
PCB Congeners (mg/Kg)											
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl	0.00202532										
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (194)	0.00038264 J										
2,2',3,3',4,4',5,6,6'-nonachlorobiphenyl	0.00014313 J										
2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)	0.00017579 J										

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2,2',3,3',4,4',5,6'-Octachlorobiphenyl (196)	0.00021888 J										
2,2',3,3',4,4',5-Heptachlorobiphenyl (170)	0.0018151 J										
2,2',3,3',4,4',6,6'-Octachlorobiphenyl (197)	0.00001127 J										
2,2',3,3',4,4',6-Heptachlorobiphenyl (171)	0.0004942 J										
2,2',3,3',4,4'-Hexachlorobiphenyl (128)	0.0023494 J										
2,2',3,3',4,5,5',6-Octachlorobiphenyl (198)	0.00126122 J										
2,2',3,3',4,5,5'-Heptachlorobiphenyl (172)	0.00019898 J										
2,2',3,3',4,5,6,6'-Octachlorobiphenyl (200)	0.00008211 J										
2,2',3,3',4,5',6,6'-Octachlorobiphenyl (201)	0.00007758 J										
2,2',3,3',4,5,6'-Heptachlorobiphenyl (174)	0.00140923 J										
2,2',3,3',4,5',6-Heptachlorobiphenyl (175)	0.00003424 J										
2,2',3,3',4,5',6'-Heptachlorobiphenyl (177)	0.0008102 J										
2,2',3,3',4,5-Hexachlorobiphenyl (129)	0.01099404 J										
2,2',3,3',4,5'-Hexachlorobiphenyl (130)	0.00080181 J										
2,2',3,3',4,6,6'-Heptachlorobiphenyl (176)	0.00013115 J										
2,2',3,3',4,6-Hexachlorobiphenyl (131)	0.00011809 J										
2,2',3,3',4,6'-Hexachlorobiphenyl (132)	0.00369936 J										
2,2',3,3',4-Pentachlorobiphenyl (82)	0.00082768 J										
2,2',3,3',5,5',6-Heptachlorobiphenyl (178)	0.00020939										
2,2',3,3',5,6-Hexachlorobiphenyl (134)	0.00051112 J										
2,2',3,3',5,6'-Hexachlorobiphenyl (135)	0.00185067 J										
2,2',3,3',5-Pentachlorobiphenyl (83)	0.0036114 J										
2,2',3,3',6,6'-Hexachlorobiphenyl (136)	0.00081979 J										
2,2',3,3',6-Pentachlorobiphenyl (84)	0.00134798 J										
2,2',3,3'-Tetrachlorobiphenyl (40)	0.0005841 J										
2,2',3,4,4',5,5',6-Octachlorobiphenyl (203)	0.00047262 J										
2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)	0.00177594 J										
2,2',3,4,4',5,6'-Heptachlorobiphenyl (182)	0.00000652 J										
2,2',3,4,4',5',6-Heptachlorobiphenyl (183)	0.00042019										
2,2',3,4,4',5-Hexachlorobiphenyl (137)	0.00124478 J										
2,2',3,4,4',6,6'-Heptachlorobiphenyl (184)	0.00015491 U										
2,2',3,4,4'-Pentachlorobiphenyl (85)	0.00164589 J										
2,2',3,4,5,5',6-Heptachlorobiphenyl (185)	0.00010098 J										
2,2',3,4',5,5',6-Heptachlorobiphenyl (187)	0.00098143 J										
2,2',3,4,5,5'-Hexachlorobiphenyl (141)	0.00131161 J										
2,2',3,4',5,5'-Hexachlorobiphenyl (146)	0.00071162 J										
2,2',3,4,5',6-Hexachlorobiphenyl (144)	0.00023454										
2,2',3,4',5,6-Hexachlorobiphenyl (147)	0.00563276 J										
2,2',3,4,5-Pentachlorobiphenyl (86)	0.00560616 J										
2,2',3,4',5-Pentachlorobiphenyl (90)	0.00744117 J										
2,2',3,4,6-Pentachlorobiphenyl (88)	0.00091194 J										
2,2',3,4,6'-Pentachlorobiphenyl (89)	0.00003207 J										
2,2',3,4'-Tetrachlorobiphenyl (42)	0.00037978										
2,2',3,5,5'-Pentachlorobiphenyl (92)	0.0013136										
2,2',3,5,6-Pentachlorobiphenyl (93)	0.0049983 J										
2,2',3,5-Tetrachlorobiphenyl (43)	0.00321474 J										
2,2',3,5'-Tetrachlorobiphenyl (44)	0.00165825 J										
2,2',3,6-Tetrachlorobiphenyl (45)	0.0001671 J										
2,2',3,6'-Tetrachlorobiphenyl (46)	0.00004792 J										
2,2',3'-Trichlorobiphenyl (16)	0.00033617										
2,2',4,4',5,5'-Hexachlorobiphenyl (153)	0.00452552 J										
2,2',4,5-Tetrachlorobiphenyl (48)	0.00021367										
2,2',4,5'-Tetrachlorobiphenyl (49)	0.0012725 J										
2,2',4,6-Tetrachlorobiphenyl (50)	0.0001181 J										
2,2',4-Trichlorobiphenyl (17)	0.00030023										

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2,2',5-Trichlorobiphenyl (18)	0.00068318 J										
2,2',6-Trichlorobiphenyl (19)	0.00007436										
2,2'-Dichlorobiphenyl (4)	0.00019493 J										
2,3,3',4,4',5,5',6-Octachlorobiphenyl (205)	0.00002401 J										
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	0.00004582 J										
2,3,3',4,4',5,6-Heptachlorobiphenyl (190)	0.00028677 J										
2,3,3',4,4',5',6-Heptachlorobiphenyl (191)	0.00003711 J										
2,3,3',4,4',5-Hexachlorobiphenyl (156)	0.00108036 J										
2,3,3',4,4',6-Hexachlorobiphenyl (158)	0.00094613 J										
2,3,3',4,4'-Pentachlorobiphenyl (105)	0.00294701 J										
2,3,3',4,5-Pentachlorobiphenyl (106)	0.00068271 J										
2,3,3',4',5'-Pentachlorobiphenyl (108)	0.00035066 J										
2,3,3',4',6-Pentachlorobiphenyl (110)	0.0092305 J										
2,3,3',4'-Tetrachlorobiphenyl (56)	0.00099071										
2,3,3',6-Tetrachlorobiphenyl (59)	0.00011835 J										
2,3,3'-Trichlorobiphenyl (20)	0.00244912 J										
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	0.00036874 J										
2,3,4,4',5-Pentachlorobiphenyl (114)	0.00016675 J										
2,3',4,4',5-Pentachlorobiphenyl (118)	0.00883673 J										
2,3,4,4'-Tetrachlorobiphenyl (60)	0.00047862										
2,3',4,4'-Tetrachlorobiphenyl (66)	0.00245189 J										
2,3,4,5-Tetrachlorobiphenyl (61)	0.00502108 J										
2,3,4',5-Tetrachlorobiphenyl (63)	0.00005875 J										
2,3,4',6-Tetrachlorobiphenyl (64)	0.00077616										
2,3,4'-Trichlorobiphenyl (22)	0.0005813										
2,3',4-Trichlorobiphenyl (25)	0.00009846										
2,3',5-Trichlorobiphenyl (26)	0.00023632 J										
2,3,6-Trichlorobiphenyl (24)	0.0000643 J										
2,3-Dichlorobiphenyl (5)	0.0000224										
2,3'-Dichlorobiphenyl (6)	0.00018402 J										
2,4',5-Trichlorobiphenyl (31)	0.0014153										
2,4',6-Trichlorobiphenyl (32)	0.0002112										
2,4-Dichlorobiphenyl (7)	0.00003896										
2,4'-Dichlorobiphenyl (8)	0.00087293 J										
2,5-Dichlorobiphenyl (9)	0.00005415										
2,6-Dichlorobiphenyl (10)	0.00001138										
2-Monochlorobiphenyl (1)	0.00011428										
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	0.00000847 J										
3,3',4,4',5-Pentachlorobiphenyl (126)	0.00004261 J										
3,3',4,4'-Tetrachlorobiphenyl (77)	0.00041288 J										
3,4,4',5-Tetrachlorobiphenyl (81)	0.00007746 U										
3,4-Dichlorobiphenyl (12)	0.00017728 J										
4-Chlorobiphenyl (3)	0.0003231										
Decachlorobiphenyl (209)	0.00202625 J										
PCB TEQ USEPA, 2010	0.0000050										
Inorgancis (mg/Kg)											
Aluminum	14791 J				3520	10600					
Antimony	0.112 U			2.8	1.2 U	2.5 J		460 J	0.273	0.235	0.965
Arsenic	4.25			2.61	3.9	7.8		6000 J	13.3	10	9.2
Barium	72.3			288	82.6	202		40100	83.7	51	191
Beryllium	1.06			3.46	0.24 U	0.35 U		1330	1.26	1.57	0.9
Cadmium	0.463 J			3.77	0.32 J	1.6 J		550	0.08 J	0.24	1.05
Calcium					2700	3860					
Chromium	33.9			46.1 J	8.9	25.7		45000 J	15.3	15.7 J	48.4
Cobalt	5.03			8.79	2.6	8.8		6600	7.25	10	8.05

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Copper	33.4			73.2	28.8	251		47000	30.7	20.5	46.4
Iron	18264				7790	17800					
Lead	158			246	162	2460		130000	67	48.5	93
Magnesium					955	2560					
Manganese	740			809	149	425		866000	489 J	2440	1790 J
Mercury	0.209				0.12 U	0.18 U					
Methyl Mercury	0.000767 J										
Molybdenum	3.48 J			5.83				11100	1.4	2.2	2.23
Nickel	12.3			30.7	9.6	48.1		11800 J	12.5 J	9.09 J	148 J
Potassium					316	792					
Selenium	0.779 J			1.78	1.2 UJ	1.8 UJ		1200 J	0.8 J	1.4	1.2
Silver	0.407			1.05	0.9 UJ	5.7 J		240 J	0.2 U	0.2 UJ	0.3
Sodium					112	234					
Thallium	0.279			0.401	1.7 U	2.5 U		550 U	0.4 U	0.4 U	0.7
Vanadium	38.6			62.7	12.2	36.7		32300	27.7	31	27.3
Zinc	97.5			454	189	574		81400	85.5	59	156
Dioxins (mg/Kg)											
1,2,3,4,6,7,8-HpCDD	0.00005714	0.000213 J	0.000229	0.000224	0.0000452 J	0.000097 J	0.000074	0.000264	0.000113	0.0000159	0.000555
1,2,3,4,6,7,8-HpCDF	0.00001822	0.0000893 J	0.0000723	0.0000752	0.0000128 J	0.0000227 J	0.0000192	0.0000844	0.0000291	0.00000759	0.00015
1,2,3,4,7,8,9-HpCDF	0.00000118 J	0.00000527 J	0.0000049 J	0.00000584	0.000000735 J	0.00000172 J	0.0000013 J	0.00000411 J	0.0000016 J	0.000000405 J	0.00000874 J
1,2,3,4,7,8-HxCDD	0.0000009 J	0.00000617 J	0.00000387 J	0.00000624	0.000000547 J	0.00000177 J	0.0000011 J	0.00000506	0.00000203 J	0.000000477 J	0.0000111 J
1,2,3,4,7,8-HxCDF	0.00000267 J	0.0000117 J	0.00000832	0.000019	0.00000247 UJ	0.00000272 J	0.0000037 U	0.00000916	0.00000211 J	0.00000151 J	0.0000097 J
1,2,3,6,7,8-HxCDD	0.00000253 J	0.0000128 J	0.00000967	0.0000119	0.00000177 J	0.00000427 J	0.0000032 U	0.0000124	0.00000457	0.000000948 J	0.0000238 J
1,2,3,6,7,8-HxCDF	0.00000166 J	0.00000855 J	0.0000143 EMPC	0.0000123	0.000000978 J	0.00000192 J	0.0000017 UJ	0.00000851	0.00000187 J	0.00000115 J	0.000011 J
1,2,3,7,8,9-HxCDD	0.00000233 J	0.00000875 J	0.00000836	0.00000909	0.00000188 J	0.00000457 J	0.0000032 J	0.00000903	0.00000413	0.000000305 U	0.0000182 J
1,2,3,7,8,9-HxCDF	0.00000116 U	0.0000027 J	0.00000428 EMPC	0.00000393 J	0.000000157 J	0.000000243 J	0.0000004 U	0.000000665 J	0.000000139 J	0.000000131 J	0.00000449 U
1,2,3,7,8-PeCDD	0.00000061 J	0.00000691 J	0.00000419 J	0.00000774	0.00000069 UJ	0.000000622 J	0.00000099 J	0.0000078	0.00000107 J	0.000000641 J	0.00000607 J
1,2,3,7,8-PeCDF	0.00000088 J	0.00000944 EMPC	0.000227 EMPC	0.000054 EMPC	0.00000103 UJ	0.00000137 UJ	0.0000015 U	0.00000394 J	0.00000105 J	0.00000106 J	0.00000414 J
1,2,4,5,7,8-hexachloro(9h)xanthene	0.00026193 J				0.000000765 J	0.00000137 J	0.00018405 J				
2,3,4,6,7,8-HxCDF	0.00000131 J	0.0000118 J	0.00000707	0.0000113	0.00000128 J	0.000003 J	0.0000019 J	0.00000997	0.00000243 J	0.00000134 J	0.0000124 J
2,3,4,7,8-PeCDF	0.00000134 J	0.0000063 J	0.0000118	0.0000174	0.0000014 UJ	0.00000144 J	0.0000021 U	0.00000713	0.00000154 J	0.00000163 J	0.00000503 J
2,3,7,8-TCDD	0.00113007	0.00427 J#	0.0018 #	0.00207 #	0.00000318 J	0.00000296 J	0.000144	0.00765 J	0.00000312	0.000233	0.000491
2,3,7,8-TCDF	0.00000226 J	0.00000754 J	0.00000673	0.0000239	0.0000026 UJ	0.000003 J	0.0000028 U	0.00000819	0.00000196	0.00000241	0.0000057 J
OCDD	0.00043255	0.00138 J	0.0016 J	0.00148 J	0.000369 J	0.000766 J	0.000665	0.00193	0.000739	0.000107	0.0037
OCDF	0.00003719	0.000114 J	0.00011 J	0.000102 J	0.0000227 J	0.0000418 J	0.0000359	0.000114	0.0000483	0.00000892	0.000274
Dioxin TEQ Mammal	0.001133439	0.004289608	0.001824375	0.002097871	0.00000537	0.00000764	0.00014769	0.00636285	0.00000828	0.00023525	0.00051645

mg/Kg - milligrams per kilogram.
EB - Compound detected in the associated equipment rinsate blank.
J - Value is estimated.
U - Compound not detected, value is detection limit.

Table B-1
Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_G-05-SS1 9/30/2010	SS_G-06-SS1 9/28/2010	SS_G-07-SS1 9/29/2010	SS_G-08-SS1 9/29/2010	SS_G-09-SS1 9/29/2010	SS_G-14-SS1 10/1/2010	SS_G-15-SS1 10/1/2010	SS_G-18-SS1 10/1/2010	SS_G-23-SS1 9/30/2010	SS_G-26-SS1 9/30/2010	SS_G-29-AVG 9/30/2010	SS_H-01-SS1 9/28/2010
Semivolatile Organics (mg/Kg)												
1,2,4-Trichlorobenzene	0.0026 U	0.0026 U	0.014 U	0.024 U	0.052 U	0.0029 U	0.0026 U	0.065 U	0.095 U	0.013 U	0.055 U	0.0026 U
1,2-Dichlorobenzene	0.0029 U	0.0029 U	0.015 U	0.026 U	0.058 U	0.0032 U	0.0029 U	0.073 U	0.11 U	0.015 U	0.061 U	0.0029 U
1,3-Dichlorobenzene	0.003 U	0.003 U	0.016 U	0.027 U	0.06 U	0.0034 U	0.003 U	0.075 U	0.11 U	0.015 U	0.063 U	0.003 U
1,4-Dichlorobenzene	0.0029 U	0.0029 U	0.015 U	0.026 U	0.058 U	0.0032 U	0.0029 U	0.073 U	0.11 U	0.015 U	0.061 U	0.0029 U
2,2'-oxybis(1-chloropropane)												
2,4,5-Trichlorophenol	0.0015 U	0.0015 U	0.0077 U	0.014 U	0.03 U	0.0033 J	0.0016 J	0.038 U	0.055 U	0.0075 U	0.032 U	0.0015 U
2,4,6-Trichlorophenol	0.0014 U	0.0014 U	0.0072 U	0.013 U	0.028 U	0.0016 U	0.0014 U	0.035 U	0.051 U	0.007 U	0.03 U	0.0014 U
2,4-Dichlorophenol	0.001 U	0.001 U	0.0051 U	0.0089 U	0.02 U	0.0012 U	0.001 U	0.025 U	0.037 U	0.005 U	0.021 U	0.001 U
2,4-Dimethylphenol	0.0055 UJ	0.0055 U	0.028 U	0.049 U	0.11 U	0.0061 UJ	0.0055 UJ	0.14 UJ	0.21 UJ	0.028 UJ	0.12 UJ	0.0055 U
2,4-Dinitrophenol	0.017 UJ	0.017 U	0.087 U	0.16 U	0.34 U	0.019 UJ	0.017 UJ	0.43 UJ	0.62 UJ	0.085 UJ	0.43 UJ	0.017 U
2,4-Dinitrotoluene	0.0015 U	0.0015 U	0.0077 U	0.014 U	0.03 U	0.0017 U	0.0015 U	0.038 U	0.055 U	0.0075 U	0.032 U	0.0015 U
2,6-Dinitrotoluene	0.002 U	0.002 U	0.011 U	0.018 U	0.04 U	0.0023 U	0.002 U	0.05 U	0.073 U	0.01 U	0.042 U	0.002 U
2-Chloronaphthalene	0.0016 U	0.0016 U	0.0082 U	0.015 U	0.032 U	0.0018 U	0.0016 U	0.04 U	0.059 U	0.008 U	0.034 U	0.0016 U
2-Chlorophenol	0.002 U	0.002 U	0.011 U	0.018 U	0.04 U	0.0023 U	0.002 U	0.05 U	0.073 U	0.01 U	0.042 U	0.002 U
2-Methyl-4,6-dinitrophenol	0.0014 U	0.0014 U	0.0072 U	0.013 U	0.028 U	0.0016 U	0.0014 U	0.035 U	0.051 U	0.007 U	0.03 U	0.0014 U
2-Methylnaphthalene	0.0022 U	0.0022 U	0.012 U	0.02 U	0.044 U	0.0059 J	0.0031 J	0.055 U	0.081 U	0.011 U	0.029 J	0.0022 U
2-Methylphenol	0.0015 U	0.0015 U	0.0077 U	0.014 U	0.03 U	0.0017 U	0.0015 U	0.038 U	0.055 U	0.0075 U	0.032 U	0.0015 U
2-Nitroaniline	0.0032 U	0.0032 U	0.017 U	0.029 U	0.064 U	0.0036 U	0.0032 U	0.08 U	0.12 U	0.016 U	0.068 U	0.0032 U
2-Nitrophenol	0.0015 U	0.0015 U	0.0077 U	0.014 U	0.03 U	0.0017 U	0.0015 U	0.038 U	0.055 U	0.0075 U	0.032 U	0.0015 U
3,3'-Dichlorobenzidine	0.0037 U	0.0037 U	0.019 U	0.033 U	0.074 U	0.0041 U	0.0037 U	0.093 U	0.14 U	0.019 U	0.08 U	0.0037 U
3-Nitroaniline	0.0025 U	0.0025 U	0.013 U	0.023 U	0.05 U	0.0028 U	0.0025 U	0.063 U	0.091 U	0.013 U	0.053 U	0.0025 U
4-Bromophenyl Phenyl Ether	0.0016 U	0.0016 U	0.0082 U	0.015 U	0.032 U	0.0018 U	0.0016 U	0.04 U	0.059 U	0.008 U	0.034 U	0.0016 U
4-Chloro-3-methylphenol	0.0014 U	0.0014 U	0.0072 U	0.013 U	0.028 U	0.0016 U	0.0014 U	0.035 U	0.051 U	0.007 U	0.03 U	0.0014 U
4-Chloroaniline	0.0019 U	0.0019 U	0.0097 U	0.017 U	0.038 U	0.0021 U	0.0019 U	0.048 U	0.07 U	0.0095 U	0.04 U	0.0019 U
4-Chlorophenyl Phenyl Ether	0.0014 U	0.0014 U	0.0072 U	0.013 U	0.028 U	0.0016 U	0.0014 U	0.035 U	0.051 U	0.007 U	0.03 U	0.0014 U
4-Methylphenol	0.0015 U	0.0015 U	0.0077 U	0.014 U	0.03 U	0.0017 U	0.0015 U	0.038 U	0.055 U	0.0075 U	0.032 U	0.0015 U
4-Nitroaniline	0.0018 U	0.0018 U	0.0092 U	0.016 U	0.036 U	0.002 U	0.0018 U	0.045 U	0.066 U	0.009 U	0.038 U	0.0018 U
4-Nitrophenol	0.018 U	0.018 U	0.092 U	0.16 U	0.36 U	0.02 U	0.018 U	0.45 U	0.66 U	0.09 U	0.38 U	0.018 U
Acenaphthene	0.0014 U	0.0018 J	0.014 J	0.015 J	0.03 J	0.0055 J	0.0033 J	0.035 U	0.06 J	0.014 J	0.12 J	0.0018 J
Acenaphthylene	0.0044 J	0.0067	0.099	0.091	0.16 J	0.026	0.017	0.094 J	0.72	0.04	0.37	0.0091
Acetophenone												
Anthracene	0.0042 J	0.0068	0.074	0.071 J	0.15 J	0.027	0.017	0.1 J	0.45	0.05	0.62	0.01
Atrazine												
Benz(a)anthracene	0.016	0.027	0.24	0.27	0.48	0.091	0.061	0.44	1.6	0.25	2.4	0.029
Benzaldehyde	0.0077 U	0.0077 U	0.04 U	0.069 U	0.16 U	0.018 J	0.0087 J	0.2 U	0.29 U	0.039 U	0.17 U	0.0077 U
Benzo(a)pyrene	0.023	0.056	0.23	0.29	0.46	0.17	0.12	0.57	2.4	0.33	2.8	0.051
Benzo(b)fluoranthene	0.029	0.055	0.37	0.41	0.7	0.17	0.11	0.83	3.2	0.48	3.6	0.051
Benzo(g,h,i)perylene	0.017	0.032	0.14	0.21	0.38	0.1	0.071	0.2 J	2.3	0.25	1.7	0.027
Benzo(k)fluoranthene	0.011	0.016	0.18	0.24	0.36	0.045	0.04	0.28	0.98	0.16	1.1	0.02
Benzoic Acid	R	0.8	0.5 J	0.86 U	2 U	0.2 J	0.13 J	R	R	R	R	0.096 U
Benzyl Alcohol	0.0054 J	0.014 J	0.011 U	0.019 U	0.042 U	0.0024 U	0.0052 J	0.053 U	0.077 U	0.011 U	0.045 U	0.0021 U
Biphenyl	0.0019 U	0.0019 U	0.0097 U	0.017 U	0.038 U	0.0024 J	0.0019 U	0.048 U	0.07 U	0.0095 U	0.04 U	0.0019 U
Bis(2-chloroethoxy)methane	0.0015 U	0.0015 U	0.0077 U	0.014 U	0.03 U	0.0017 U	0.0015 U	0.038 U	0.055 U	0.0075 U	0.032 U	0.0015 U
Bis(2-chloroethyl) Ether	0.0019 U	0.0019 U	0.0097 U	0.017 U	0.038 U	0.0021 U	0.0019 U	0.048 U	0.07 U	0.0095 U	0.04 U	0.0019 U
Bis(2-chloroisopropyl) Ether	0.0026 U	0.0026 U	0.014 U	0.024 U	0.052 U	0.0029 U	0.0026 U	0.065 U	0.095 U	0.013 U	0.055 U	0.0026 U
Bis(2-ethylhexyl) Phthalate	0.01 J	0.01 J	0.11 J	0.17 J	0.24 J	0.041 J	0.025 J	0.18 U	0.33 J	0.095 J	0.66 J	0.012 J
Butyl Benzyl Phthalate	0.0058 J	0.0059 J	0.046 J	0.047 J	0.091 J	0.021	0.01	0.095 J	0.12 U	0.035	0.16	0.0063
Caprolactam												
Carbazole	0.0034 J	0.0054 J	0.048 J	0.06 J	0.089 J	0.017	0.011	0.075 J	0.2 J	0.04	0.36 J	0.0056 J
Chrysene	0.024	0.044	0.35	0.46	0.61	0.14	0.094	0.64	2.4	0.37	2.9	0.034
Dibenz(a,h)anthracene	0.0038 J	0.0064 J	0.031 J	0.041 J	0.082 J	0.021	0.014	0.1 J	0.49	0.055	0.46	0.0063
Dibenzofuran	0.0012 U	0.0015 J	0.011 J	0.011 U	0.024 U	0.0053 J	0.0025 J	0.03 U	0.057 J	0.0087 J	0.085 J	0.0014 J
Diethyl Phthalate	0.0013 U	0.0013 U	0.0067 U	0.012 U	0.026 U	0.0021 U	0.0013 U	0.033 U	0.048 U	0.0065 U	0.028 U	0.0016 U
Dimethyl Phthalate	0.001 U	0.001 U	0.052	0.082 J	0.067 J	0.0012 U	0.001 U	0.046 J	0.13 J	0.025 J	0.039 J	0.001 U

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Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_G-05-SS1 9/30/2010	SS_G-06-SS1 9/28/2010	SS_G-07-SS1 9/29/2010	SS_G-08-SS1 9/29/2010	SS_G-09-SS1 9/29/2010	SS_G-14-SS1 10/1/2010	SS_G-15-SS1 10/1/2010	SS_G-18-SS1 10/1/2010	SS_G-23-SS1 9/30/2010	SS_G-26-SS1 9/30/2010	SS_G-29-AVG 9/30/2010	SS_H-01-SS1 9/28/2010
Di-n-butyl Phthalate	0.0079 U	0.0079 U	0.041 U	0.071 U	0.16 U	0.0091 J	0.0079 U	0.2 U	0.29 U	0.04 U	0.17 U	0.0079 U
Di-n-octyl Phthalate	0.0017 U	0.0017 U	0.0087 U	0.016 U	0.034 U	0.0019 U	0.0017 U	0.043 U	0.062 U	0.0085 U	0.036 U	0.0017 U
Fluoranthene	0.037	0.067	0.68	0.83	1	0.23	0.15	0.98	2.7	0.59	5	0.071
Fluorene	0.0011 J	0.0027 J	0.02 J	0.022 J	0.036 J	0.0074 J	0.0044 J	0.039 J	0.078 J	0.016 J	0.2 J	0.0029 J
Hexachlorobenzene	0.0012 U	0.0012 U	0.0061 U	0.011 U	0.024 U	0.0014 U	0.0012 U	0.03 U	0.044 U	0.006 U	0.025 U	0.0012 U
Hexachlorobutadiene	0.0025 U	0.0025 U	0.013 U	0.023 U	0.05 U	0.0028 U	0.0025 U	0.063 U	0.091 U	0.013 U	0.053 U	0.0025 U
Hexachlorocyclopentadiene	0.029 U	0.029 U	0.15 U	0.26 U	0.58 U	0.032 U	0.029 U	0.73 U	1.1 U	0.15 U	0.61 U	0.029 U
Hexachloroethane	0.0031 U	0.0031 U	0.016 U	0.028 U	0.062 U	0.0035 U	0.0031 U	0.078 U	0.12 U	0.016 U	0.066 U	0.0031 U
Indeno(1,2,3-cd)pyrene	0.017	0.031	0.23	0.28	0.49	0.1	0.076	0.46	2.1	0.26	1.9	0.03
Isophorone	0.001 U	0.001 U	0.0051 U	0.0089 U	0.02 U	0.0012 U	0.001 U	0.025 U	0.037 U	0.005 U	0.021 U	0.001 U
Naphthalene	0.0023 U	0.0026 J	0.019 J	0.021 U	0.046 U	0.0091 J	0.0041 J	0.058 U	0.084 U	0.012 U	0.05 J	0.003 J
Nitrobenzene	0.0022 U	0.0022 U	0.012 U	0.02 U	0.044 U	0.0025 U	0.0022 U	0.055 U	0.081 U	0.011 U	0.047 U	0.0022 U
N-Nitrosodi-n-propylamine	0.0024 U	0.0024 U	0.013 U	0.022 U	0.048 U	0.0027 U	0.0024 U	0.06 U	0.088 U	0.012 U	0.051 U	0.0024 U
N-Nitrosodiphenylamine	0.0016 U	0.0016 U	0.0082 U	0.015 U	0.032 U	0.0018 U	0.0016 U	0.04 U	0.059 U	0.008 U	0.034 U	0.0016 U
Pentachlorophenol	0.02 U	0.02 U	0.11 U	0.18 U	0.4 U	0.023 U	0.02 U	0.5 U	0.73 U	0.1 U	0.42 U	0.02 U
Phenanthrene	0.018	0.029	0.25	0.28	0.45	0.11	0.064	0.42	1.1	0.24	2.8	0.039
Phenol	0.002 U	0.002 U	0.011 U	0.018 U	0.04 U	0.0023 U	0.0068 J	0.05 U	0.073 U	0.01 U	0.042 U	0.002 U
Pyrene	0.037	0.066	0.55	0.69	0.91	0.22	0.15	0.91	2.7	0.55	4.9	0.076
Pesticides/PCBs (mg/Kg)												
4,4'-DDD	0.00018 U	0.00011 U	0.0022	0.00048 J	0.0011 U	0.00014 U	0.00016 U	0.00079 U	0.0041 J	0.00065 U	0.0033 J	0.00011 U
4,4'-DDE	0.0012	0.001	0.012	0.0063	0.014	0.0019	0.0017	0.0065	0.0053	0.0026	0.0062 J	0.0022
4,4'-DDT	0.00094 U	0.002	0.012	0.01	0.027	0.0061	0.004	0.018	0.017	0.0054	0.028	0.0025
Aldrin	0.00016 U	0.00016 U	0.00086 U	0.00016 U	0.00096 U	0.00018 U	0.00016 U	0.00017 U	0.0014 U	0.00016 U	0.00098 U	0.00016 U
alpha-BHC	0.00011 U	0.00011 U	0.00012 U	0.00089 U	0.00014 J	0.00013 U	0.00011 U	0.00011 U	0.00027 J	0.00011 U	0.00017 J	0.00011 U
alpha-Chlordane	0.0001 U	0.0001 U	0.0016 U	0.001	0.0011	0.00012 J	0.00017 J	0.00094	0.03	0.0016	0.0078	0.0001 U
beta-BHC	0.00018 U	0.00018 U	0.00037 U	0.00018 U	0.00048 U	0.0002 U	0.00018 U	0.00018 U	0.0013 U	0.00018 U	0.00039 U	0.00018 U
Chlordane	0.003 U	0.0034 U	0.034	0.024	0.031 U	0.0072 U	0.0077 U	0.024 U	0.54	0.028	0.1 J	0.0034 U
delta-BHC	0.000074 U	0.000074 U	0.000077 U	0.00047 U	0.000074 U	0.000082 U	0.00017 U	0.000074 U	0.00023 U	0.000074 U	0.00024 J	0.000074 U
Dieldrin	0.00014 U	0.00014 U	0.0016 U	0.0025 U	0.0049 U	0.00052 J	0.0012	0.0018 U	0.0018 U	0.00065 U	0.0033 U	0.00022 J
Endosulfan I	0.000063 U	0.000063 U	0.0011 U	0.00089 U	0.00093 U	0.00007 U	0.000063 U	0.00079 U	0.0026 U	0.00065 U	0.0033 U	0.000063 U
Endosulfan II	0.00015 U	0.00014 U	0.0021 U	0.0017	0.0031 U	0.0012 U	0.00067 U	0.0023 U	0.004 U	0.0015 U	0.0039 J	0.00018 U
Endosulfan Sulfate	0.00011 U	0.00011 U	0.00028 J	0.00033 U	0.00048 U	0.00013 U	0.00011 U	0.00079 U	0.034 U	0.00065 U	0.00032 J	0.00053 U
Endrin	0.000094 U	0.000094 U	0.0011 U	0.00019 U	0.00093 U	0.00013 U	0.00025 J	0.0011	0.0006 J	0.00021 J	0.00085	0.000094 U
Endrin Aldehyde	0.00015 U	0.00012 U	0.0011 U	0.00068 U	0.00093 U	0.00014 U	0.00025 J	0.00039 J	0.00016 U	0.00065 U	0.0015 J	0.00012 U
Endrin Ketone	0.000093 U	0.000093 U	0.00014 U	0.00089 U	0.00077 J	0.00011 U	0.000093 U	0.00079 U	0.004 U	0.00065 U	0.0011 J	0.000097 U
gamma-BHC (Lindane)	0.00008 U	0.00008 U	0.00018 J	0.00008 U	0.0015 U	0.0002 U	0.000093 U	0.00079 U	0.0029 U	0.00076 U	0.0024 U	0.00008 U
gamma-Chlordane	0.00009 U	0.00015 J	0.0034	0.0033	0.005	0.00041 J	0.00052 J	0.0028	0.045	0.003	0.016	0.00018 J
Heptachlor	0.00012 U	0.00012 U	0.00013 U	0.00012 U	0.00093 U	0.00014 U	0.00093 U	0.00079 U	0.0062	0.00013 U	0.00035 U	0.00012 U
Heptachlor Epoxide	0.000084 U	0.000084 U	0.0011 U	0.00089 U	0.0018 U	0.00026 U	0.000085 J	0.00068 U	0.0013 U	0.000084 U	0.00038 J	0.000084 U
Methoxychlor	0.00019 U	0.00019 U	0.0002 U	0.00089 U	0.0012 U	0.00022 U	0.00019 U	0.00047 U	0.0018 U	0.00049 U	0.0017 U	0.00019 U
Toxaphene	0.014 U	0.021 U	0.054 U	0.081 U	0.11 U	0.04 U	0.041 U	0.14 U	0.13 U	0.084 U	0.23 U	0.015 U
Aroclor 1016	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U	0.0024 U	0.0021 U	0.0021 U	0.0027 U	0.0021 U	0.0052 U	0.0021 U
Aroclor 1221	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U	0.0024 U	0.0021 U	0.0021 U	0.0027 U	0.0021 U	0.0052 U	0.0021 U
Aroclor 1232	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U	0.0024 U	0.0021 U	0.0021 U	0.0027 U	0.0021 U	0.0052 U	0.0021 U
Aroclor 1242	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U	0.0024 U	0.0021 U	0.0021 U	0.0027 U	0.0021 U	0.0052 U	0.0021 U
Aroclor 1248	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U	0.0024 U	0.0021 U	0.0021 U	0.0027 U	0.0021 U	0.0052 U	0.0021 U
Aroclor 1254	0.0028 U	0.0021 U	0.11	0.058	0.096	0.011 U	0.011 U	0.055 U	0.1 J	0.04	0.24	0.0021 U
Aroclor 1260	0.004 U	0.0036 U	0.0022 U	0.062	0.12	0.019 U	0.018 U	0.067 U	0.0027 U	0.0021 U	0.0052 U	0.0048 U
Aroclor 1262	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U	0.0024 U	0.0021 U	0.0021 U	0.0027 U	0.0021 U	0.0052 U	0.0021 U
Aroclor 1268	0.0021 U	0.0021 U	0.0022 U	0.0021 U	0.0021 U	0.0024 U	0.0021 U	0.0021 U	0.0027 U	0.0021 U	0.02	0.0021 U
PCB Congeners (mg/Kg)												
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl												
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (194)												
2,2',3,3',4,4',5,6,6'-nonachlorobiphenyl												
2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)												

Table B-1
Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_G-05-SS1 9/30/2010	SS_G-06-SS1 9/28/2010	SS_G-07-SS1 9/29/2010	SS_G-08-SS1 9/29/2010	SS_G-09-SS1 9/29/2010	SS_G-14-SS1 10/1/2010	SS_G-15-SS1 10/1/2010	SS_G-18-SS1 10/1/2010	SS_G-23-SS1 9/30/2010	SS_G-26-SS1 9/30/2010	SS_G-29-AVG 9/30/2010	SS_H-01-SS1 9/28/2010
2,2',3,3',4,4',5,6'-Octachlorobiphenyl (196)												
2,2',3,3',4,4',5-Heptachlorobiphenyl (170)												
2,2',3,3',4,4',6,6'-Octachlorobiphenyl (197)												
2,2',3,3',4,4',6-Heptachlorobiphenyl (171)												
2,2',3,3',4,4'-Hexachlorobiphenyl (128)												
2,2',3,3',4,5,5',6-Octachlorobiphenyl (198)												
2,2',3,3',4,5,5'-Heptachlorobiphenyl (172)												
2,2',3,3',4,5,6,6'-Octachlorobiphenyl (200)												
2,2',3,3',4,5',6,6'-Octachlorobiphenyl (201)												
2,2',3,3',4,5,6'-Heptachlorobiphenyl (174)												
2,2',3,3',4,5',6-Heptachlorobiphenyl (175)												
2,2',3,3',4,5',6'-Heptachlorobiphenyl (177)												
2,2',3,3',4,5-Hexachlorobiphenyl (129)												
2,2',3,3',4,5'-Hexachlorobiphenyl (130)												
2,2',3,3',4,6,6'-Heptachlorobiphenyl (176)												
2,2',3,3',4,6-Hexachlorobiphenyl (131)												
2,2',3,3',4,6'-Hexachlorobiphenyl (132)												
2,2',3,3',4-Pentachlorobiphenyl (82)												
2,2',3,3',5,5',6-Heptachlorobiphenyl (178)												
2,2',3,3',5,6-Hexachlorobiphenyl (134)												
2,2',3,3',5,6'-Hexachlorobiphenyl (135)												
2,2',3,3',5-Pentachlorobiphenyl (83)												
2,2',3,3',6,6'-Hexachlorobiphenyl (136)												
2,2',3,3',6-Pentachlorobiphenyl (84)												
2,2',3,3'-Tetrachlorobiphenyl (40)												
2,2',3,4,4',5,5',6-Octachlorobiphenyl (203)												
2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)												
2,2',3,4,4',5,6'-Heptachlorobiphenyl (182)												
2,2',3,4,4',5',6-Heptachlorobiphenyl (183)												
2,2',3,4,4',5-Hexachlorobiphenyl (137)												
2,2',3,4,4',6,6'-Heptachlorobiphenyl (184)												
2,2',3,4,4'-Pentachlorobiphenyl (85)												
2,2',3,4,5,5',6-Heptachlorobiphenyl (185)												
2,2',3,4',5,5',6-Heptachlorobiphenyl (187)												
2,2',3,4,5,5'-Hexachlorobiphenyl (141)												
2,2',3,4',5,5'-Hexachlorobiphenyl (146)												
2,2',3,4,5',6-Hexachlorobiphenyl (144)												
2,2',3,4',5,6-Hexachlorobiphenyl (147)												
2,2',3,4,5-Pentachlorobiphenyl (86)												
2,2',3,4',5-Pentachlorobiphenyl (90)												
2,2',3,4,6-Pentachlorobiphenyl (88)												
2,2',3,4,6'-Pentachlorobiphenyl (89)												
2,2',3,4'-Tetrachlorobiphenyl (42)												
2,2',3,5,5'-Pentachlorobiphenyl (92)												
2,2',3,5,6-Pentachlorobiphenyl (93)												
2,2',3,5-Tetrachlorobiphenyl (43)												
2,2',3,5'-Tetrachlorobiphenyl (44)												
2,2',3,6-Tetrachlorobiphenyl (45)												
2,2',3,6'-Tetrachlorobiphenyl (46)												
2,2',3'-Trichlorobiphenyl (16)												
2,2',4,4',5,5'-Hexachlorobiphenyl (153)												
2,2',4,5-Tetrachlorobiphenyl (48)												
2,2',4,5'-Tetrachlorobiphenyl (49)												
2,2',4,6-Tetrachlorobiphenyl (50)												
2,2',4-Trichlorobiphenyl (17)												

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Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_G-05-SS1 9/30/2010	SS_G-06-SS1 9/28/2010	SS_G-07-SS1 9/29/2010	SS_G-08-SS1 9/29/2010	SS_G-09-SS1 9/29/2010	SS_G-14-SS1 10/1/2010	SS_G-15-SS1 10/1/2010	SS_G-18-SS1 10/1/2010	SS_G-23-SS1 9/30/2010	SS_G-26-SS1 9/30/2010	SS_G-29-AVG 9/30/2010	SS_H-01-SS1 9/28/2010
2,2',5-Trichlorobiphenyl (18)												
2,2',6-Trichlorobiphenyl (19)												
2,2'-Dichlorobiphenyl (4)												
2,3,3',4,4',5,5',6-Octachlorobiphenyl (205)												
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)												
2,3,3',4,4',5,6-Heptachlorobiphenyl (190)												
2,3,3',4,4',5',6-Heptachlorobiphenyl (191)												
2,3,3',4,4',5-Hexachlorobiphenyl (156)												
2,3,3',4,4',6-Hexachlorobiphenyl (158)												
2,3,3',4,4'-Pentachlorobiphenyl (105)												
2,3,3',4,5-Pentachlorobiphenyl (106)												
2,3,3',4',5'-Pentachlorobiphenyl (108)												
2,3,3',4',6-Pentachlorobiphenyl (110)												
2,3,3',4'-Tetrachlorobiphenyl (56)												
2,3,3',6-Tetrachlorobiphenyl (59)												
2,3,3'-Trichlorobiphenyl (20)												
2,3',4,4',5,5'-Hexachlorobiphenyl (167)												
2,3,4,4',5-Pentachlorobiphenyl (114)												
2,3',4,4',5-Pentachlorobiphenyl (118)												
2,3,4,4'-Tetrachlorobiphenyl (60)												
2,3',4,4'-Tetrachlorobiphenyl (66)												
2,3,4,5-Tetrachlorobiphenyl (61)												
2,3,4',5-Tetrachlorobiphenyl (63)												
2,3,4',6-Tetrachlorobiphenyl (64)												
2,3,4'-Trichlorobiphenyl (22)												
2,3',4-Trichlorobiphenyl (25)												
2,3',5-Trichlorobiphenyl (26)												
2,3,6-Trichlorobiphenyl (24)												
2,3-Dichlorobiphenyl (5)												
2,3'-Dichlorobiphenyl (6)												
2,4',5-Trichlorobiphenyl (31)												
2,4',6-Trichlorobiphenyl (32)												
2,4-Dichlorobiphenyl (7)												
2,4'-Dichlorobiphenyl (8)												
2,5-Dichlorobiphenyl (9)												
2,6-Dichlorobiphenyl (10)												
2-Monochlorobiphenyl (1)												
3,3',4,4',5,5'-Hexachlorobiphenyl (169)												
3,3',4,4',5-Pentachlorobiphenyl (126)												
3,3',4,4'-Tetrachlorobiphenyl (77)												
3,4,4',5-Tetrachlorobiphenyl (81)												
3,4-Dichlorobiphenyl (12)												
4-Chlorobiphenyl (3)												
Decachlorobiphenyl (209)												
PCB TEQ USEPA, 2010												
Inorgancis (mg/Kg)												
Aluminum												
Antimony	0.089 U	0.112 U	0.638	0.636	1.33	0.488	0.402	0.955	0.564	0.237	0.711	0.086
Arsenic	7.7	3.3	4.5	4.2	6.1	4.5	3.4	4.9	4.8	3.1	7 J	1.8 J
Barium	23.3	36	42	35	37	17	15.3	38.7	76.3	31.4	57	14.8
Beryllium	1.28	0.72	0.46	0.43	0.51	0.25 J	0.26 J	0.54	0.9	0.42	1.1	0.36
Cadmium	0.11	0.17	0.16	0.08 J	0.04 U	0.08 J	0.04 J	0.29	0.42	0.19	0.93 J	0.1
Calcium												
Chromium	11.4	5.66 J	20.7 J	17.5 J	33.2 J	19	11.9	29.3	41.4	13.6	52	4.1
Cobalt	8.64	3.49	1.87	2.42	2.39	1.3 J	0.94 J	3.41	6.7	2.68	3.6	1.6

Table B-1
Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_G-05-SS1 9/30/2010	SS_G-06-SS1 9/28/2010	SS_G-07-SS1 9/29/2010	SS_G-08-SS1 9/29/2010	SS_G-09-SS1 9/29/2010	SS_G-14-SS1 10/1/2010	SS_G-15-SS1 10/1/2010	SS_G-18-SS1 10/1/2010	SS_G-23-SS1 9/30/2010	SS_G-26-SS1 9/30/2010	SS_G-29-AVG 9/30/2010	SS_H-01-SS1 9/28/2010
Copper	6.2	7.1	24.2	21.5	37.7	16.2	10.7	32.9	41.1	14.9	46	4.8
Iron												
Lead	26	32.3	334	73.8	161	118	83	149	124	48	172	24.5
Magnesium												
Manganese	1140 J	1220	1140	250	249	187 J	156 J	317 J	831 J	178 J	326 J	122
Mercury												
Methyl Mercury												
Molybdenum	4.74	1.67	3.03	3.26	6.62	2.42	1.39	4.51	4.32	1.76	6	1.2
Nickel	5.95 J	3.21 J	6.39 J	4.99 J	8.11 J	6.25 J	2.57 J	8.58 J	17.5 J	5.95 J	13 J	2.8
Potassium												
Selenium	1.2	0.7 J	0.7 J	0.7 J	0.8 J	1.1	0.5 J	0.7 J	0.5 J	0.1 J	0.68 J	0.4 J
Silver	0.2 U	0.2 UJ	0.3 J	0.2 J	0.3 J	0.3 J	0.2 J	0.2 U	0.2 U	0.2 U	0.23 J	0.2 U
Sodium												
Thallium	0.4 J	0.4 U	0.5 U	0.4 U	0.4 U	0.4 U	0.4 U	0.5 U	0.4 U	0.4 U	0.6 U	0.4 U
Vanadium	25.4	18	23	20	31	23.8	22.3	30.3	30.8	16.2	25	15.8
Zinc	47	27.1	54	54	41.5	22.5	16	64.5	118	53.8	108	22.5
Dioxins (mg/Kg)												
1,2,3,4,6,7,8-HpCDD	0.00000834	0.00000836	0.000118	0.0000912	0.000223	0.000058	0.0000772	0.000183	0.000276	0.0000826	0.000421	0.00000615
1,2,3,4,6,7,8-HpCDF	0.00000405	0.00000376	0.0000435 J	0.0000378	0.0000665	0.0000228	0.0000251	0.0000782	0.0000897	0.0000257	0.000131	0.0000129
1,2,3,4,7,8,9-HpCDF	0.000000244 J	0.000000251 J	0.0000038 U	0.00000174 J	0.00000405 J	0.00000111 J	0.00000124 J	0.00000468 U	0.00000542 J	0.0000015 J	0.00000819 J	0.000000545 J
1,2,3,4,7,8-HxCDD	0.000000265 U	0.000000381 J	0.00000404 U	0.0000017 J	0.00000505 U	0.00000169 J	0.00000158 J	0.0000055 U	0.00000477 U	0.0000014 J	0.00000613 J	0.000000278 J
1,2,3,4,7,8-HxCDF	0.000000662 J	0.000000971 J	0.00000161 U	0.00000395	0.0000115 J	0.00000435	0.00000356	0.00000953 J	0.00000249 U	0.00000214 J	0.0000115 J	0.00000459
1,2,3,6,7,8-HxCDD	0.000000542 J	0.00000097 J	0.0000042 U	0.00000452	0.00000825 J	0.00000284	0.0000033	0.00000914 J	0.00000508 U	0.00000334	0.0000217 J	0.000000657 J
1,2,3,6,7,8-HxCDF	0.000000514 J	0.000000751 J	0.00000569 J	0.00000372	0.00000782 J	0.00000328	0.00000303	0.00000864 J	0.00000274 U	0.00000217 J	0.0000112 J	0.00000123 J
1,2,3,7,8,9-HxCDD	0.000000417 J	0.00000113 J	0.00000513 U	0.00000331	0.0000064 U	0.00000252	0.00000236 J	0.00000719 U	0.00000599 J	0.00000226 J	0.000012	0.000000437 J
1,2,3,7,8,9-HxCDF	0.000000248 U	0.000000113 J	0.00000307 U	0.00000038 J	0.00000368 U	0.000000216 U	0.000000107 J	0.00000552 U	0.00000502 U	0.000000398 U	0.00000174 J	0.000000118 J
1,2,3,7,8-PeCDD	0.000000114 U	0.000000322 J	0.00000335 J	0.00000135 J	0.00000395 J	0.00000115 J	0.00000113 J	0.00000464 U	0.00000455 J	0.000000928 J	0.00000579 J	0.000000355 J
1,2,3,7,8-PeCDF	0.000000413 J	0.000000605 J	0.00000498 J	0.00000244 J	0.00000636 J	0.00000282	0.00000188 J	0.00000274 U	0.00000335 J	0.000000809 J	0.00000397 J	0.000000943 J
1,2,4,5,7,8-hexachloro(9h)xanthene												
2,3,4,6,7,8-HxCDF	0.000000608 J	0.000000889 J	0.0000064 J	0.00000392	0.0000103 J	0.00000387	0.00000326	0.00000947 J	0.00000932 J	0.00000257	0.0000138 J	0.00000121 J
2,3,4,7,8-PeCDF	0.000000557 J	0.000000757 J	0.00000641 J	0.000004	0.00000883 J	0.00000411	0.00000273	0.0000113 J	0.00000501 J	0.00000152 J	0.00000618 J	0.00000185 J
2,3,7,8-TCDD	0.0000446	0.00000795	0.00206	0.000585 J	0.00227	0.00039	0.000392	0.00119	0.001	0.00059 J	0.00617 J	0.00000369
2,3,7,8-TCDF	0.000000922	0.00000115	0.0000125	0.0000047	0.0000141	0.00000292	0.00000298	0.00001 J	0.00000276 U	0.00000152	0.00000717 J	0.00000208
OCDD	0.0000591	0.0000489	0.000933	0.000733	0.00173	0.000401	0.000559	0.00131	0.00225	0.000644	0.00325 J	0.0000359
OCDF	0.00000434 J	0.00000413 J	0.0000605 J	0.0000549	0.0000912 J	0.0000271	0.0000377	0.000112 J	0.000152	0.0000435	0.000226	0.0000155
Dioxin TEQ Mammal	0.00004537	0.00000929	0.00207072	0.00059179	0.00228623	0.00039557	0.00039724	0.00120440	0.00101326	0.00059427	0.00618367	0.00000590

mg/Kg - milligrams per kilogram.
EB - Compound detected in the associated equipment rinsate blank.
J - Value is estimated.
U - Compound not detected, value is detection limit.

Tab[illegible]
Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_H-03-SS1 9/29/2010	SS_H-06-SS1 9/28/2010	SS_H-07-SS1 9/29/2010	SS_H-10-SS1 9/29/2010	SS_H-13-SS1 9/29/2010	SS_H-16-SS1 9/28/2010	SS_H-18-SS1 9/29/2010	SS_H-19-SS1 9/30/2010	SS_H-22-SS1 9/28/2010
Semivolatile Organics (mg/Kg)									
1,2,4-Trichlorobenzene	0.0026 U	0.013 U	0.0026 U	0.0026 U	0.026 U	0.0026 U	0.0026 U	0.0026 U	0.013 U
1,2-Dichlorobenzene	0.0029 U	0.015 U	0.0029 U	0.0029 U	0.029 U	0.0029 U	0.0029 U	0.0029 U	0.015 U
1,3-Dichlorobenzene	0.003 U	0.015 U	0.003 U	0.003 U	0.03 U	0.003 U	0.003 U	0.003 U	0.015 U
1,4-Dichlorobenzene	0.0029 U	0.015 U	0.0029 U	0.0029 U	0.029 U	0.0029 U	0.0029 U	0.0029 U	0.015 U
2,2'-oxybis(1-chloropropane)									
2,4,5-Trichlorophenol	0.0015 U	0.0075 U	0.0015 U	0.0015 U	0.015 U	0.0015 U	0.0015 U	0.0015 U	0.0075 U
2,4,6-Trichlorophenol	0.0014 U	0.007 U	0.0014 U	0.0014 U	0.014 U	0.0014 U	0.0014 U	0.0014 U	0.007 U
2,4-Dichlorophenol	0.001 U	0.005 U	0.001 U	0.001 U	0.01 U	0.001 U	0.001 U	0.001 U	0.005 U
2,4-Dimethylphenol	0.0055 U	0.028 U	0.0055 U	0.0055 U	0.055 U	0.0055 U	0.0055 U	0.0055 UJ	0.028 U
2,4-Dinitrophenol	0.017 U	0.085 U	0.017 U	0.017 U	0.17 U	0.017 U	0.017 U	0.017 UJ	0.085 U
2,4-Dinitrotoluene	0.0015 U	0.0075 U	0.0015 U	0.0015 U	0.015 U	0.0015 U	0.0015 U	0.034	0.0075 U
2,6-Dinitrotoluene	0.002 U	0.01 U	0.002 U	0.002 U	0.02 U	0.002 U	0.002 U	0.002 U	0.01 U
2-Chloronaphthalene	0.0016 U	0.008 U	0.0016 U	0.0016 U	0.016 U	0.0016 U	0.0016 U	0.0016 U	0.008 U
2-Chlorophenol	0.002 U	0.01 U	0.002 U	0.002 U	0.02 U	0.002 U	0.002 U	0.002 U	0.01 U
2-Methyl-4,6-dinitrophenol	0.0014 U	0.007 U	0.0014 U	0.0014 U	0.014 U	0.0014 U	0.0014 U	0.0014 U	0.007 U
2-Methylnaphthalene	0.0022 U	0.011 U	0.0022 U	0.0025 J	0.022 U	0.0035 J	0.0022 U	0.003 J	0.011 U
2-Methylphenol	0.0015 U	0.0075 U	0.0015 U	0.0015 U	0.015 U	0.0015 U	0.0015 U	0.0015 U	0.0075 U
2-Nitroaniline	0.0032 U	0.016 U	0.0032 U	0.0032 U	0.032 U	0.0032 U	0.0032 U	0.0032 U	0.016 U
2-Nitrophenol	0.0015 U	0.0075 U	0.0015 U	0.0015 U	0.015 U	0.0015 U	0.0015 U	0.0015 U	0.0075 U
3,3'-Dichlorobenzidine	0.0037 U	0.019 U	0.0037 U	0.0037 U	0.037 U	0.0037 U	0.0037 U	0.0037 U	0.019 U
3-Nitroaniline	0.0025 U	0.013 U	0.0025 U	0.0025 U	0.025 U	0.0025 U	0.0025 U	0.0025 U	0.013 U
4-Bromophenyl Phenyl Ether	0.0016 U	0.008 U	0.0016 U	0.0016 U	0.016 U	0.0016 U	0.0016 U	0.0016 U	0.008 U
4-Chloro-3-methylphenol	0.0014 U	0.007 U	0.0014 U	0.0014 U	0.014 U	0.0014 U	0.0014 U	0.0014 U	0.007 U
4-Chloroaniline	0.0019 U	0.0095 U	0.0019 U	0.0019 U	0.019 U	0.0019 U	0.0019 U	0.0019 U	0.0095 U
4-Chlorophenyl Phenyl Ether	0.0014 U	0.007 U	0.0014 U	0.0014 U	0.014 U	0.0014 U	0.0014 U	0.0014 U	0.007 U
4-Methylphenol	0.0015 U	0.0075 U	0.0015 U	0.0015 U	0.015 U	0.0015 U	0.0015 U	0.0015 U	0.0075 U
4-Nitroaniline	0.0018 U	0.009 U	0.0018 U	0.0018 U	0.018 U	0.0018 U	0.0018 U	0.0018 U	0.009 U
4-Nitrophenol	0.018 U	0.09 U	0.018 U	0.018 U	0.18 U	0.018 U	0.018 U	0.018 U	0.09 U
Acenaphthene	0.0014 U	0.007 U	0.0014 U	0.0014 U	0.014 U	0.0021 J	0.0014 U	0.0024 J	0.007 U
Acenaphthylene	0.0067	0.0072 J	0.0051 J	0.0085	0.013 J	0.016	0.0075 J	0.016	0.0083 J
Acetophenone									
Anthracene	0.0057 J	0.008 U	0.0046 J	0.0061 J	0.016 U	0.011	0.0046 J	0.015	0.008 U
Atrazine									
Benz(a)anthracene	0.018	0.024 J	0.018	0.02	0.039 J	0.038	0.018	0.04	0.024 J
Benzaldehyde	0.011 J	0.039 U	0.012 U	0.017	0.077 U	0.0077 U	0.01 J	0.013 J	0.039 U
Benzo(a)pyrene	0.015	0.047 U	0.038 U	0.049 U	0.062 U	0.088 U	0.015	0.072	0.03 U
Benzo(b)fluoranthene	0.027	0.048	0.036	0.044	0.074	0.08	0.024	0.075	0.047
Benzo(g,h,i)perylene	0.015	0.028	0.025	0.033	0.038 J	0.051	0.015	0.049	0.031 J
Benzo(k)fluoranthene	0.013	0.017 J	0.013	0.014	0.02 J	0.025	0.012	0.02	0.015 J
Benzoic Acid	0.11 J	0.48 U	0.14	0.15	0.96 U	0.096 U	0.14 J	0.19 J	0.48 U
Benzyl Alcohol	0.0021 U	0.011 U	0.0021 U	0.0021 U	0.021 U	0.0068 J	0.0039 J	0.007 J	0.011 U
Biphenyl	0.0019 U	0.0095 U	0.0019 U	0.0019 U	0.019 U	0.0019 U	0.0019 U	0.0019 U	0.0095 U
Bis(2-chloroethoxy)methane	0.0015 U	0.0075 U	0.0015 U	0.0015 U	0.015 U	0.0015 U	0.0015 U	0.0015 U	0.0075 U
Bis(2-chloroethyl) Ether	0.0019 U	0.0095 U	0.0019 U	0.0019 U	0.019 U	0.0019 U	0.0019 U	0.0019 U	0.0095 U
Bis(2-chloroisopropyl) Ether	0.0026 U	0.013 U	0.0026 U	0.0026 U	0.026 U	0.0026 U	0.0026 U	0.0026 U	0.013 U
Bis(2-ethylhexyl) Phthalate	0.011 J	0.035 U	0.011 J	0.011 J	0.07 U	0.013 J	0.0073 J	0.018 J	0.035 U
Butyl Benzyl Phthalate	0.0064	0.016 U	0.0087	0.007	0.032 U	0.0072	0.0052 J	0.01	0.016 U
Caprolactam									
Carbazole	0.0036 J	0.0065 U	0.0036 J	0.0043 J	0.013 U	0.0072	0.0034 J	0.0081	0.0065 U
Chrysene	0.026	0.042	0.029	0.036	0.047 J	0.062	0.025	0.068	0.033
Dibenz(a,h)anthracene	0.003 J	0.0075 U	0.0053 J	0.0015 U	0.015 U	0.0083	0.0025 J	0.0015 U	0.0075 U
Dibenzofuran	0.0013 J	0.006 U	0.0012 U	0.0017 J	0.012 U	0.0019 J	0.0012 U	0.0023 J	0.006 U
Diethyl Phthalate	0.0013 U	0.0065 U	0.0013 U	0.0013 U	0.013 U	0.0013 U	0.0013 U	0.0013 U	0.0065 U
Dimethyl Phthalate	0.001 U	0.005 U	0.001 U	0.001 U	0.03 J	0.001 U	0.001 U	0.001 U	0.005 U

Table B-1
Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_H-03-SS1 9/29/2010	SS_H-06-SS1 9/28/2010	SS_H-07-SS1 9/29/2010	SS_H-10-SS1 9/29/2010	SS_H-13-SS1 9/29/2010	SS_H-16-SS1 9/28/2010	SS_H-18-SS1 9/29/2010	SS_H-19-SS1 9/30/2010	SS_H-22-SS1 9/28/2010
Di-n-butyl Phthalate	0.0079 U	0.04 U	0.0079 U	0.0079 U	0.079 U	0.0084 J	0.0079 U	0.01 J	0.04 U
Di-n-octyl Phthalate	0.0017 U	0.0085 U	0.0017 U	0.0017 U	0.017 U	0.0017 U	0.0017 U	0.0017 U	0.0085 U
Fluoranthene	0.042	0.067	0.046	0.054	0.086	0.099	0.037	0.11	0.055
Fluorene	0.0021 J	0.0055 U	0.0011 U	0.0011 U	0.011 U	0.003 J	0.0022 J	0.0037 J	0.0055 U
Hexachlorobenzene	0.0012 U	0.006 U	0.0012 U	0.0012 U	0.012 U	0.0012 U	0.0012 U	0.0012 U	0.006 U
Hexachlorobutadiene	0.0025 U	0.013 U	0.0025 U	0.0025 U	0.025 U	0.0025 U	0.0025 U	0.0025 U	0.013 U
Hexachlorocyclopentadiene	0.029 U	0.15 U	0.029 U	0.029 U	0.29 U	0.029 U	0.029 U	0.029 U	0.15 U
Hexachloroethane	0.0031 U	0.016 U	0.0031 U	0.0031 U	0.031 U	0.0031 U	0.0031 U	0.0031 U	0.016 U
Indeno(1,2,3-cd)pyrene	0.018	0.027	0.025	0.03	0.048 J	0.053	0.014	0.045	0.028 J
Isophorone	0.001 U	0.005 U	0.001 U	0.001 U	0.01 U	0.001 U	0.001 U	0.001 U	0.005 U
Naphthalene	0.0023 U	0.012 U	0.0023 U	0.0032 J	0.023 U	0.0041 J	0.0023 U	0.0038 J	0.012 U
Nitrobenzene	0.0022 U	0.011 U	0.0022 U	0.0022 U	0.022 U	0.0022 U	0.0022 U	0.0022 U	0.011 U
N-Nitrosodi-n-propylamine	0.0024 U	0.012 U	0.0024 U	0.0024 U	0.024 U	0.0024 U	0.0024 U	0.0024 U	0.012 U
N-Nitrosodiphenylamine	0.0016 U	0.008 U	0.0016 U	0.0016 U	0.016 U	0.0016 U	0.0016 U	0.0016 U	0.008 U
Pentachlorophenol	0.02 U	0.1 U	0.02 U	0.02 U	0.2 U	0.02 U	0.02 U	0.02 U	0.1 U
Phenanthrene	0.023	0.033	0.022	0.029	0.046 J	0.046	0.021	0.055	0.03 J
Phenol	0.002 U	0.01 U	0.002 U	0.002 U	0.02 U	0.002 U	0.002 U	0.0029 J	0.01 U
Pyrene	0.041	0.059	0.044	0.055	0.086	0.1	0.039	0.11	0.052
Pesticides/PCBs (mg/Kg)									
4,4'-DDD	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00024 U	0.00013 J	0.00011 U
4,4'-DDE	0.00049 J	0.00046 J	0.0012	0.0004 J	0.0024	0.00057	0.0029	0.0025	0.00088
4,4'-DDT	0.00053 J	0.00085	0.002	0.00058 U	0.0015	0.0017	0.0024	0.0037	0.002
Aldrin	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.00016 U	0.00016 U
alpha-BHC	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U	0.00011 U
alpha-Chlordane	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.00026 J	0.00013 J	0.0001 U
beta-BHC	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00018 U	0.00055 U
Chlordane	0.0019 U	0.0022 U	0.0039 U	0.0019 U	0.0041 U	0.0024 U	0.0058 U	0.0041 U	0.0023 U
delta-BHC	0.000074 U	0.000074 U	0.000074 U	0.000074 U	0.000083 U	0.000074 U	0.000074 U	0.00012 U	0.000074 U
Dieldrin	0.00014 U	0.00014 U	0.00025 J	0.00014 U	0.00014 U	0.00014 U	0.00071 J	0.00014 U	0.00014 U
Endosulfan I	0.000063 U	0.000079 U	0.000063 U	0.000063 U	0.00013 J	0.000063 U	0.000077 U	0.000077 U	0.00011 U
Endosulfan II	0.00014 U	0.00014 U	0.00014 U	0.00014 U	0.00042 U	0.00014 U	0.00014 U	0.00014 U	0.00055 U
Endosulfan Sulfate	0.00011 U	0.00011 U	0.00022 U	0.00011 U	0.0004 J	0.00054 U	0.00011 U	0.0003 J	0.00055 U
Endrin	0.000094 U	0.000094 U	0.000094 U	0.000094 U	0.000094 U	0.000094 U	0.000094 U	0.000094 U	0.000094 U
Endrin Aldehyde	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00089 U	0.00012 U
Endrin Ketone	0.000093 U	0.00012 U	0.000093 U	0.000093 U	0.000093 U	0.000093 U	0.000093 U	0.000093 U	0.000093 U
gamma-BHC (Lindane)	0.00008 U	0.00008 U	0.00008 U	0.00008 U	0.00008 U	0.00013 U	0.00008 U	0.0002 J	0.00027 U
gamma-Chlordane	0.00009 U	0.000098 J	0.00009 U	0.00009 U	0.00016 U	0.00017 U	0.00011 U	0.00019 J	0.0001 J
Heptachlor	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00012 U	0.00059 U	0.00012 U
Heptachlor Epoxide	0.000084 U	0.000084 U	0.000095 J	0.000086 U	0.000084 U	0.00013 J	0.00053 J	0.000084 U	0.000084 U
Methoxychlor	0.00019 U	0.00019 U	0.00019 U	0.00019 U	0.00021 U	0.00019 U	0.00019 U	0.00019 U	0.00019 U
Toxaphene	0.0064 U	0.0064 U	0.0072 U	0.029 U	0.051 U	0.027 U	0.042 U	0.023 U	0.028 U
Aroclor 1016	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
Aroclor 1221	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
Aroclor 1232	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
Aroclor 1242	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
Aroclor 1248	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
Aroclor 1254	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0038 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
Aroclor 1260	0.0024 U	0.0023 U	0.0031 U	0.0053 U	0.0065 U	0.0038 U	0.0043 U	0.0055 U	0.0023 U
Aroclor 1262	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
Aroclor 1268	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U
PCB Congeners (mg/Kg)									
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl									
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (194)									
2,2',3,3',4,4',5,6,6'-nonachlorobiphenyl									
2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)									

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Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_H-03-SS1 9/29/2010	SS_H-06-SS1 9/28/2010	SS_H-07-SS1 9/29/2010	SS_H-10-SS1 9/29/2010	SS_H-13-SS1 9/29/2010	SS_H-16-SS1 9/28/2010	SS_H-18-SS1 9/29/2010	SS_H-19-SS1 9/30/2010	SS_H-22-SS1 9/28/2010
2,2',3,3',4,4',5,6'-Octachlorobiphenyl (196)									
2,2',3,3',4,4',5-Heptachlorobiphenyl (170)									
2,2',3,3',4,4',6,6'-Octachlorobiphenyl (197)									
2,2',3,3',4,4',6-Heptachlorobiphenyl (171)									
2,2',3,3',4,4'-Hexachlorobiphenyl (128)									
2,2',3,3',4,5,5',6-Octachlorobiphenyl (198)									
2,2',3,3',4,5,5'-Heptachlorobiphenyl (172)									
2,2',3,3',4,5,6,6'-Octachlorobiphenyl (200)									
2,2',3,3',4,5',6,6'-Octachlorobiphenyl (201)									
2,2',3,3',4,5,6'-Heptachlorobiphenyl (174)									
2,2',3,3',4,5',6-Heptachlorobiphenyl (175)									
2,2',3,3',4,5',6'-Heptachlorobiphenyl (177)									
2,2',3,3',4,5-Hexachlorobiphenyl (129)									
2,2',3,3',4,5'-Hexachlorobiphenyl (130)									
2,2',3,3',4,6,6'-Heptachlorobiphenyl (176)									
2,2',3,3',4,6-Hexachlorobiphenyl (131)									
2,2',3,3',4,6'-Hexachlorobiphenyl (132)									
2,2',3,3',4-Pentachlorobiphenyl (82)									
2,2',3,3',5,5',6-Heptachlorobiphenyl (178)									
2,2',3,3',5,6-Hexachlorobiphenyl (134)									
2,2',3,3',5,6'-Hexachlorobiphenyl (135)									
2,2',3,3',5-Pentachlorobiphenyl (83)									
2,2',3,3',6,6'-Hexachlorobiphenyl (136)									
2,2',3,3',6-Pentachlorobiphenyl (84)									
2,2',3,3'-Tetrachlorobiphenyl (40)									
2,2',3,4,4',5,5',6-Octachlorobiphenyl (203)									
2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)									
2,2',3,4,4',5,6'-Heptachlorobiphenyl (182)									
2,2',3,4,4',5',6-Heptachlorobiphenyl (183)									
2,2',3,4,4',5-Hexachlorobiphenyl (137)									
2,2',3,4,4',6,6'-Heptachlorobiphenyl (184)									
2,2',3,4,4'-Pentachlorobiphenyl (85)									
2,2',3,4,5,5',6-Heptachlorobiphenyl (185)									
2,2',3,4',5,5',6-Heptachlorobiphenyl (187)									
2,2',3,4,5,5'-Hexachlorobiphenyl (141)									
2,2',3,4',5,5'-Hexachlorobiphenyl (146)									
2,2',3,4,5',6-Hexachlorobiphenyl (144)									
2,2',3,4',5,6-Hexachlorobiphenyl (147)									
2,2',3,4,5-Pentachlorobiphenyl (86)									
2,2',3,4',5-Pentachlorobiphenyl (90)									
2,2',3,4,6-Pentachlorobiphenyl (88)									
2,2',3,4,6'-Pentachlorobiphenyl (89)									
2,2',3,4'-Tetrachlorobiphenyl (42)									
2,2',3,5,5'-Pentachlorobiphenyl (92)									
2,2',3,5,6-Pentachlorobiphenyl (93)									
2,2',3,5-Tetrachlorobiphenyl (43)									
2,2',3,5'-Tetrachlorobiphenyl (44)									
2,2',3,6-Tetrachlorobiphenyl (45)									
2,2',3,6'-Tetrachlorobiphenyl (46)									
2,2',3'-Trichlorobiphenyl (16)									
2,2',4,4',5,5'-Hexachlorobiphenyl (153)									
2,2',4,5-Tetrachlorobiphenyl (48)									
2,2',4,5'-Tetrachlorobiphenyl (49)									
2,2',4,6-Tetrachlorobiphenyl (50)									
2,2',4-Trichlorobiphenyl (17)									

Table B-1
Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_H-03-SS1 9/29/2010	SS_H-06-SS1 9/28/2010	SS_H-07-SS1 9/29/2010	SS_H-10-SS1 9/29/2010	SS_H-13-SS1 9/29/2010	SS_H-16-SS1 9/28/2010	SS_H-18-SS1 9/29/2010	SS_H-19-SS1 9/30/2010	SS_H-22-SS1 9/28/2010
2,2',5-Trichlorobiphenyl (18)									
2,2',6-Trichlorobiphenyl (19)									
2,2'-Dichlorobiphenyl (4)									
2,3,3',4,4',5,5',6-Octachlorobiphenyl (205)									
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)									
2,3,3',4,4',5,6-Heptachlorobiphenyl (190)									
2,3,3',4,4',5',6-Heptachlorobiphenyl (191)									
2,3,3',4,4',5-Hexachlorobiphenyl (156)									
2,3,3',4,4',6-Hexachlorobiphenyl (158)									
2,3,3',4,4'-Pentachlorobiphenyl (105)									
2,3,3',4,5-Pentachlorobiphenyl (106)									
2,3,3',4',5'-Pentachlorobiphenyl (108)									
2,3,3',4',6-Pentachlorobiphenyl (110)									
2,3,3',4'-Tetrachlorobiphenyl (56)									
2,3,3',6-Tetrachlorobiphenyl (59)									
2,3,3'-Trichlorobiphenyl (20)									
2,3',4,4',5,5'-Hexachlorobiphenyl (167)									
2,3,4,4',5-Pentachlorobiphenyl (114)									
2,3',4,4',5-Pentachlorobiphenyl (118)									
2,3,4,4'-Tetrachlorobiphenyl (60)									
2,3',4,4'-Tetrachlorobiphenyl (66)									
2,3,4,5-Tetrachlorobiphenyl (61)									
2,3,4',5-Tetrachlorobiphenyl (63)									
2,3,4',6-Tetrachlorobiphenyl (64)									
2,3,4'-Trichlorobiphenyl (22)									
2,3',4-Trichlorobiphenyl (25)									
2,3',5-Trichlorobiphenyl (26)									
2,3,6-Trichlorobiphenyl (24)									
2,3-Dichlorobiphenyl (5)									
2,3'-Dichlorobiphenyl (6)									
2,4',5-Trichlorobiphenyl (31)									
2,4',6-Trichlorobiphenyl (32)									
2,4-Dichlorobiphenyl (7)									
2,4'-Dichlorobiphenyl (8)									
2,5-Dichlorobiphenyl (9)									
2,6-Dichlorobiphenyl (10)									
2-Monochlorobiphenyl (1)									
3,3',4,4',5,5'-Hexachlorobiphenyl (169)									
3,3',4,4',5-Pentachlorobiphenyl (126)									
3,3',4,4'-Tetrachlorobiphenyl (77)									
3,4,4',5-Tetrachlorobiphenyl (81)									
3,4-Dichlorobiphenyl (12)									
4-Chlorobiphenyl (3)									
Decachlorobiphenyl (209)									
PCB TEQ USEPA, 2010									
Inorganics (mg/Kg)									
Aluminum									
Antimony	0.085 U	0.098 U	0.08 U	0.196	0.137	0.12	0.257	0.186	0.154
Arsenic	2.8	2.5	1.7 J	2.3	2 J	2.9	3.3	2.6	8.9
Barium	26	17	18	29	18	15	13	19.6	25
Beryllium	0.42	0.24 J	0.32	0.38	0.32 J	0.29 J	0.31	0.36	0.4
Cadmium	0.04 U	0.1	0.05 U	0.16	0.11	0.09 J	0.05 U	0.07 J	0.15
Calcium									
Chromium	3.88 J	4.28 J	5.72 J	4.01 J	6.93 J	4.67 J	6.06 J	7.8	5.41 J
Cobalt	1.3	2.18	1.14	1.6	1.19	1.09	0.75	1.65 J	2.2

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Surface Soil Data Human Health Concern and General Area

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	SS_H-03-SS1 9/29/2010	SS_H-06-SS1 9/28/2010	SS_H-07-SS1 9/29/2010	SS_H-10-SS1 9/29/2010	SS_H-13-SS1 9/29/2010	SS_H-16-SS1 9/28/2010	SS_H-18-SS1 9/29/2010	SS_H-19-SS1 9/30/2010	SS_H-22-SS1 9/28/2010
Copper	5.9	5.4	8.3	7.2	8.8	8.6	13.5	8.9	10.9
Iron									
Lead	21.7	23.7	22.4	41.4	36.4	34.6	38.7	45	32.6
Magnesium									
Manganese	181	721 J	82.9	452	150 J	106 J	40.5	177 J	276
Mercury									
Methyl Mercury									
Molybdenum	0.74 U	0.99 U	0.76 U	0.63 U	0.82 U	1.07 U	1.2	1.05	0.89 U
Nickel	3.08 J	3.01 J	3.34 J	3.04 J	3.69 J	2.73 J	2.05 J	4.41 J	3.13 J
Potassium									
Selenium	0.2 J	0.1 U	0.2 J	0.3 J	0.3 J	0.3 J	0.5 J	0.7 J	0.2 J
Silver	0.2 U	0.2 UJ	0.2 U	0.2 UJ	0.2 UJ	0.2 UJ	0.2 U	0.2 U	0.2 UJ
Sodium									
Thallium	0.4 U	0.4 U	0.5 U	0.5 U	0.4 U	0.4 U	0.5 U	0.5 U	0.4 U
Vanadium	18	12	13	20	18	19	18	25.7	20
Zinc	32.3	17.1	19.2	29.7	28.2	20.1	11.5	28.4	22.8
Dioxins (mg/Kg)									
1,2,3,4,6,7,8-HpCDD	0.00000324	0.00000604	0.00000504	0.00000573	0.0000052	0.00000492	0.00000501	0.00001	0.00000351
1,2,3,4,6,7,8-HpCDF	0.00000249	0.00000363	0.00000285	0.00000376	0.00000314	0.00000553	0.0000027	0.0000089	0.0000431
1,2,3,4,7,8,9-HpCDF	0.000000143 U	0.000000222 J	0.000000118 U	0.000000321 J	0.00000016 U	0.000000249 J	0.000000229 J	0.000000213 U	0.000000291 J
1,2,3,4,7,8-HxCDD	0.000000185 J	0.000000225 J	0.000000242 J	0.000000309 J	0.000000193 J	0.000000194 J	0.000000281 J	0.000000231 U	0.000000209 U
1,2,3,4,7,8-HxCDF	0.000000613 J	0.000000825 J	0.000000666 J	0.00000102 J	0.000000777 J	0.000000743 J	0.000000671 J	0.0000018 J	0.000000626 J
1,2,3,6,7,8-HxCDD	0.000000322 J	0.000000393 J	0.000000404 J	0.000000483 J	0.000000421 J	0.00000037 J	0.000000427 J	0.000000717 J	0.000000838 J
1,2,3,6,7,8-HxCDF	0.000000432 J	0.000000627 J	0.000000476 J	0.000000748 J	0.000000505 J	0.000000611 J	0.000000501 J	0.00000124 J	0.000000445 J
1,2,3,7,8,9-HxCDD	0.00000024 U	0.000000431 J	0.000000367 J	0.000000347 J	0.000000197 U	0.000000286 J	0.00000036 J	0.000000683 J	0.000000265 U
1,2,3,7,8,9-HxCDF	0.000000173 U	0.000000149 U	0.00000013 U	0.000000143 U	0.000000124 U	0.0000000653 J	0.000000156 U	0.00000024 U	0.000000207 U
1,2,3,7,8-PeCDD	0.000000151 J	0.000000216 J	0.000000114 U	0.000000227 J	0.00000011 U	0.000000179 J	0.000000189 J	0.000000349 J	0.000000365 J
1,2,3,7,8-PeCDF	0.000000109 U	0.000000597 J	0.000000494 J	0.000000667 J	0.00000058 J	0.000000476 J	0.000000422 J	0.000000964 J	0.000000387 J
1,2,4,5,7,8-hexachloro(9h)xanthene									
2,3,4,6,7,8-HxCDF	0.000000573 J	0.000000754 J	0.00000058 J	0.000000975 J	0.000000644 J	0.000000792 J	0.000000632 J	0.00000204 J	0.000000636 J
2,3,4,7,8-PeCDF	0.00000075 J	0.000000906 J	0.000000738 J	0.0000011 J	0.000000816 J	0.000000727 J	0.000000734 J	0.00000185 J	0.000000549 J
2,3,7,8-TCDD	0.000000717	0.00000196	0.00000192	0.00000125	0.0000079	0.00000189	0.00000362	0.0000022	0.00000167
2,3,7,8-TCDF	0.000000973	0.00000146	0.00000115	0.00000153	0.00000146	0.000000836	0.000000405 J	0.0000015	0.000000755
OCDD	0.0000201	0.0000405	0.0000312	0.0000339	0.0000352	0.0000349	0.0000325	0.0000647	0.000021
OCDF	0.00000254 J	0.00000397 J	0.0000031 J	0.00000407 J	0.00000339 J	0.00000505	0.00000299 J	0.00000763	0.0000249
Dioxin TEQ Mammal	0.00000149	0.00000306	0.00000270	0.00000248	0.00000873	0.00000281	0.00000447	0.00000417	0.00000306

mg/Kg - milligrams per kilogram.
EB - Compound detected in the associated equipment rinsate blank.
J - Value is estimated.
U - Compound not detected, value is detection limit.

Prepared by: KJC 3/28/11
Checked by: BJR 3/29/11

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	TEF (1)	SS_G-01-SS1Re 9/28/2010		% of Total TEQ	TEQ	SS_G-01-SS2 11/18/2010		% of Total TEQ	TEQ	SS_G-01-SS3 11/18/2010		% of Total TEQ	TEQ
Dioxins/Furans (mg/Kg)													
1,2,3,4,6,7,8-HpCDD	0.01	0.000111		0.04%	1.1E-06	0.00015		0.04%	1.5E-06	0.000424		0.03%	4.2E-06
1,2,3,4,6,7,8-HpCDF	0.01	0.0000329	J	0.01%	3.3E-07	0.0000445		0.01%	4.5E-07	0.000115		0.01%	1.2E-06
1,2,3,4,7,8,9-HpCDF	0.01	0.00000487	U	0.00%	2.4E-08	0.00000212	J	0.00%	2.1E-08	0.00000606		0.00%	6.1E-08
1,2,3,4,7,8-HxCDD	0.1	0.00000551	U	0.01%	2.8E-07	0.00000264		0.01%	2.6E-07	0.00000826		0.01%	8.3E-07
1,2,3,4,7,8-HxCDF	0.1	0.00000497	J	0.02%	5E-07	0.00000491		0.01%	4.9E-07	0.0000136		0.01%	1.4E-06
1,2,3,6,7,8-HxCDD	0.1	0.00000544	J	0.02%	5.4E-07	0.00000696		0.02%	7E-07	0.0000182		0.01%	1.8E-06
1,2,3,6,7,8-HxCDF	0.1	0.00000556	J	0.02%	5.6E-07	0.0000046		0.01%	4.6E-07	0.000012		0.01%	1.2E-06
1,2,3,7,8,9-HxCDD	0.1	0.00000655	U	0.01%	3.3E-07	0.00000546		0.02%	5.5E-07	0.0000138		0.01%	1.4E-06
1,2,3,7,8,9-HxCDF	0.1	0.00000441	U	0.01%	2.2E-07	0.000000266	J	0.00%	2.7E-08	0.000000779	J	0.00%	7.8E-08
1,2,3,7,8-PeCDD	1	0.00000685	U	0.14%	3.4E-06	0.00000377		0.11%	3.8E-06	0.0000147		0.10%	1.5E-05
1,2,3,7,8-PeCDF	0.03	0.00000389	U	0.00%	5.8E-08	0.00000198	J	0.00%	5.9E-08	0.00000563		0.00%	1.7E-07
2,3,4,6,7,8-HxCDF	0.1	0.00000674	J	0.03%	6.7E-07	0.0000055		0.02%	5.5E-07	0.0000139		0.01%	1.4E-06
2,3,4,7,8-PeCDF	0.3	0.00000886	J	0.11%	2.7E-06	0.00000334		0.03%	1E-06	0.0000086		0.02%	2.6E-06
2,3,7,8-TCDD	1	0.00247		99.54%	0.00247	0.00347	J	99.69%	0.00347	0.0146	J	99.77%	0.0146
2,3,7,8-TCDF	0.1	0.00000474	J	0.02%	4.7E-07	0.00000482		0.01%	4.8E-07	0.0000122		0.01%	1.2E-06
OCDD	0.0003	0.00074		0.01%	2.2E-07	0.00111		0.01%	3.3E-07	0.00304		0.01%	9.1E-07
OCDF	0.0003	0.0000506	J	0.00%	1.5E-08	0.0000595		0.00%	1.8E-08	0.000158		0.00%	4.7E-08
Dioxin TEQ Mammal (2)		0.00248				0.00348				0.0146			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	SS_G-01-SS5 11/18/2010		% of Total TEQ	TEQ	LPX-FP-4004-0000-01 7/19/2001		% of Total TEQ	TEQ	LPX-SD-4405-0005-01 6/21/2004		% of Total	TEQ	LPX-SD-4406-0005-01 6/21/2004		% of Total	TEQ
Dioxins/Furans (mg/Kg)																
1,2,3,4,6,7,8-HpCDD	0.000218		0.04%	2.2E-06	0.00005714		0.05%	5.7E-07	0.000213	J	0.05%	2.1E-06	0.000229		0.13%	2.3E-06
1,2,3,4,6,7,8-HpCDF	0.0000936		0.02%	9.4E-07	0.00001822		0.02%	1.8E-07	0.0000893	J	0.02%	8.9E-07	0.0000723		0.04%	7.2E-07
1,2,3,4,7,8,9-HpCDF	0.00000416		0.00%	4.2E-08	0.00000118	J	0.00%	1.2E-08	0.00000527	J	0.00%	5.3E-08	0.0000049	J	0.00%	4.9E-08
1,2,3,4,7,8-HxCDD	0.00000429		0.01%	4.3E-07	0.0000009	J	0.01%	9E-08	0.00000617	J	0.01%	6.2E-07	0.00000387	J	0.02%	3.9E-07
1,2,3,4,7,8-HxCDF	0.00000897		0.02%	9E-07	0.00000267	J	0.02%	2.7E-07	0.0000117	J	0.03%	1.2E-06	0.00000832		0.05%	8.3E-07
1,2,3,6,7,8-HxCDD	0.0000121		0.02%	1.2E-06	0.00000253	J	0.02%	2.5E-07	0.0000128	J	0.03%	1.3E-06	0.00000967		0.05%	9.7E-07
1,2,3,6,7,8-HxCDF	0.00000892		0.02%	8.9E-07	0.00000166	J	0.01%	1.7E-07	0.00000855	J	0.02%	8.6E-07	0.0000143	EMPC	0.08%	1.4E-06
1,2,3,7,8,9-HxCDD	0.00000784		0.02%	7.8E-07	0.00000233	J	0.02%	2.3E-07	0.00000875	J	0.02%	8.8E-07	0.00000836		0.05%	8.4E-07
1,2,3,7,8,9-HxCDF	0.00000095	J	0.00%	9.5E-08	0.00000116	U	0.01%	5.8E-08	0.0000027	J	0.01%	2.7E-07	0.00000428	EMPC	0.02%	4.3E-07
1,2,3,7,8-PeCDD	0.00000494		0.10%	4.9E-06	0.00000061	J	0.05%	6.1E-07	0.00000691	J	0.16%	6.9E-06	0.00000419	J	0.23%	4.2E-06
1,2,3,7,8-PeCDF	0.0000042		0.00%	1.3E-07	0.00000088	J	0.00%	2.6E-08	0.00000944	EMPC	0.01%	2.8E-07	0.000227	EMPC	0.37%	6.8E-06
2,3,4,6,7,8-HxCDF	0.0000105		0.02%	1.1E-06	0.00000131	J	0.01%	1.3E-07	0.0000118	J	0.03%	1.2E-06	0.00000707		0.04%	7.1E-07
2,3,4,7,8-PeCDF	0.00000944		0.06%	2.8E-06	0.00000134	J	0.04%	4E-07	0.0000063	J	0.04%	1.9E-06	0.0000118		0.19%	3.5E-06
2,3,7,8-TCDD	0.00487	J	99.64%	0.00487	0.00113007		99.70%	0.00113	0.00427	J#	99.54%	0.00427	0.0018	#	98.66%	0.0018
2,3,7,8-TCDF	0.00000755		0.02%	7.6E-07	0.00000226	J	0.02%	2.3E-07	0.00000754	J	0.02%	7.5E-07	0.00000673		0.04%	6.7E-07
OCDD	0.00165		0.01%	5E-07	0.00043255		0.01%	1.3E-07	0.00138	J	0.01%	4.1E-07	0.0016	J	0.03%	4.8E-07
OCDF	0.000124		0.00%	3.7E-08	0.00003719		0.00%	1.1E-08	0.000114	J	0.00%	3.4E-08	0.00011	J	0.00%	3.3E-08
Dioxin TEQ Mammal (2)	0.00489				0.00113				0.00429				0.00182			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	LPX-SD-4407-0005-01 6/21/2004		% of Total	TEQ	RES-SS-11-011-01 12/2/1999		% of Total	TEQ	RES-SS-11-011-02 12/2/1999		% of Total	TEQ	RES-SS-11-011-03 12/2/1999		% of Total	TEQ
Dioxins/Furans (mg/Kg)																
1,2,3,4,6,7,8-HpCDD	0.000224		0.11%	2.2E-06	0.000033	J	4.57%	3.3E-07	0.0000195	J	4.40%	2E-07	0.0000832	J	18.60%	8.3E-07
1,2,3,4,6,7,8-HpCDF	0.0000752		0.04%	7.5E-07	0.0000103	J	1.43%	1E-07	0.0000064	J	1.44%	6.4E-08	0.0000217	J	4.85%	2.2E-07
1,2,3,4,7,8,9-HpCDF	0.00000584		0.00%	5.8E-08	0.0000003	UJ	0.02%	1.5E-09	0.00000051	UJ	0.06%	2.6E-09	0.0000018	J	0.40%	1.8E-08
1,2,3,4,7,8-HxCDD	0.00000624		0.03%	6.2E-07	0.00000072	UJ	0.50%	3.6E-08	0.00000053	EMPC	1.20%	5.3E-08	0.0000015	UJ	1.68%	7.5E-08
1,2,3,4,7,8-HxCDF	0.000019		0.09%	1.9E-06	0.0000018	UJ	1.25%	9E-08	0.0000021	UJ	2.37%	1.1E-07	0.0000035	UJ	3.91%	1.8E-07
1,2,3,6,7,8-HxCDD	0.0000119		0.06%	1.2E-06	0.0000017	UJ	1.18%	8.5E-08	0.0000011	UJ	1.24%	5.5E-08	0.0000039	J	8.72%	3.9E-07
1,2,3,6,7,8-HxCDF	0.0000123		0.06%	1.2E-06	0.0000011	UJ	0.76%	5.5E-08	0.00000097	UJ	1.09%	4.9E-08	0.0000019	J	4.25%	1.9E-07
1,2,3,7,8,9-HxCDD	0.00000909		0.04%	9.1E-07	0.000002	UJ	1.39%	1E-07	0.0000013	UJ	1.47%	6.5E-08	0.000004	J	8.94%	4E-07
1,2,3,7,8,9-HxCDF	0.00000393	J	0.02%	3.9E-07	0.0000002	UJ	0.14%	1E-08	0.0000002	UJ	0.23%	1E-08	0.00000027	J	0.60%	2.7E-08
1,2,3,7,8-PeCDD	0.00000774		0.37%	7.7E-06	0.00000058	UJ	4.02%	2.9E-07	0.00000055	UJ	6.20%	2.8E-07	0.00000094	UJ	10.51%	4.7E-07
1,2,3,7,8-PeCDF	0.000054	EMPC	0.08%	1.6E-06	0.00000079	UJ	0.16%	1.2E-08	0.000001	UJ	0.34%	1.5E-08	0.0000013	UJ	0.44%	2E-08
2,3,4,6,7,8-HxCDF	0.0000113		0.05%	1.1E-06	0.0000013	UJ	0.90%	6.5E-08	0.0000012	UJ	1.35%	6E-08	0.0000026	J	5.81%	2.6E-07
2,3,4,7,8-PeCDF	0.0000174		0.25%	5.2E-06	0.0000011	UJ	2.29%	1.7E-07	0.0000013	UJ	4.40%	2E-07	0.0000018	UJ	6.04%	2.7E-07
2,3,7,8-TCDD	0.00207	#	98.67%	0.00207	0.0000057	J	79.02%	5.7E-06	0.0000031	J	69.91%	3.1E-06	0.00000075	J	16.76%	7.5E-07
2,3,7,8-TCDF	0.0000239		0.11%	2.4E-06	0.000002	UJ	1.39%	1E-07	0.0000026	UJ	2.93%	1.3E-07	0.0000032	UJ	3.58%	1.6E-07
OCDD	0.00148	J	0.02%	4.4E-07	0.00022	J	0.91%	6.6E-08	0.000194	J	1.31%	5.8E-08	0.000692	J	4.64%	2.1E-07
OCDF	0.000102	J	0.00%	3.1E-08	0.0000159	J	0.07%	4.8E-09	0.0000103	J	0.07%	3.1E-09	0.000042	J	0.28%	1.3E-08
Dioxin TEQ Mammal (2)	0.00210				0.00000721				0.00000443				0.00000447			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	RES-SS-11-012-01 12/2/1999		% of Total	TEQ	RES-SS-11-012-02 12/2/1999		% of Total	TEQ	RES-SS-11-012-03 12/2/1999		% of Total	TEQ	RES-SS-11-419-02 11/19/1999		% of Total	TEQ
Dioxins/Furans (mg/Kg)																
1,2,3,4,6,7,8-HpCDD	0.00015	J	10.93%	1.5E-06	0.0000586	J	16.88%	5.9E-07	0.0000825	J	14.38%	8.3E-07	0.000074		0.50%	7.4E-07
1,2,3,4,6,7,8-HpCDF	0.000038	J	2.77%	3.8E-07	0.000012	J	3.46%	1.2E-07	0.0000182	J	3.17%	1.8E-07	0.0000192		0.13%	1.9E-07
1,2,3,4,7,8,9-HpCDF	0.0000035	J	0.26%	3.5E-08	0.0000003	UJ	0.04%	1.5E-09	0.0000015	J	0.26%	1.5E-08	0.0000013	J	0.01%	1.3E-08
1,2,3,4,7,8-HxCDD	0.0000026	J	1.90%	2.6E-07	0.0000016	J	4.61%	1.6E-07	0.0000011	EMPC	1.92%	1.1E-07	0.0000011	J	0.07%	1.1E-07
1,2,3,4,7,8-HxCDF	0.0000043	UJ	1.57%	2.2E-07	0.0000018	UJ	2.59%	9E-08	0.0000051	J	8.89%	5.1E-07	0.0000037	U	0.13%	1.9E-07
1,2,3,6,7,8-HxCDD	0.0000068	J	4.96%	6.8E-07	0.000003	J	8.64%	3E-07	0.000003	J	5.23%	3E-07	0.0000032	U	0.11%	1.6E-07
1,2,3,6,7,8-HxCDF	0.0000028	J	2.04%	2.8E-07	0.0000013	UJ	1.87%	6.5E-08	0.0000023	J	4.01%	2.3E-07	0.0000017	UJ	0.06%	8.5E-08
1,2,3,7,8,9-HxCDD	0.0000072	J	5.25%	7.2E-07	0.0000033	J	9.50%	3.3E-07	0.0000032	J	5.58%	3.2E-07	0.0000032	J	0.22%	3.2E-07
1,2,3,7,8,9-HxCDF	0.0000003	UJ	0.11%	1.5E-08	0.00000048	J	1.38%	4.8E-08	0.0000002	UJ	0.17%	1E-08	0.0000004	U	0.01%	2E-08
1,2,3,7,8-PeCDD	0.0000013	UJ	4.74%	6.5E-07	0.00000075	EMPC	21.60%	7.5E-07	0.00000093	UJ	8.11%	4.7E-07	0.00000099	J	0.67%	9.9E-07
1,2,3,7,8-PeCDF	0.0000014	UJ	0.15%	2.1E-08	0.0000009	UJ	0.39%	1.4E-08	0.0000018	UJ	0.47%	2.7E-08	0.0000015	U	0.02%	2.3E-08
2,3,4,6,7,8-HxCDF	0.0000042	J	3.06%	4.2E-07	0.0000015	J	4.32%	1.5E-07	0.0000033	J	5.75%	3.3E-07	0.0000019	J	0.13%	1.9E-07
2,3,4,7,8-PeCDF	0.0000021	UJ	2.30%	3.2E-07	0.00000094	UJ	4.06%	1.4E-07	0.0000028	J	14.64%	8.4E-07	0.0000021	U	0.21%	3.2E-07
2,3,7,8-TCDD	0.0000077	J	56.13%	7.7E-06	0.0000005	J	14.40%	5E-07	0.00000069	J	12.03%	6.9E-07	0.000144		97.50%	0.00014
2,3,7,8-TCDF	0.0000035	UJ	1.28%	1.8E-07	0.0000015	UJ	2.16%	7.5E-08	0.0000065	J	11.33%	6.5E-07	0.0000028	U	0.09%	1.4E-07
OCDD	0.0011	J	2.41%	3.3E-07	0.000451	J	3.90%	1.4E-07	0.000746	J	3.90%	2.2E-07	0.000665		0.14%	2E-07
OCDF	0.0000748	J	0.16%	2.2E-08	0.000023	J	0.20%	6.9E-09	0.0000275	J	0.14%	8.3E-09	0.0000359		0.01%	1.1E-08
Dioxin TEQ Mammal (2)	0.0000137				0.00000347				0.00000574				0.000148			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	SS_G-02-SS1 9/29/2010		% of Total	TEQ	SS_G-03-SS1 9/28/2010		% of Total	TEQ	SS_G-04-SS1 9/29/2010		% of Total	TEQ	SS_G-05-SS1 9/30/2010		% of Total	TEQ
Dioxins/Furans (mg/Kg)																
1,2,3,4,6,7,8-HpCDD	0.000113		13.65%	1.1E-06	0.0000159		0.07%	1.6E-07	0.000555		1.07%	5.6E-06	0.00000834		0.18%	8.3E-08
1,2,3,4,6,7,8-HpCDF	0.0000291		3.51%	2.9E-07	0.00000759		0.03%	7.6E-08	0.00015		0.29%	1.5E-06	0.00000405		0.09%	4.1E-08
1,2,3,4,7,8,9-HpCDF	0.0000016	J	0.19%	1.6E-08	0.000000405	J	0.00%	4.1E-09	0.00000874	J	0.02%	8.7E-08	0.000000244	J	0.01%	2.4E-09
1,2,3,4,7,8-HxCDD	0.00000203	J	2.45%	2E-07	0.000000477	J	0.02%	4.8E-08	0.0000111	J	0.21%	1.1E-06	0.000000265	U	0.03%	1.3E-08
1,2,3,4,7,8-HxCDF	0.00000211	J	2.55%	2.1E-07	0.00000151	J	0.06%	1.5E-07	0.0000097	J	0.19%	9.7E-07	0.000000662	J	0.15%	6.6E-08
1,2,3,6,7,8-HxCDD	0.00000457		5.52%	4.6E-07	0.000000948	J	0.04%	9.5E-08	0.0000238	J	0.46%	2.4E-06	0.000000542	J	0.12%	5.4E-08
1,2,3,6,7,8-HxCDF	0.00000187	J	2.26%	1.9E-07	0.00000115	J	0.05%	1.2E-07	0.000011	J	0.21%	1.1E-06	0.000000514	J	0.11%	5.1E-08
1,2,3,7,8,9-HxCDD	0.00000413		4.99%	4.1E-07	0.000000305	U	0.01%	1.5E-08	0.0000182	J	0.35%	1.8E-06	0.000000417	J	0.09%	4.2E-08
1,2,3,7,8,9-HxCDF	0.000000139	J	0.17%	1.4E-08	0.000000131	J	0.01%	1.3E-08	0.00000449	U	0.04%	2.2E-07	0.000000248	U	0.03%	1.2E-08
1,2,3,7,8-PeCDD	0.00000107	J	12.92%	1.1E-06	0.000000641	J	0.27%	6.4E-07	0.00000607	J	1.18%	6.1E-06	0.000000114	U	0.13%	5.7E-08
1,2,3,7,8-PeCDF	0.00000105	J	0.38%	3.2E-08	0.00000106	J	0.01%	3.2E-08	0.00000414	J	0.02%	1.2E-07	0.000000413	J	0.03%	1.2E-08
2,3,4,6,7,8-HxCDF	0.00000243	J	2.93%	2.4E-07	0.00000134	J	0.06%	1.3E-07	0.0000124	J	0.24%	1.2E-06	0.000000608	J	0.13%	6.1E-08
2,3,4,7,8-PeCDF	0.00000154	J	5.58%	4.6E-07	0.00000163	J	0.21%	4.9E-07	0.00000503	J	0.29%	1.5E-06	0.000000557	J	0.37%	1.7E-07
2,3,7,8-TCDD	0.00000312		37.68%	3.1E-06	0.000233		99.04%	0.00023	0.000491		95.07%	0.00049	0.0000446		98.29%	4.5E-05
2,3,7,8-TCDF	0.00000196		2.37%	2E-07	0.00000241		0.10%	2.4E-07	0.0000057	J	0.11%	5.7E-07	0.000000922		0.20%	9.2E-08
OCDD	0.000739		2.68%	2.2E-07	0.000107		0.01%	3.2E-08	0.0037		0.21%	1.1E-06	0.0000591		0.04%	1.8E-08
OCDF	0.0000483		0.17%	1.4E-08	0.00000892		0.00%	2.7E-09	0.000274		0.02%	8.2E-08	0.00000434	J	0.00%	1.3E-09
Dioxin TEQ Mammal (2)	0.00000828				0.000235				0.000516				0.0000454			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	SS_G-06-SS1 9/28/2010		% of Total	TEQ	SS_G-07-SS1 9/29/2010		% of Total	TEQ	SS_G-08-SS1 9/29/2010		% of Total	TEQ	SS_G-09-SS1 9/29/2010		% of Total	TEQ
Dioxins/Furans (mg/Kg)																
1,2,3,4,6,7,8-HpCDD	0.00000836		0.90%	8.4E-08	0.000118		0.06%	1.2E-06	0.0000912		0.15%	9.1E-07	0.000223		0.10%	2.2E-06
1,2,3,4,6,7,8-HpCDF	0.00000376		0.40%	3.8E-08	0.0000435	J	0.02%	4.4E-07	0.0000378		0.06%	3.8E-07	0.0000665		0.03%	6.7E-07
1,2,3,4,7,8,9-HpCDF	0.000000251	J	0.03%	2.5E-09	0.0000038	U	0.00%	1.9E-08	0.00000174	J	0.00%	1.7E-08	0.00000405	J	0.00%	4.1E-08
1,2,3,4,7,8-HxCDD	0.000000381	J	0.41%	3.8E-08	0.00000404	U	0.01%	2E-07	0.0000017	J	0.03%	1.7E-07	0.00000505	U	0.01%	2.5E-07
1,2,3,4,7,8-HxCDF	0.000000971	J	1.04%	9.7E-08	0.00000161	U	0.00%	8.1E-08	0.00000395		0.07%	4E-07	0.0000115	J	0.05%	1.2E-06
1,2,3,6,7,8-HxCDD	0.00000097	J	1.04%	9.7E-08	0.0000042	U	0.01%	2.1E-07	0.00000452		0.08%	4.5E-07	0.00000825	J	0.04%	8.3E-07
1,2,3,6,7,8-HxCDF	0.000000751	J	0.81%	7.5E-08	0.00000569	J	0.03%	5.7E-07	0.00000372		0.06%	3.7E-07	0.00000782	J	0.03%	7.8E-07
1,2,3,7,8,9-HxCDD	0.00000113	J	1.22%	1.1E-07	0.00000513	U	0.01%	2.6E-07	0.00000331		0.06%	3.3E-07	0.0000064	U	0.01%	3.2E-07
1,2,3,7,8,9-HxCDF	0.000000113	J	0.12%	1.1E-08	0.00000307	U	0.01%	1.5E-07	0.00000038	J	0.01%	3.8E-08	0.00000368	U	0.01%	1.8E-07
1,2,3,7,8-PeCDD	0.000000322	J	3.47%	3.2E-07	0.00000335	J	0.16%	3.4E-06	0.00000135	J	0.23%	1.4E-06	0.00000395	J	0.17%	4E-06
1,2,3,7,8-PeCDF	0.000000605	J	0.20%	1.8E-08	0.00000498	J	0.01%	1.5E-07	0.00000244	J	0.01%	7.3E-08	0.00000636	J	0.01%	1.9E-07
2,3,4,6,7,8-HxCDF	0.000000889	J	0.96%	8.9E-08	0.0000064	J	0.03%	6.4E-07	0.00000392		0.07%	3.9E-07	0.0000103	J	0.05%	1E-06
2,3,4,7,8-PeCDF	0.000000757	J	2.44%	2.3E-07	0.00000641	J	0.09%	1.9E-06	0.000004		0.20%	1.2E-06	0.00000883	J	0.12%	2.6E-06
2,3,7,8-TCDD	0.00000795		85.55%	8E-06	0.00206		99.48%	0.00206	0.000585	J	98.85%	0.00059	0.00227		99.29%	0.00227
2,3,7,8-TCDF	0.00000115		1.24%	1.2E-07	0.0000125		0.06%	1.3E-06	0.0000047		0.08%	4.7E-07	0.0000141		0.06%	1.4E-06
OCDD	0.0000489		0.16%	1.5E-08	0.000933		0.01%	2.8E-07	0.000733		0.04%	2.2E-07	0.00173		0.02%	5.2E-07
OCDF	0.00000413	J	0.01%	1.2E-09	0.0000605	J	0.00%	1.8E-08	0.0000549		0.00%	1.6E-08	0.0000912	J	0.00%	2.7E-08
Dioxin TEQ Mammal (2)	0.00000929				0.00207				0.000592				0.00229			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	SS_G-14-SS1 10/1/2010		% of Total	TEQ	SS_G-15-SS1 10/1/2010		% of Total	TEQ	SS_G-18-SS1 10/1/2010		% of Total	TEQ	SS_G-23-SS1 9/30/2010		% of Total	TEQ
Dioxins/Furans (mg/Kg)																
1,2,3,4,6,7,8-HpCDD	0.000058		0.15%	5.8E-07	0.0000772		0.19%	7.7E-07	0.000183		0.15%	1.8E-06	0.000276		0.27%	2.8E-06
1,2,3,4,6,7,8-HpCDF	0.0000228		0.06%	2.3E-07	0.0000251		0.06%	2.5E-07	0.0000782		0.06%	7.8E-07	0.0000897		0.09%	9E-07
1,2,3,4,7,8,9-HpCDF	0.00000111	J	0.00%	1.1E-08	0.00000124	J	0.00%	1.2E-08	0.00000468	U	0.00%	2.3E-08	0.00000542	J	0.01%	5.4E-08
1,2,3,4,7,8-HxCDD	0.00000169	J	0.04%	1.7E-07	0.00000158	J	0.04%	1.6E-07	0.0000055	U	0.02%	2.8E-07	0.00000477	U	0.02%	2.4E-07
1,2,3,4,7,8-HxCDF	0.00000435		0.11%	4.4E-07	0.00000356		0.09%	3.6E-07	0.00000953	J	0.08%	9.5E-07	0.00000249	U	0.01%	1.2E-07
1,2,3,6,7,8-HxCDD	0.00000284		0.07%	2.8E-07	0.0000033		0.08%	3.3E-07	0.00000914	J	0.08%	9.1E-07	0.00000508	U	0.03%	2.5E-07
1,2,3,6,7,8-HxCDF	0.00000328		0.08%	3.3E-07	0.00000303		0.08%	3E-07	0.00000864	J	0.07%	8.6E-07	0.00000274	U	0.01%	1.4E-07
1,2,3,7,8,9-HxCDD	0.00000252		0.06%	2.5E-07	0.00000236	J	0.06%	2.4E-07	0.00000719	U	0.03%	3.6E-07	0.00000599	J	0.06%	6E-07
1,2,3,7,8,9-HxCDF	0.000000216	U	0.00%	1.1E-08	0.000000107	J	0.00%	1.1E-08	0.00000552	U	0.02%	2.8E-07	0.00000502	U	0.02%	2.5E-07
1,2,3,7,8-PeCDD	0.00000115	J	0.29%	1.2E-06	0.00000113	J	0.28%	1.1E-06	0.00000464	U	0.19%	2.3E-06	0.00000455	J	0.45%	4.6E-06
1,2,3,7,8-PeCDF	0.00000282		0.02%	8.5E-08	0.00000188	J	0.01%	5.6E-08	0.00000274	U	0.00%	4.1E-08	0.00000335	J	0.01%	1E-07
2,3,4,6,7,8-HxCDF	0.00000387		0.10%	3.9E-07	0.00000326		0.08%	3.3E-07	0.00000947	J	0.08%	9.5E-07	0.00000932	J	0.09%	9.3E-07
2,3,4,7,8-PeCDF	0.00000411		0.31%	1.2E-06	0.00000273		0.21%	8.2E-07	0.0000113	J	0.28%	3.4E-06	0.00000501	J	0.15%	1.5E-06
2,3,7,8-TCDD	0.00039		98.59%	0.00039	0.000392		98.68%	0.00039	0.00119		98.80%	0.00119	0.001		98.69%	0.001
2,3,7,8-TCDF	0.00000292		0.07%	2.9E-07	0.00000298		0.08%	3E-07	0.00001	J	0.08%	1E-06	0.00000276	U	0.01%	1.4E-07
OCDD	0.000401		0.03%	1.2E-07	0.000559		0.04%	1.7E-07	0.00131		0.03%	3.9E-07	0.00225		0.07%	6.8E-07
OCDF	0.0000271		0.00%	8.1E-09	0.0000377		0.00%	1.1E-08	0.000112	J	0.00%	3.4E-08	0.000152		0.00%	4.6E-08
Dioxin TEQ Mammal (2)	0.000396				0.000397				0.00120				0.00101			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	SS_G-26-SS1 9/30/2010		% of Total	TEQ	SS_G-29-SS1 9/30/2010		% of Total	TEQ	SS_G-29-SS2 11/18/2010		% of Total	TEQ	SS_G-29-SS3 11/18/2010		% of Total	TEQ
Dioxins/Furans (mg/Kg)																
1,2,3,4,6,7,8-HpCDD	0.0000826		0.14%	8.3E-07	0.000371		0.07%	3.7E-06	0.0000645		0.08%	6.5E-07	0.000826		0.07%	8.3E-06
1,2,3,4,6,7,8-HpCDF	0.0000257		0.04%	2.6E-07	0.000105		0.02%	1.1E-06	0.0000242		0.03%	2.4E-07	0.000265		0.02%	2.7E-06
1,2,3,4,7,8,9-HpCDF	0.0000015	J	0.00%	1.5E-08	0.00000752	J	0.00%	7.5E-08	0.00000276		0.00%	2.8E-08	0.0000143		0.00%	1.4E-07
1,2,3,4,7,8-HxCDD	0.0000014	J	0.02%	1.4E-07	0.00000556	U	0.01%	2.8E-07	0.0000016	J	0.02%	1.6E-07	0.000014		0.01%	1.4E-06
1,2,3,4,7,8-HxCDF	0.00000214	J	0.04%	2.1E-07	0.0000108	J	0.02%	1.1E-06	0.00000616		0.08%	6.2E-07	0.0000174		0.01%	1.7E-06
1,2,3,6,7,8-HxCDD	0.00000334		0.06%	3.3E-07	0.0000151	J	0.03%	1.5E-06	0.00000942		0.12%	9.4E-07	0.0000405		0.03%	4.1E-06
1,2,3,6,7,8-HxCDF	0.00000217	J	0.04%	2.2E-07	0.00000908	J	0.02%	9.1E-07	0.00000362		0.05%	3.6E-07	0.0000209		0.02%	2.1E-06
1,2,3,7,8,9-HxCDD	0.00000226	J	0.04%	2.3E-07	0.00000697	U	0.01%	3.5E-07	0.0000047		0.06%	4.7E-07	0.0000277		0.02%	2.8E-06
1,2,3,7,8,9-HxCDF	0.000000398	U	0.00%	2E-08	0.00000371	U	0.00%	1.9E-07	0.00000162	J	0.02%	1.6E-07	0.00000173	J	0.00%	1.7E-07
1,2,3,7,8-PeCDD	0.000000928	J	0.16%	9.3E-07	0.00000577	J	0.11%	5.8E-06	0.00000202	J	0.25%	2E-06	0.00000957		0.08%	9.6E-06
1,2,3,7,8-PeCDF	0.000000809	J	0.00%	2.4E-08	0.00000404	J	0.00%	1.2E-07	0.000000974	J	0.00%	2.9E-08	0.00000691		0.00%	2.1E-07
2,3,4,6,7,8-HxCDF	0.00000257		0.04%	2.6E-07	0.000013	J	0.03%	1.3E-06	0.00000411		0.05%	4.1E-07	0.0000244		0.02%	2.4E-06
2,3,4,7,8-PeCDF	0.00000152	J	0.08%	4.6E-07	0.00000692	J	0.04%	2.1E-06	0.00000204	J	0.08%	6.1E-07	0.00000957		0.02%	2.9E-06
2,3,7,8-TCDD	0.00059	J	99.28%	0.00059	0.00513		99.61%	0.00513	0.000794	J	99.13%	0.00079	0.0126	J	99.67%	0.0126
2,3,7,8-TCDF	0.00000152		0.03%	1.5E-07	0.00000852	J	0.02%	8.5E-07	0.0000013		0.02%	1.3E-07	0.0000117		0.01%	1.2E-06
OCDD	0.000644		0.03%	1.9E-07	0.00277		0.02%	8.3E-07	0.000499		0.02%	1.5E-07	0.00649	J	0.02%	1.9E-06
OCDF	0.0000435		0.00%	1.3E-08	0.000172		0.00%	5.2E-08	0.0000454		0.00%	1.4E-08	0.000462		0.00%	1.4E-07
Dioxin TEQ Mammal (2)	0.000594				0.00515				0.000801				0.0126			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	SS_H-01-SS1 9/28/2010		% of Total TEQ	TEQ	SS_H-03-SS1 9/29/2010		% of Total TEQ	TEQ	SS_H-06-SS1 9/28/2010		% of Total TEQ	TEQ	SS_H-07-SS1 9/29/2010		% of Total TEQ	TEQ
Dioxins/Furans (mg/Kg)																
1,2,3,4,6,7,8-HpCDD	0.00000615		1.04%	6.2E-08	0.00000324		2.17%	3.2E-08	0.00000604		1.98%	6E-08	0.00000504		1.87%	5E-08
1,2,3,4,6,7,8-HpCDF	0.0000129		2.19%	1.3E-07	0.00000249		1.67%	2.5E-08	0.00000363		1.19%	3.6E-08	0.00000285		1.06%	2.9E-08
1,2,3,4,7,8,9-HpCDF	0.000000545	J	0.09%	5.5E-09	0.000000143	U	0.05%	7.2E-10	0.000000222	J	0.07%	2.2E-09	0.000000118	U	0.02%	5.9E-10
1,2,3,4,7,8-HxCDD	0.000000278	J	0.47%	2.8E-08	0.000000185	J	1.24%	1.9E-08	0.000000225	J	0.74%	2.3E-08	0.000000242	J	0.90%	2.4E-08
1,2,3,4,7,8-HxCDF	0.00000459		7.78%	4.6E-07	0.000000613	J	4.11%	6.1E-08	0.000000825	J	2.70%	8.3E-08	0.000000666	J	2.47%	6.7E-08
1,2,3,6,7,8-HxCDD	0.000000657	J	1.11%	6.6E-08	0.000000322	J	2.16%	3.2E-08	0.000000393	J	1.29%	3.9E-08	0.000000404	J	1.50%	4E-08
1,2,3,6,7,8-HxCDF	0.00000123	J	2.08%	1.2E-07	0.000000432	J	2.90%	4.3E-08	0.000000627	J	2.05%	6.3E-08	0.000000476	J	1.76%	4.8E-08
1,2,3,7,8,9-HxCDD	0.000000437	J	0.74%	4.4E-08	0.00000024	U	0.81%	1.2E-08	0.000000431	J	1.41%	4.3E-08	0.000000367	J	1.36%	3.7E-08
1,2,3,7,8,9-HxCDF	0.000000118	J	0.20%	1.2E-08	0.000000173	U	0.58%	8.7E-09	0.000000149	U	0.24%	7.5E-09	0.00000013	U	0.24%	6.5E-09
1,2,3,7,8-PeCDD	0.000000355	J	6.02%	3.6E-07	0.000000151	J	10.13%	1.5E-07	0.000000216	J	7.07%	2.2E-07	0.000000114	U	2.11%	5.7E-08
1,2,3,7,8-PeCDF	0.000000943	J	0.48%	2.8E-08	0.000000109	U	0.11%	1.6E-09	0.000000597	J	0.59%	1.8E-08	0.000000494	J	0.55%	1.5E-08
2,3,4,6,7,8-HxCDF	0.00000121	J	2.05%	1.2E-07	0.000000573	J	3.85%	5.7E-08	0.000000754	J	2.47%	7.5E-08	0.00000058	J	2.15%	5.8E-08
2,3,4,7,8-PeCDF	0.00000185	J	9.41%	5.6E-07	0.00000075	J	15.10%	2.3E-07	0.000000906	J	8.89%	2.7E-07	0.000000738	J	8.21%	2.2E-07
2,3,7,8-TCDD	0.00000369		62.55%	3.7E-06	0.000000717		48.12%	7.2E-07	0.00000196		64.12%	2E-06	0.00000192		71.16%	1.9E-06
2,3,7,8-TCDF	0.00000208		3.53%	2.1E-07	0.000000973		6.53%	9.7E-08	0.00000146		4.78%	1.5E-07	0.00000115		4.26%	1.2E-07
OCDD	0.0000359		0.18%	1.1E-08	0.0000201		0.40%	6E-09	0.0000405		0.40%	1.2E-08	0.0000312		0.35%	9.4E-09
OCDF	0.0000155		0.08%	4.7E-09	0.00000254	J	0.05%	7.6E-10	0.00000397	J	0.04%	1.2E-09	0.0000031	J	0.03%	9.3E-10
Dioxin TEQ Mammal (2)	0.00000590				0.00000149				0.00000306				0.00000270			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	SS_H-10-SS1 9/29/2010		% of Total TEQ	TEQ	SS_H-13-SS1 9/29/2010		% of Total TEQ	TEQ	SS_H-16-SS1 9/28/2010		% of Total TEQ	TEQ
Dioxins/Furans (mg/Kg)												
1,2,3,4,6,7,8-HpCDD	0.00000573		2.31%	5.7E-08	0.0000052		0.60%	5.2E-08	0.00000492		1.75%	4.9E-08
1,2,3,4,6,7,8-HpCDF	0.00000376		1.51%	3.8E-08	0.00000314		0.36%	3.1E-08	0.00000553		1.97%	5.5E-08
1,2,3,4,7,8,9-HpCDF	0.000000321	J	0.13%	3.2E-09	0.00000016	U	0.01%	8E-10	0.000000249	J	0.09%	2.5E-09
1,2,3,4,7,8-HxCDD	0.000000309	J	1.24%	3.1E-08	0.000000193	J	0.22%	1.9E-08	0.000000194	J	0.69%	1.9E-08
1,2,3,4,7,8-HxCDF	0.00000102	J	4.10%	1E-07	0.000000777	J	0.89%	7.8E-08	0.000000743	J	2.64%	7.4E-08
1,2,3,6,7,8-HxCDD	0.000000483	J	1.94%	4.8E-08	0.000000421	J	0.48%	4.2E-08	0.00000037	J	1.32%	3.7E-08
1,2,3,6,7,8-HxCDF	0.000000748	J	3.01%	7.5E-08	0.000000505	J	0.58%	5.1E-08	0.000000611	J	2.17%	6.1E-08
1,2,3,7,8,9-HxCDD	0.000000347	J	1.40%	3.5E-08	0.000000197	U	0.11%	9.9E-09	0.000000286	J	1.02%	2.9E-08
1,2,3,7,8,9-HxCDF	0.000000143	U	0.29%	7.2E-09	0.000000124	U	0.07%	6.2E-09	6.53E-08	J	0.23%	6.5E-09
1,2,3,7,8-PeCDD	0.000000227	J	9.14%	2.3E-07	0.00000011	U	0.63%	5.5E-08	0.000000179	J	6.37%	1.8E-07
1,2,3,7,8-PeCDF	0.000000667	J	0.81%	2E-08	0.00000058	J	0.20%	1.7E-08	0.000000476	J	0.51%	1.4E-08
2,3,4,6,7,8-HxCDF	0.000000975	J	3.92%	9.8E-08	0.000000644	J	0.74%	6.4E-08	0.000000792	J	2.82%	7.9E-08
2,3,4,7,8-PeCDF	0.0000011	J	13.28%	3.3E-07	0.000000816	J	2.80%	2.4E-07	0.000000727	J	7.76%	2.2E-07
2,3,7,8-TCDD	0.00000125		50.30%	1.3E-06	0.0000079		90.50%	7.9E-06	0.00000189		67.26%	1.9E-06
2,3,7,8-TCDF	0.00000153		6.16%	1.5E-07	0.00000146		1.67%	1.5E-07	0.000000836		2.97%	8.4E-08
OCDD	0.0000339		0.41%	1E-08	0.0000352		0.12%	1.1E-08	0.0000349		0.37%	1E-08
OCDF	0.00000407	J	0.05%	1.2E-09	0.00000339	J	0.01%	1E-09	0.00000505		0.05%	1.5E-09
Dioxin TEQ Mammal (2)	0.00000248				0.00000873				0.00000281			

Table B-2
Calculation of Dioxin TEQ Mammal Values for Soil Samples - Oxbow Area
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

PARAMETER	SS_H-18-SS1 9/29/2010		% of Total TEQ	TEQ	SS_H-19-SS1 9/30/2010		% of Total TEQ	TEQ	SS_H-22-SS1 9/28/2010		% of Total TEQ	TEQ
Dioxins/Furans (mg/Kg)												
1,2,3,4,6,7,8-HpCDD	0.00000501		1.12%	5E-08	0.00001		2.40%	1E-07	0.00000351		1.15%	3.5E-08
1,2,3,4,6,7,8-HpCDF	0.0000027		0.60%	2.7E-08	0.0000089		2.14%	8.9E-08	0.0000431		14.09%	4.3E-07
1,2,3,4,7,8,9-HpCDF	0.000000229	J	0.05%	2.3E-09	0.000000213	U	0.03%	1.1E-09	0.000000291	J	0.10%	2.9E-09
1,2,3,4,7,8-HxCDD	0.000000281	J	0.63%	2.8E-08	0.000000231	U	0.28%	1.2E-08	0.000000209	U	0.34%	1E-08
1,2,3,4,7,8-HxCDF	0.000000671	J	1.50%	6.7E-08	0.0000018	J	4.32%	1.8E-07	0.000000626	J	2.05%	6.3E-08
1,2,3,6,7,8-HxCDD	0.000000427	J	0.96%	4.3E-08	0.000000717	J	1.72%	7.2E-08	0.000000838	J	2.74%	8.4E-08
1,2,3,6,7,8-HxCDF	0.000000501	J	1.12%	5E-08	0.00000124	J	2.98%	1.2E-07	0.000000445	J	1.46%	4.5E-08
1,2,3,7,8,9-HxCDD	0.00000036	J	0.81%	3.6E-08	0.000000683	J	1.64%	6.8E-08	0.000000265	U	0.43%	1.3E-08
1,2,3,7,8,9-HxCDF	0.000000156	U	0.17%	7.8E-09	0.00000024	U	0.29%	1.2E-08	0.000000207	U	0.34%	1E-08
1,2,3,7,8-PeCDD	0.000000189	J	4.23%	1.9E-07	0.000000349	J	8.38%	3.5E-07	0.000000365	J	11.94%	3.7E-07
1,2,3,7,8-PeCDF	0.000000422	J	0.28%	1.3E-08	0.000000964	J	0.69%	2.9E-08	0.000000387	J	0.38%	1.2E-08
2,3,4,6,7,8-HxCDF	0.000000632	J	1.41%	6.3E-08	0.00000204	J	4.90%	2E-07	0.000000636	J	2.08%	6.4E-08
2,3,4,7,8-PeCDF	0.000000734	J	4.93%	2.2E-07	0.00000185	J	13.32%	5.6E-07	0.000000549	J	5.39%	1.6E-07
2,3,7,8-TCDD	0.00000362		81.03%	3.6E-06	0.0000022		52.81%	2.2E-06	0.00000167		54.61%	1.7E-06
2,3,7,8-TCDF	0.000000405	J	0.91%	4.1E-08	0.0000015		3.60%	1.5E-07	0.000000755		2.47%	7.6E-08
OCDD	0.0000325		0.22%	9.8E-09	0.0000647		0.47%	1.9E-08	0.000021		0.21%	6.3E-09
OCDF	0.00000299	J	0.02%	9E-10	0.00000763		0.05%	2.3E-09	0.0000249		0.24%	7.5E-09
Dioxin TEQ Mammal (2)	0.00000447				0.00000417				0.00000306			

(1) TEFs are obtained from USEPA, 2010.
(2) Dioxin TEQ is calculated by multiplying the individual congeners by their TEF and then take a sum of the results. If a congener is not detected half the detection limit is used for the calculation.
mg/Kg = milligram per kilogram
U = not detected, value is the detection limits
J = value is estimated
EMPC = Estimated Maximum Possible Concentration
# = Result from second column confirmation analysis
R = value is rejected
EB = compounds detected in equipment blank

Prepared by / Date: KJC 03/29/11
Checked by / Date: BJR 03/29/11

Table B-3
Dioxin PCB TEQ Calculations for Soil Samples

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	TEF	LPX-FP-4004-0000-01 7/19/2001		TEQ
PCB Congener (mg/Kg)				
2-Monochlorobiphenyl (1)		0.00011428		
4-Chlorobiphenyl (3)		0.0003231		
2,2'-Dichlorobiphenyl (4)		0.00019493	J	
2,3-Dichlorobiphenyl (5)		0.0000224		
2,3'-Dichlorobiphenyl (6)		0.00018402	J	
2,4-Dichlorobiphenyl (7)		0.00003896		
2,4'-Dichlorobiphenyl (8)		0.00087293	J	
2,5-Dichlorobiphenyl (9)		0.00005415		
2,6-Dichlorobiphenyl (10)		0.00001138		
3,4-Dichlorobiphenyl (12)		0.00017728	J	
2,2',3'-Trichlorobiphenyl (16)		0.00033617		
2,2',4-Trichlorobiphenyl (17)		0.00030023		
2,2',5-Trichlorobiphenyl (18)		0.00068318	J	
2,2',6-Trichlorobiphenyl (19)		0.00007436		
2,3,3'-Trichlorobiphenyl (20)		0.00244912	J	
2,3,4'-Trichlorobiphenyl (22)		0.0005813		
2,3,6-Trichlorobiphenyl (24)		0.0000643	J	
2,3',4-Trichlorobiphenyl (25)		0.00009846		
2,3',5-Trichlorobiphenyl (26)		0.00023632	J	
2,4',5-Trichlorobiphenyl (31)		0.0014153		
2,4',6-Trichlorobiphenyl (32)		0.0002112		
2,2',3,3'-Tetrachlorobiphenyl (40)		0.0005841	J	
2,2',3,4'-Tetrachlorobiphenyl (42)		0.00037978		
2,2',3,5-Tetrachlorobiphenyl (43)		0.00321474	J	
2,2',3,5'-Tetrachlorobiphenyl (44)		0.00165825	J	
2,2',3,6-Tetrachlorobiphenyl (45)		0.0001671	J	
2,2',3,6'-Tetrachlorobiphenyl (46)		0.00004792	J	
2,2',4,5-Tetrachlorobiphenyl (48)		0.00021367		
2,2',4,5'-Tetrachlorobiphenyl (49)		0.0012725	J	
2,2',4,6-Tetrachlorobiphenyl (50)		0.0001181	J	
2,3,3',4'-Tetrachlorobiphenyl (56)		0.00099071		
2,3,3',6-Tetrachlorobiphenyl (59)		0.00011835	J	
2,3,4,4'-Tetrachlorobiphenyl (60)		0.00047862		
2,3,4,5-Tetrachlorobiphenyl (61)		0.00502108	J	
2,3,4',5-Tetrachlorobiphenyl (63)		0.00005875	J	
2,3,4',6-Tetrachlorobiphenyl (64)		0.00077616		
2,3',4,4'-Tetrachlorobiphenyl (66)		0.00245189	J	
3,3',4,4'-Tetrachlorobiphenyl (77)	0.0001	0.00041288	J	4.1288E-08
3,4,4',5-Tetrachlorobiphenyl (81)	0.0003	0.00007746	U	1.1619E-08
2,2',3,3',4-Pentachlorobiphenyl (82)		0.00082768	J	
2,2',3,3',5-Pentachlorobiphenyl (83)		0.0036114	J	
2,2',3,3',6-Pentachlorobiphenyl (84)		0.00134798	J	
2,2',3,4,4'-Pentachlorobiphenyl (85)		0.00164589	J	
2,2',3,4,5-Pentachlorobiphenyl (86)		0.00560616	J	
2,2',3,4,6-Pentachlorobiphenyl (88)		0.00091194	J	
2,2',3,4,6'-Pentachlorobiphenyl (89)		0.00003207	J	
2,2',3,4',5-Pentachlorobiphenyl (90)		0.00744117	J	
2,2',3,5,5'-Pentachlorobiphenyl (92)		0.0013136		
2,2',3,5,6-Pentachlorobiphenyl (93)		0.0049983	J	
2,3,3',4,4'-Pentachlorobiphenyl (105)	0.00003	0.00294701	J	8.841E-08
2,3,3',4,5-Pentachlorobiphenyl (106)		0.00068271	J	
2,3,3',4',5'-Pentachlorobiphenyl (108)		0.00035066	J	
2,3,3',4',6-Pentachlorobiphenyl (110)		0.0092305	J	
2,3,4,4',5-Pentachlorobiphenyl (114)	0.00003	0.00016675	J	5.0025E-09
2,3',4,4',5-Pentachlorobiphenyl (118)	0.00003	0.00883673	J	2.651E-07
3,3',4,4',5-Pentachlorobiphenyl (126)	0.1	0.00004261	J	4.261E-06
2,2',3,3',4,4'-Hexachlorobiphenyl (128)		0.0023494	J	
2,2',3,3',4,5-Hexachlorobiphenyl (129)		0.01099404	J	
2,2',3,3',4,5'-Hexachlorobiphenyl (130)		0.00080181	J	

Table B-3
Dioxin PCB TEQ Calculations for Soil Samples

Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

Parameter	TEF	LPX-FP-4004-0000-01 7/19/2001		TEQ
2,2',3,3',4,6-Hexachlorobiphenyl (131)		0.00011809	J	
2,2',3,3',4,6'-Hexachlorobiphenyl (132)		0.00369936	J	
2,2',3,3',5,6-Hexachlorobiphenyl (134)		0.00051112	J	
2,2',3,3',5,6'-Hexachlorobiphenyl (135)		0.00185067	J	
2,2',3,3',6,6'-Hexachlorobiphenyl (136)		0.00081979	J	
2,2',3,4,4',5-Hexachlorobiphenyl (137)		0.00124478	J	
2,2',3,4,5,5'-Hexachlorobiphenyl (141)		0.00131161	J	
2,2',3,4,5',6-Hexachlorobiphenyl (144)		0.00023454		
2,2',3,4',5,5'-Hexachlorobiphenyl (146)		0.00071162	J	
2,2',3,4',5,6-Hexachlorobiphenyl (147)		0.00563276	J	
2,2',4,4',5,5'-Hexachlorobiphenyl (153)		0.00452552	J	
2,3,3',4,4',5-Hexachlorobiphenyl (156)	0.00003	0.00108036	J	3.2411E-08
2,3,3',4,4',6-Hexachlorobiphenyl (158)		0.00094613	J	
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	0.00003	0.00036874	J	1.1062E-08
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	0.03	0.00000847	J	2.541E-07
2,2',3,3',4,4',5-Heptachlorobiphenyl (170)		0.0018151	J	
2,2',3,3',4,4',6-Heptachlorobiphenyl (171)		0.0004942	J	
2,2',3,3',4,5,5'-Heptachlorobiphenyl (172)		0.00019898	J	
2,2',3,3',4,5,6'-Heptachlorobiphenyl (174)		0.00140923	J	
2,2',3,3',4,5',6-Heptachlorobiphenyl (175)		0.00003424	J	
2,2',3,3',4,6,6'-Heptachlorobiphenyl (176)		0.00013115	J	
2,2',3,3',4,5',6'-Heptachlorobiphenyl (177)		0.0008102	J	
2,2',3,3',5,5',6-Heptachlorobiphenyl (178)		0.00020939		
2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)		0.00177594	J	
2,2',3,4,4',5,6'-Heptachlorobiphenyl (182)		0.00000652	J	
2,2',3,4,4',5',6-Heptachlorobiphenyl (183)		0.00042019		
2,2',3,4,4',6,6'-Heptachlorobiphenyl (184)		0.00015491	U	
2,2',3,4,5,5',6-Heptachlorobiphenyl (185)		0.00010098	J	
2,2',3,4',5,5',6-Heptachlorobiphenyl (187)		0.00098143	J	
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	0.00003	0.00004582	J	1.3746E-09
2,3,3',4,4',5,6-Heptachlorobiphenyl (190)		0.00028677	J	
2,3,3',4,4',5',6-Heptachlorobiphenyl (191)		0.00003711	J	
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (194)		0.00038264	J	
2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)		0.00017579	J	
2,2',3,3',4,4',5,6'-Octachlorobiphenyl (196)		0.00021888	J	
2,2',3,3',4,4',6,6'-Octachlorobiphenyl (197)		0.00001127	J	
2,2',3,3',4,5,5',6-Octachlorobiphenyl (198)		0.00126122	J	
2,2',3,3',4,5,6,6'-Octachlorobiphenyl (200)		0.00008211	J	
2,2',3,3',4,5',6,6'-Octachlorobiphenyl (201)		0.00007758	J	
2,2',3,4,4',5,5',6-Octachlorobiphenyl (203)		0.00047262	J	
2,3,3',4,4',5,5',6-Octachlorobiphenyl (205)		0.00002401	J	
2,2',3,3',4,4',5,5',6-nonachlorobiphenyl		0.00202532		
2,2',3,3',4,4',5,6,6'-nonachlorobiphenyl		0.00014313	J	
Decachlorobiphenyl (209)		0.00202625	J	
PCB TEQ USEPA, 2010		0.00000497		

mg/Kg = milligram per kilogram

U = not detected, value is the detection limits
J = value is estimated

Prepared by / Date: KJC 03/29/11
Checked by / Date: BJR 03/29/11

LPX-FP-4004-0000-01 was collected in the general area

APPENDIX C

Site Photographs

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Photo 1: Soil sample location SS_H-18 in the human health concern area.

Photo 2: Soil sample location SS_H-10 in the human health concern area.

Photo 3: Soil sample location SS_G-01 in the general area.

Photo 4: Sediment sample location SD_G-06.

APPENDIX D

ProUCL Calculations

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Pro UCL Output Human Health Concern Area

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

alpha-Chlordane

General Statistics

Number of Valid Data	10	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	8
		Percent Non-Detects	80.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.00013	Minimum Detected	-8.948
Maximum Detected	0.00026	Maximum Detected	-8.255
Mean of Detected	0.000195	Mean of Detected	-8.601
SD of Detected	9.192E-05	SD of Detected	0.49
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.0001	Maximum Non-Detect	-9.21

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.000079	Mean	-9.643
SD	6.839E-05	SD	0.573
95% DL/2 (t) UCL	0.0001186	95% H-Stat (DL/2) UCL	0.0001192
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A

SD in Original Scale	N/A
95% t UCL	N/A
95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A
95% H-UCL	N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.000143
SD	0.000039
SE of Mean	1.744E-05
95% KM (t) UCL	0.000175
95% KM (z) UCL	0.0001717
95% KM (jackknife) UCL	N/A
95% KM (bootstrap t) UCL	N/A
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	N/A
95% KM (Chebyshev) UCL	0.000219
97.5% KM (Chebyshev) UCL	0.0002519
99% KM (Chebyshev) UCL	0.0003165

Potential UCLs to Use

95% KM (t) UCL	0.000175
95% KM (% Bootstrap) UCL	N/A

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Aroclor 1254

General Statistics

Number of Valid Data	10	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	10
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Aroclor 1254 was not processed!

Aroclor 1268

General Statistics

Number of Valid Data	10	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	10
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Aroclor 1268 was not processed!

Arsenic

General Statistics

Number of Valid Observations	10	Number of Distinct Observations	10

Raw Statistics		**Log-transformed Statistics**	
Minimum	1.7	Minimum of Log Data	0.531
Maximum	8.9	Maximum of Log Data	2.186
Mean	3.08	Mean of log Data	0.999
Median	2.55	SD of log Data	0.468
SD	2.106		
Std. Error of Mean	0.666		
Coefficient of Variation	0.684		
Skewness	2.831		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.597	Shapiro Wilk Test Statistic	0.799
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4.301	95% H-UCL	4.254
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	4.957
95% Adjusted-CLT UCL (Chen-1995)	4.812	97.5% Chebyshev (MVUE) UCL	5.806
95% Modified-t UCL (Johnson-1978)	4.4	99% Chebyshev (MVUE) UCL	7.473

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	2.959	**Data do not follow a Discernable Distribution (0.05)**
Theta Star	1.041	
MLE of Mean	3.08	
MLE of Standard Deviation	1.791	
nu star	59.18	
Approximate Chi Square Value (.05)	42.49	**Nonparametric Statistics**
Adjusted Level of Significance	0.0267	95% CLT UCL 4.175
Adjusted Chi Square Value	40.04	95% Jackknife UCL 4.301
		95% Standard Bootstrap UCL 4.104
Anderson-Darling Test Statistic	1.088	95% Bootstrap-t UCL 6.897
Anderson-Darling 5% Critical Value	0.729	95% Hall's Bootstrap UCL 9.06
Kolmogorov-Smirnov Test Statistic	0.282	95% Percentile Bootstrap UCL 4.32
Kolmogorov-Smirnov 5% Critical Value	0.268	95% BCA Bootstrap UCL 4.94

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 4.29

95% Adjusted Gamma UCL 4.552

95% Chebyshev(Mean, Sd) UCL 5.983

97.5% Chebyshev(Mean, Sd) UCL 7.239

99% Chebyshev(Mean, Sd) UCL 9.706

Potential UCL to Use

Use 95% Student's-t UCL 4.301

or 95% Modified-t UCL 4.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Benz(a)anthracene

General Statistics

Number of Valid Observations 10

Number of Distinct Observations 7

Raw Statistics

Minimum 0.018

Maximum 0.04

Mean 0.0268

Median 0.024

SD 0.00911

Std. Error of Mean 0.00288

Coefficient of Variation 0.34

Skewness 0.574

Log-transformed Statistics

Minimum of Log Data -4.017

Maximum of Log Data -3.219

Mean of log Data -3.67

SD of log Data 0.332

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.831

Shapiro Wilk Critical Value 0.842

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.852

Shapiro Wilk Critical Value 0.842

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 0.0321

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 0.0321

95% Modified-t UCL (Johnson-1978) 0.0322

Assuming Lognormal Distribution

95% H-UCL 0.0336

95% Chebyshev (MVUE) UCL 0.0391

97.5% Chebyshev (MVUE) UCL 0.0444

99% Chebyshev (MVUE) UCL 0.0549

Gamma Distribution Test

k star (bias corrected) 7.129

Theta Star 0.00376

MLE of Mean 0.0268

MLE of Standard Deviation 0.01

nu star 142.6

Approximate Chi Square Value (.05) 116

Adjusted Level of Significance 0.0267

Adjusted Chi Square Value 111.8

Anderson-Darling Test Statistic 0.668

Anderson-Darling 5% Critical Value 0.725

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 0.0315

95% Jackknife UCL 0.0321

95% Standard Bootstrap UCL 0.0315

95% Bootstrap-t UCL 0.033

95% Hall's Bootstrap UCL 0.0307

Kolmogorov-Smirnov Test Statistic	0.2	95% Percentile Bootstrap UCL	0.0315
Kolmogorov-Smirnov 5% Critical Value	0.267	95% BCA Bootstrap UCL	0.0321
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	0.0394
		97.5% Chebyshev(Mean, Sd) UCL	0.0448
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	0.0555
95% Approximate Gamma UCL	0.0329		
95% Adjusted Gamma UCL	0.0342		
Potential UCL to Use		Use 95% Approximate Gamma UCL	0.0329

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Benzo(a)pyrene

General Statistics

Number of Valid Data	10	Number of Detected Data	4
Number of Distinct Detected Data	3	Number of Non-Detect Data	6
		Percent Non-Detects	60.00%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.015	Minimum Detected	-4.2
Maximum Detected	0.072	Maximum Detected	-2.631
Mean of Detected	0.0383	Mean of Detected	-3.502
SD of Detected	0.0282	SD of Detected	0.818
Minimum Non-Detect	0.03	Minimum Non-Detect	-3.507
Maximum Non-Detect	0.088	Maximum Non-Detect	-2.43

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	10
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.858	Shapiro Wilk Test Statistic	0.82
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.031	Mean	-3.623
SD	0.019	SD	0.559
95% DL/2 (t) UCL	0.042	95% H-Stat (DL/2) UCL	0.048

Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Log ROS Method	
Mean in Log Scale	-3.83
SD in Log Scale	0.556
Mean in Original Scale	0.0258
SD in Original Scale	0.0195
95% t UCL	0.0371
95% Percentile Bootstrap UCL	0.0363
95% BCA Bootstrap UCL	0.0392
95% H-UCL	0.0388

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.73
Theta Star	0.0524
nu star	5.84
A-D Test Statistic	0.504
5% A-D Critical Value	0.66
K-S Test Statistic	0.66
5% K-S Critical Value	0.398

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.015
Maximum	0.072
Mean	0.0261
Median	0.0157
SD	0.0195
k star	2.173
Theta star	0.012
Nu star	43.47
AppChi2	29.35
95% Gamma Approximate UCL	0.0387
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0259
SD	0.0202
SE of Mean	0.00795
95% KM (t) UCL	0.0405
95% KM (z) UCL	0.039
95% KM (jackknife) UCL	0.0395
95% KM (bootstrap t) UCL	0.0406
95% KM (BCA) UCL	0.058
95% KM (Percentile Bootstrap) UCL	0.0557
95% KM (Chebyshev) UCL	0.0606
97.5% KM (Chebyshev) UCL	0.0756
99% KM (Chebyshev) UCL	0.105

Potential UCLs to Use

95% KM (t) UCL	0.0405
95% KM (Percentile Bootstrap) UCL	0.0557

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Benzo(b)fluoranthene

General Statistics

Number of Valid Observations	10	Number of Distinct Observations	10

Raw Statistics

Minimum	0.024
Maximum	0.08
Mean	0.0506
Median	0.0475
SD	0.0199
Std. Error of Mean	0.00628

Log-transformed Statistics

Minimum of Log Data	-3.73
Maximum of Log Data	-2.526
Mean of log Data	-3.058
SD of log Data	0.415

Coefficient of Variation 0.392
Skewness 0.307

Relevant UCL Statistics

Normal Distribution Test
Shapiro Wilk Test Statistic 0.915
Shapiro Wilk Critical Value 0.842
Data appear Normal at 5% Significance Level

Lognormal Distribution Test
Shapiro Wilk Test Statistic 0.93
Shapiro Wilk Critical Value 0.842
Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution
95% Student's-t UCL 0.0621
95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL (Chen-1995) 0.0616
95% Modified-t UCL (Johnson-1978) 0.0622

Assuming Lognormal Distribution
95% H-UCL 0.0685
95% Chebyshev (MVUE) UCL 0.0801
97.5% Chebyshev (MVUE) UCL 0.0928
99% Chebyshev (MVUE) UCL 0.118

Gamma Distribution Test
k star (bias corrected) 4.903
Theta Star 0.0103
MLE of Mean 0.0506
MLE of Standard Deviation 0.0229
nu star 98.05
Approximate Chi Square Value (.05) 76.21
Adjusted Level of Significance 0.0267
Adjusted Chi Square Value 72.87

Anderson-Darling Test Statistic 0.345
Anderson-Darling 5% Critical Value 0.728
Kolmogorov-Smirnov Test Statistic 0.183
Kolmogorov-Smirnov 5% Critical Value 0.267
Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution
95% Approximate Gamma UCL 0.0651
95% Adjusted Gamma UCL 0.0681

Data Distribution
Data appear Normal at 5% Significance Level

Nonparametric Statistics
95% CLT UCL 0.0609
95% Jackknife UCL 0.0621
95% Standard Bootstrap UCL 0.0606
95% Bootstrap-t UCL 0.0636
95% Hall's Bootstrap UCL 0.0606
95% Percentile Bootstrap UCL 0.0607
95% BCA Bootstrap UCL 0.0602
95% Chebyshev(Mean, Sd) UCL 0.078
97.5% Chebyshev(Mean, Sd) UCL 0.0898
99% Chebyshev(Mean, Sd) UCL 0.113

Potential UCL to Use
Use 95% Student's-t UCL 0.0621

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Benzo(k)fluoranthene

General Statistics
Number of Valid Observations 10
Number of Distinct Observations 7

Raw Statistics
Minimum 0.012
Maximum 0.025
Mean 0.0169
Median 0.016
SD 0.00423
Std. Error of Mean 0.00134

Log-transformed Statistics
Minimum of Log Data -4.423
Maximum of Log Data -3.689
Mean of log Data -4.108
SD of log Data 0.244

Coefficient of Variation 0.25
Skewness 0.649

Relevant UCL Statistics

Normal Distribution Test
Shapiro Wilk Test Statistic 0.907
Shapiro Wilk Critical Value 0.842
Data appear Normal at 5% Significance Level

Lognormal Distribution Test
Shapiro Wilk Test Statistic 0.925
Shapiro Wilk Critical Value 0.842
Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution
95% Student's-t UCL 0.0194

95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL (Chen-1995) 0.0194
95% Modified-t UCL (Johnson-1978) 0.0194

Assuming Lognormal Distribution
95% H-UCL 0.0198
95% Chebyshev (MVUE) UCL 0.0226
97.5% Chebyshev (MVUE) UCL 0.0251
99% Chebyshev (MVUE) UCL 0.0299

Gamma Distribution Test
k star (bias corrected) 13.05
Theta Star 0.00129
MLE of Mean 0.0169
MLE of Standard Deviation 0.00468
nu star 261.1
Approximate Chi Square Value (.05) 224.6
Adjusted Level of Significance 0.0267
Adjusted Chi Square Value 218.8

Anderson-Darling Test Statistic 0.434
Anderson-Darling 5% Critical Value 0.725
Kolmogorov-Smirnov Test Statistic 0.195
Kolmogorov-Smirnov 5% Critical Value 0.266
Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution
95% Approximate Gamma UCL 0.0196
95% Adjusted Gamma UCL 0.0202

Data Distribution
Data appear Normal at 5% Significance Level

Nonparametric Statistics
95% CLT UCL 0.0191
95% Jackknife UCL 0.0194
95% Standard Bootstrap UCL 0.019
95% Bootstrap-t UCL 0.02
95% Hall's Bootstrap UCL 0.0193
95% Percentile Bootstrap UCL 0.019
95% BCA Bootstrap UCL 0.0191
95% Chebyshev(Mean, Sd) UCL 0.0227
97.5% Chebyshev(Mean, Sd) UCL 0.0253
99% Chebyshev(Mean, Sd) UCL 0.0302

Potential UCL to Use

Use 95% Student's-t UCL 0.0194

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Beryllium

General Statistics
Number of Valid Observations 10
Number of Distinct Observations 8

Raw Statistics
Minimum 0.24
Maximum 0.42
Mean 0.34
Median 0.34
SD 0.0544

Log-transformed Statistics
Minimum of Log Data -1.427
Maximum of Log Data -0.868
Mean of log Data -1.091
SD of log Data 0.167

Std. Error of Mean	0.0172
Coefficient of Variation	0.16
Skewness	-0.311

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.974
Shapiro Wilk Critical Value	0.842

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.955
Shapiro Wilk Critical Value	0.842

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.372

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.366
95% Modified-t UCL (Johnson-1978)	0.371

Assuming Lognormal Distribution

95% H-UCL	0.378
95% Chebyshev (MVUE) UCL	0.419
97.5% Chebyshev (MVUE) UCL	0.453
99% Chebyshev (MVUE) UCL	0.519

Gamma Distribution Test

k star (bias corrected)	28.96
Theta Star	0.0117
MLE of Mean	0.34
MLE of Standard Deviation	0.0632
nu star	579.2
Approximate Chi Square Value (.05)	524.4
Adjusted Level of Significance	0.0267
Adjusted Chi Square Value	515.3
Anderson-Darling Test Statistic	0.228
Anderson-Darling 5% Critical Value	0.724
Kolmogorov-Smirnov Test Statistic	0.164
Kolmogorov-Smirnov 5% Critical Value	0.266

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.376
95% Adjusted Gamma UCL	0.382

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.368
95% Jackknife UCL	0.372
95% Standard Bootstrap UCL	0.367
95% Bootstrap-t UCL	0.37
95% Hall's Bootstrap UCL	0.367
95% Percentile Bootstrap UCL	0.366
95% BCA Bootstrap UCL	0.365
95% Chebyshev(Mean, Sd) UCL	0.415
97.5% Chebyshev(Mean, Sd) UCL	0.447
99% Chebyshev(Mean, Sd) UCL	0.511

Potential UCL to Use

Use 95% Student's-t UCL 0.372

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Note: For highly negative-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Carbazole

General Statistics

Number of Valid Data	10	Number of Detected Data	7
Number of Distinct Detected Data	6	Number of Non-Detect Data	3

Pro UCL Output Human Health Concern Area

Percent Non-Detects	30.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0034	Minimum Detected	-5.684
Maximum Detected	0.0081	Maximum Detected	-4.816
Mean of Detected	0.00511	Mean of Detected	-5.332
SD of Detected	0.0019	SD of Detected	0.355
Minimum Non-Detect	0.0065	Minimum Non-Detect	-5.036
Maximum Non-Detect	0.013	Maximum Non-Detect	-4.343

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	10
Number treated as Detected	0
Single DL Non-Detect Percentage	100.00%

Warning: There are only 7 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.853	Shapiro Wilk Test Statistic	0.872
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00488	Mean	-5.382
SD	0.00183	SD	0.355
95% DL/2 (t) UCL	0.00594	95% H-Stat (DL/2) UCL	0.00624
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-5.368
		SD in Log Scale	0.304
		Mean in Original Scale	0.00487
		SD in Original Scale	0.00162
		95% t UCL	0.00582
		95% Percentile Bootstrap UCL	0.00578
		95% BCA Bootstrap UCL	0.0059
		95% H-UCL	0.00597

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	5.3	Data appear Normal at 5% Significance Level
Theta Star	0.000965	
nu star	74.2	
A-D Test Statistic	0.508	Nonparametric Statistics
5% A-D Critical Value	0.709	Kaplan-Meier (KM) Method
K-S Test Statistic	0.709	Mean 0.00489
5% K-S Critical Value	0.312	SD 0.00165
Data appear Gamma Distributed at 5% Significance Level		SE of Mean 0.0006171
		95% KM (t) UCL 0.00602

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.0034
Maximum	0.0081
Mean	0.005
Median	0.00476
SD	0.00162
k star	8.15
Theta star	0.0006135
Nu star	163
AppChi2	134.5
95% Gamma Approximate UCL	0.00606
95% Adjusted Gamma UCL	0.00627

95% KM (z) UCL	0.0059
95% KM (jackknife) UCL	0.00603
95% KM (bootstrap t) UCL	0.00649
95% KM (BCA) UCL	0.0059
95% KM (Percentile Bootstrap) UCL	0.00586
95% KM (Chebyshev) UCL	0.00758
97.5% KM (Chebyshev) UCL	0.00874
99% KM (Chebyshev) UCL	0.011

Potential UCLs to Use

95% KM (t) UCL	0.00602
95% KM (Percentile Bootstrap) UCL	0.00586

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Chromium

General Statistics

Number of Valid Observations 10

Number of Distinct Observations 10

Raw Statistics

Minimum	3.88
Maximum	7.8
Mean	5.286
Median	5.04
SD	1.343
Std. Error of Mean	0.425
Coefficient of Variation	0.254
Skewness	0.752

Log-transformed Statistics

Minimum of Log Data	1.356
Maximum of Log Data	2.054
Mean of log Data	1.637
SD of log Data	0.245

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.907
Shapiro Wilk Critical Value	0.842

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.924
Shapiro Wilk Critical Value	0.842

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	6.064

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	6.092
95% Modified-t UCL (Johnson-1978)	6.081

Assuming Lognormal Distribution

95% H-UCL	6.198
95% Chebyshev (MVUE) UCL	7.072
97.5% Chebyshev (MVUE) UCL	7.847
99% Chebyshev (MVUE) UCL	9.369

Gamma Distribution Test

k star (bias corrected)	12.86
Theta Star	0.411
MLE of Mean	5.286
MLE of Standard Deviation	1.474
nu star	257.3
Approximate Chi Square Value (.05)	221.1

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Adjusted Level of Significance	0.0267	95% CLT UCL	5.984
Adjusted Chi Square Value	215.3	95% Jackknife UCL	6.064
		95% Standard Bootstrap UCL	5.973
Anderson-Darling Test Statistic	0.374	95% Bootstrap-t UCL	6.27
Anderson-Darling 5% Critical Value	0.725	95% Hall's Bootstrap UCL	6.172
Kolmogorov-Smirnov Test Statistic	0.186	95% Percentile Bootstrap UCL	5.952
Kolmogorov-Smirnov 5% Critical Value	0.266	95% BCA Bootstrap UCL	6.043
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	7.137
		97.5% Chebyshev(Mean, Sd) UCL	7.938
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	9.511
95% Approximate Gamma UCL	6.15		
95% Adjusted Gamma UCL	6.316		
Potential UCL to Use		Use 95% Student's-t UCL	6.064

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cobalt

General Statistics

Number of Valid Observations	10	Number of Distinct Observations	9

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.75	Minimum of Log Data	-0.288
Maximum	2.2	Maximum of Log Data	0.788
Mean	1.47	Mean of log Data	0.337
Median	1.45	SD of log Data	0.332
SD	0.469		
Std. Error of Mean	0.148		
Coefficient of Variation	0.319		
Skewness	0.358		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.936	Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1.742	95% H-UCL	1.849
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	2.151
95% Adjusted-CLT UCL (Chen-1995)	1.732	97.5% Chebyshev (MVUE) UCL	2.444
95% Modified-t UCL (Johnson-1978)	1.745	99% Chebyshev (MVUE) UCL	3.021
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	7.5	Data appear Normal at 5% Significance Level	
Theta Star	0.196		
MLE of Mean	1.47		
MLE of Standard Deviation	0.537		
nu star	150		

Approximate Chi Square Value (.05)	122.7
Adjusted Level of Significance	0.0267
Adjusted Chi Square Value	118.4
Anderson-Darling Test Statistic	0.282
Anderson-Darling 5% Critical Value	0.725
Kolmogorov-Smirnov Test Statistic	0.149
Kolmogorov-Smirnov 5% Critical Value	0.267

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	1.797
95% Adjusted Gamma UCL	1.862

Nonparametric Statistics

95% CLT UCL	1.714
95% Jackknife UCL	1.742
95% Standard Bootstrap UCL	1.699
95% Bootstrap-t UCL	1.778
95% Hall's Bootstrap UCL	1.791
95% Percentile Bootstrap UCL	1.701
95% BCA Bootstrap UCL	1.722
95% Chebyshev(Mean, Sd) UCL	2.117
97.5% Chebyshev(Mean, Sd) UCL	2.397
99% Chebyshev(Mean, Sd) UCL	2.947

Potential UCL to Use

Use 95% Student's-t UCL 1.742

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Dibenz(a,h)anthracene

General Statistics

Number of Valid Data	10	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	5
		Percent Non-Detects	50.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0025	Minimum Detected	-5.991
Maximum Detected	0.0083	Maximum Detected	-4.791
Mean of Detected	0.00508	Mean of Detected	-5.38
SD of Detected	0.00239	SD of Detected	0.505
Minimum Non-Detect	0.0015	Minimum Non-Detect	-6.502
Maximum Non-Detect	0.015	Maximum Non-Detect	-4.2

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	10
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.945	Shapiro Wilk Test Statistic	0.933
5% Shapiro Wilk Critical Value	0.762	5% Shapiro Wilk Critical Value	0.762
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	0.00419
SD	0.00262
95% DL/2 (t) UCL	0.00571
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

DL/2 Substitution Method	
Mean	-5.736
SD	0.861
95% H-Stat (DL/2) UCL	0.0105
Log ROS Method	
Mean in Log Scale	-5.721
SD in Log Scale	0.566
Mean in Original Scale	0.00379
SD in Original Scale	0.0022
95% t UCL	0.00506
95% Percentile Bootstrap UCL	0.00491
95% BCA Bootstrap UCL	0.00507
95% H-UCL	0.00596

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.251
Theta Star	0.00226
nu star	22.51
A-D Test Statistic	0.287
5% A-D Critical Value	0.681
K-S Test Statistic	0.681
5% K-S Critical Value	0.358

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.0083
Mean	0.00334
Median	0.00312
SD	0.00279
k star	0.345
Theta star	0.00969
Nu star	6.891
AppChi2	2.111
95% Gamma Approximate UCL	0.0109
95% Adjusted Gamma UCL	0.0137

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0042
SD	0.00205
SE of Mean	0.0008246
95% KM (t) UCL	0.00571
95% KM (z) UCL	0.00555
95% KM (jackknife) UCL	0.00564
95% KM (bootstrap t) UCL	0.00572
95% KM (BCA) UCL	0.0063
95% KM (Percentile Bootstrap) UCL	0.00614
95% KM (Chebyshev) UCL	0.00779
97.5% KM (Chebyshev) UCL	0.00935
99% KM (Chebyshev) UCL	0.0124

Potential UCLs to Use

95% KM (t) UCL	0.00571
95% KM (Percentile Bootstrap) UCL	0.00614

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006). *For additional insight, the user may want to consult a statistician.*

Dimethyl Phthalate

General Statistics

Number of Valid Data	10	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	9
		Percent Non-Detects	90.00%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!

It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Dimethyl Phthalate was not processed!

Endosulfan Sulfate

General Statistics

Number of Valid Data	10	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	8
		Percent Non-Detects	80.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0003	Minimum Detected	-8.112
Maximum Detected	0.0004	Maximum Detected	-7.824
Mean of Detected	0.00035	Mean of Detected	-7.968
SD of Detected	7.071E-05	SD of Detected	0.203
Minimum Non-Detect	0.00011	Minimum Non-Detect	-9.115
Maximum Non-Detect	0.00055	Maximum Non-Detect	-7.506

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	10
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.
This may not be adequate enough to compute meaningful and reliable test statistics and estimates.
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	N/A	Shapiro Wilk Test Statistic	N/A
5% Shapiro Wilk Critical Value	N/A	5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.000184	Mean	-8.894
SD	0.000131	SD	0.851
95% DL/2 (t) UCL	0.0002599	95% H-Stat (DL/2) UCL	0.0004375
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A

Mean in Original Scale	N/A
SD in Original Scale	N/A
95% t UCL	N/A
95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A
95% H-UCL	N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0003143
SD	3.499E-05
SE of Mean	1.87E-05
95% KM (t) UCL	0.0003486
95% KM (z) UCL	0.0003451
95% KM (jackknife) UCL	0.0003836
95% KM (bootstrap t) UCL	0.0003218
95% KM (BCA) UCL	0.0004
95% KM (Percentile Bootstrap) UCL	N/A
95% KM (Chebyshev) UCL	0.0003958
97.5% KM (Chebyshev) UCL	0.0004311
99% KM (Chebyshev) UCL	0.0005004

Potential UCLs to Use

95% KM (t) UCL	0.0003486
95% KM (% Bootstrap) UCL	N/A

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Endrin Aldehyde

General Statistics

Number of Valid Data	10	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	10
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Endrin Aldehyde was not processed!

gamma-Chlordane

Pro UCL Output Human Health Concern Area

General Statistics

Number of Valid Data	10	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	6
		Percent Non-Detects	60.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.000098	Minimum Detected	-9.231
Maximum Detected	0.00019	Maximum Detected	-8.568
Mean of Detected	0.000142	Mean of Detected	-8.908
SD of Detected	4.983E-05	SD of Detected	0.362
Minimum Non-Detect	0.00009	Minimum Non-Detect	-9.316
Maximum Non-Detect	0.00017	Maximum Non-Detect	-8.68

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	8
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	80.00%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.789	Shapiro Wilk Test Statistic	0.781
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.0000923	Mean	-9.427
SD	5.337E-05	SD	0.541
95% DL/2 (t) UCL	0.0001232	95% H-Stat (DL/2) UCL	0.0001405
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-9.387
		SD in Log Scale	0.491
		Mean in Original Scale	9.405E-05
		SD in Original Scale	5.114E-05
		95% t UCL	0.0001237
		95% Percentile Bootstrap UCL	0.0001192
		95% BCA Bootstrap UCL	0.0001249
		95% H-UCL	0.0001358

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	2.796	Data appear Normal at 5% Significance Level
Theta Star	5.079E-05	
nu star	22.37	
A-D Test Statistic	0.612	Nonparametric Statistics
5% A-D Critical Value	0.657	Kaplan-Meier (KM) Method

K-S Test Statistic	0.657
5% K-S Critical Value	0.395

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.00019
Mean	6.246E-05
Median	1.777E-05
SD	7.457E-05
k star	0.413
Theta star	0.0001511
Nu star	8.269
AppChi2	2.892
95% Gamma Approximate UCL	0.0001786
95% Adjusted Gamma UCL	N/A

Mean	0.0001157
SD	3.472E-05
SE of Mean	1.268E-05
95% KM (t) UCL	0.000139
95% KM (z) UCL	0.0001366
95% KM (jackknife) UCL	0.0001363
95% KM (bootstrap t) UCL	0.0001292
95% KM (BCA) UCL	0.00019
95% KM (Percentile Bootstrap) UCL	0.000181
95% KM (Chebyshev) UCL	0.000171
97.5% KM (Chebyshev) UCL	0.0001949
99% KM (Chebyshev) UCL	0.0002419

Potential UCLs to Use

95% KM (t) UCL	0.000139
95% KM (Percentile Bootstrap) UCL	0.000181

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Indeno(1,2,3-cd)pyrene

General Statistics

Number of Valid Observations 10

Number of Distinct Observations 9

Raw Statistics

Minimum	0.014
Maximum	0.053
Mean	0.0318
Median	0.029
SD	0.0128
Std. Error of Mean	0.00406
Coefficient of Variation	0.404
Skewness	0.48

Log-transformed Statistics

Minimum of Log Data	-4.269
Maximum of Log Data	-2.937
Mean of log Data	-3.525
SD of log Data	0.421

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.922
Shapiro Wilk Critical Value	0.842

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.945
Shapiro Wilk Critical Value	0.842

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.0392

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.0391
95% Modified-t UCL (Johnson-1978)	0.0393

Assuming Lognormal Distribution

95% H-UCL	0.0433
95% Chebyshev (MVUE) UCL	0.0506
97.5% Chebyshev (MVUE) UCL	0.0587
99% Chebyshev (MVUE) UCL	0.0747

Gamma Distribution Test

k star (bias corrected)	4.739

Data Distribution

Data appear Normal at 5% Significance Level

Theta Star	0.00671
MLE of Mean	0.0318
MLE of Standard Deviation	0.0146
nu star	94.78
Approximate Chi Square Value (.05)	73.32
Adjusted Level of Significance	0.0267
Adjusted Chi Square Value	70.05
Anderson-Darling Test Statistic	0.344
Anderson-Darling 5% Critical Value	0.728
Kolmogorov-Smirnov Test Statistic	0.208
Kolmogorov-Smirnov 5% Critical Value	0.267

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.0411
95% Adjusted Gamma UCL	0.043

Nonparametric Statistics

95% CLT UCL	0.0385
95% Jackknife UCL	0.0392
95% Standard Bootstrap UCL	0.0382
95% Bootstrap-t UCL	0.04
95% Hall's Bootstrap UCL	0.039
95% Percentile Bootstrap UCL	0.0382
95% BCA Bootstrap UCL	0.038
95% Chebyshev(Mean, Sd) UCL	0.0495
97.5% Chebyshev(Mean, Sd) UCL	0.0572
99% Chebyshev(Mean, Sd) UCL	0.0722

Potential UCL to Use

Use 95% Student's-t UCL 0.0392

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Manganese

General Statistics

Number of Valid Observations	10	Number of Distinct Observations	10

Raw Statistics

Minimum	40.5
Maximum	721
Mean	230.8
Median	163.5
SD	207.8
Std. Error of Mean	65.72
Coefficient of Variation	0.9
Skewness	1.772

Log-transformed Statistics

Minimum of Log Data	3.701
Maximum of Log Data	6.581
Mean of log Data	5.129
SD of log Data	0.83

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.797
Shapiro Wilk Critical Value	0.842

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.983
Shapiro Wilk Critical Value	0.842

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	351.3

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	378.3
95% Modified-t UCL (Johnson-1978)	357.4

Assuming Lognormal Distribution

95% H-UCL	512.5
95% Chebyshev (MVUE) UCL	499.9
97.5% Chebyshev (MVUE) UCL	617.4
99% Chebyshev (MVUE) UCL	848.3

Gamma Distribution Test

k star (bias corrected) 1.288

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Theta Star	179.2
MLE of Mean	230.8
MLE of Standard Deviation	203.4
nu star	25.77
Approximate Chi Square Value (.05)	15.2
Adjusted Level of Significance	0.0267
Adjusted Chi Square Value	13.81
Anderson-Darling Test Statistic	0.325
Anderson-Darling 5% Critical Value	0.737
Kolmogorov-Smirnov Test Statistic	0.22
Kolmogorov-Smirnov 5% Critical Value	0.27

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	391.3
95% Adjusted Gamma UCL	430.8

Nonparametric Statistics

95% CLT UCL	338.9
95% Jackknife UCL	351.3
95% Standard Bootstrap UCL	336.4
95% Bootstrap-t UCL	541.4
95% Hall's Bootstrap UCL	907.4
95% Percentile Bootstrap UCL	340.9
95% BCA Bootstrap UCL	385.4
95% Chebyshev(Mean, Sd) UCL	517.3
97.5% Chebyshev(Mean, Sd) UCL	641.2
99% Chebyshev(Mean, Sd) UCL	884.7

Potential UCL to Use

Use 95% Approximate Gamma UCL 391.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Thallium

General Statistics

Number of Valid Data	10	Number of Detected Data	0
Number of Distinct Detected Data	0	Number of Non-Detect Data	10
		Percent Non-Detects	100.00%

Warning: All observations are Non-Detects (NDs), therefore all statistics and estimates should also be NDs!
Specifically, sample mean, UCLs, UPLs, and other statistics are also NDs lying below the largest detection limit!
The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable Thallium was not processed!

Vanadium

General Statistics

Number of Valid Observations	10	Number of Distinct Observations	7

Raw Statistics

Minimum	12
Maximum	25.7
Mean	17.95
Median	18
SD	3.86
Std. Error of Mean	1.221
Coefficient of Variation	0.215
Skewness	0.343

Log-transformed Statistics

Minimum of Log Data	2.485
Maximum of Log Data	3.246
Mean of log Data	2.866
SD of log Data	0.219

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.933
Shapiro Wilk Critical Value	0.842

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.933
Shapiro Wilk Critical Value	0.842

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	20.19

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	20.1
95% Modified-t UCL (Johnson-1978)	20.21

Assuming Lognormal Distribution

95% H-UCL	20.68
95% Chebyshev (MVUE) UCL	23.41
97.5% Chebyshev (MVUE) UCL	25.77
99% Chebyshev (MVUE) UCL	30.4

Gamma Distribution Test

k star (bias corrected)	16.65
Theta Star	1.078
MLE of Mean	17.95
MLE of Standard Deviation	4.399
nu star	333
Approximate Chi Square Value (.05)	291.7
Adjusted Level of Significance	0.0267
Adjusted Chi Square Value	285
Anderson-Darling Test Statistic	0.417
Anderson-Darling 5% Critical Value	0.725
Kolmogorov-Smirnov Test Statistic	0.233
Kolmogorov-Smirnov 5% Critical Value	0.266

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	20.49
95% Adjusted Gamma UCL	20.97

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	19.96
95% Jackknife UCL	20.19
95% Standard Bootstrap UCL	19.91
95% Bootstrap-t UCL	20.28
95% Hall's Bootstrap UCL	20.74
95% Percentile Bootstrap UCL	19.84
95% BCA Bootstrap UCL	19.82
95% Chebyshev(Mean, Sd) UCL	23.27
97.5% Chebyshev(Mean, Sd) UCL	25.57
99% Chebyshev(Mean, Sd) UCL	30.1

Potential UCL to Use

Use 95% Student's-t UCL 20.19

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Dioxin TEQ

General Statistics

Number of Valid Observations	10
Number of Distinct Observations	10

Raw Statistics

Minimum	1.49E-06
Maximum	8.729E-06
Mean	3.886E-06
Median	3.058E-06
SD	2.097E-06
Std. Error of Mean	6.631E-07
Coefficient of Variation	N/A

Log-transformed Statistics

Minimum of Log Data	-13.42
Maximum of Log Data	-11.65
Mean of log Data	-12.57
SD of log Data	0.494

Skewness 1.528

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.857
Shapiro Wilk Critical Value 0.842
Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.964
Shapiro Wilk Critical Value 0.842
Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL 5.102E-06

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 5.319E-06
95% Modified-t UCL (Johnson-1978) 5.155E-06

Assuming Lognormal Distribution

95% H-UCL 5.639E-06
95% Chebyshev (MVUE) UCL 6.545E-06
97.5% Chebyshev (MVUE) UCL 7.704E-06
99% Chebyshev (MVUE) UCL 9.981E-06

Gamma Distribution Test

k star (bias corrected) 3.253
Theta Star 1.195E-06
MLE of Mean 3.886E-06
MLE of Standard Deviation 2.155E-06
nu star 65.05
Approximate Chi Square Value (.05) 47.49
Adjusted Level of Significance 0.0267
Adjusted Chi Square Value 44.9

Anderson-Darling Test Statistic 0.371
Anderson-Darling 5% Critical Value 0.729
Kolmogorov-Smirnov Test Statistic 0.23
Kolmogorov-Smirnov 5% Critical Value 0.268
Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 5.323E-06
95% Adjusted Gamma UCL 5.631E-06

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 4.977E-06
95% Jackknife UCL 5.102E-06
95% Standard Bootstrap UCL 4.911E-06
95% Bootstrap-t UCL 6.143E-06
95% Hall's Bootstrap UCL 1.084E-05
95% Percentile Bootstrap UCL 4.957E-06
95% BCA Bootstrap UCL 5.238E-06
95% Chebyshev(Mean, Sd) UCL 6.776E-06
97.5% Chebyshev(Mean, Sd) UCL 8.027E-06
99% Chebyshev(Mean, Sd) UCL 1.048E-05

Potential UCL to Use

Use 95% Student's-t UCL 5.102E-06

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

ProUCL Output General Area Surface Soil

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

From File	Sheet1.wst
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

alpha-Chlordane

General Statistics

Number of Valid Data	19	Number of Detected Data	14
Number of Distinct Detected Data	14	Number of Non-Detect Data	5
		Percent Non-Detects	26.32%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00012	Minimum Detected	-9.028
Maximum Detected	0.03	Maximum Detected	-3.507
Mean of Detected	0.00525	Mean of Detected	-6.327
SD of Detected	0.00827	SD of Detected	1.637
Minimum Non-Detect	0.0001	Minimum Non-Detect	-9.21
Maximum Non-Detect	0.0028	Maximum Non-Detect	-5.878

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	13
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	6
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	68.42%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.656	Shapiro Wilk Test Statistic	0.971
5% Shapiro Wilk Critical Value	0.874	5% Shapiro Wilk Critical Value	0.874
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00399	Mean	-6.947
SD	0.00735	SD	1.924
95% DL/2 (t) UCL	0.00691	95% H-Stat (DL/2) UCL	0.0396
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-7.112
		SD in Log Scale	2.018
		Mean in Original Scale	0.0039
		SD in Original Scale	0.00739
		95% t UCL	0.00685
		95% Percentile Bootstrap UCL	0.00699
		95% BCA Bootstrap UCL	0.0084
		95% H-UCL	0.048

Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**
k star (bias corrected)	0.501	**Data appear Gamma Distributed at 5% Significance Level**
Theta Star	0.0105	
nu star	14.03	

A-D Test Statistic	0.43
5% A-D Critical Value	0.786
K-S Test Statistic	0.786
5% K-S Critical Value	0.24

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.03
Mean	0.00387
Median	0.001
SD	0.00741
k star	0.252
Theta star	0.0153
Nu star	9.582
AppChi2	3.682
95% Gamma Approximate UCL	0.0101
95% Adjusted Gamma UCL	0.011

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.00394
SD	0.00718
SE of Mean	0.00171
95% KM (t) UCL	0.00691
95% KM (z) UCL	0.00676
95% KM (jackknife) UCL	0.00687
95% KM (bootstrap t) UCL	0.0116
95% KM (BCA) UCL	0.00732
95% KM (Percentile Bootstrap) UCL	0.00714
95% KM (Chebyshev) UCL	0.0114
97.5% KM (Chebyshev) UCL	0.0146
99% KM (Chebyshev) UCL	0.021

Potential UCLs to Use

95% KM (Chebyshev) UCL	0.0114

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Aluminum

General Statistics

Number of Valid Observations 3 Number of Distinct Observations 3

Warning: This data set only has 3 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Aluminum was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Aroclor 1254

General Statistics

Number of Valid Data	19	Number of Detected Data	12
Number of Distinct Detected Data	12	Number of Non-Detect Data	7
		Percent Non-Detects	36.84%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.0077	Minimum Detected	-4.867
Maximum Detected	0.638	Maximum Detected	-0.45
Mean of Detected	0.157	Mean of Detected	-2.331
SD of Detected	0.171	SD of Detected	1.115
Minimum Non-Detect	0.0021	Minimum Non-Detect	-6.166

Maximum Non-Detect	0.055	Maximum Non-Detect	-2.9

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	10
Number treated as Detected	9
Single DL Non-Detect Percentage	52.63%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.737
5% Shapiro Wilk Critical Value	0.859

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.954
5% Shapiro Wilk Critical Value	0.859

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.103
SD	0.152
95% DL/2 (t) UCL	0.164
Maximum Likelihood Estimate(MLE) Method	
Mean	0.0174
SD	0.234
95% MLE (t) UCL	0.111
95% MLE (Tiku) UCL	0.137

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-3.467
SD	1.942
95% H-Stat (DL/2) UCL	1.373
Log ROS Method	
Mean in Log Scale	-3.235
SD in Log Scale	1.52
Mean in Original Scale	0.103
SD in Original Scale	0.152
95% t UCL	0.163
95% Percentile Bootstrap UCL	0.161
95% BCA Bootstrap UCL	0.201
95% H UCL	0.426

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.938
Theta Star	0.168
nu star	22.52
A-D Test Statistic	0.285
5% A-D Critical Value	0.753
K-S Test Statistic	0.753
5% K-S Critical Value	0.251

Data appear Gamma Distributed at 5% Significance Level

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.638
Mean	0.0994
Median	0.049
SD	0.155
k star	0.184
Theta star	0.541
Nu star	6.978
AppChi2	2.159
95% Gamma Approximate UCL	0.321
95% Adjusted Gamma UCL	0.359

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.103
SD	0.148
SE of Mean	0.0355
95% KM (t) UCL	0.165
95% KM (z) UCL	0.162
95% KM (jackknife) UCL	0.159
95% KM (bootstrap t) UCL	0.212
95% KM (BCA) UCL	0.179
95% KM (Percentile Bootstrap) UCL	0.169
95% KM (Chebyshev) UCL	0.258
97.5% KM (Chebyshev) UCL	0.325
99% KM (Chebyshev) UCL	0.457

Potential UCLs to Use

95% KM (BCA) UCL	0.179

ProUCL Output General Area Surface Soil

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Aroclor 1268

General Statistics

Number of Valid Data	17	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	14
		Percent Non-Detects	82.35%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.02	Minimum Detected	-3.912
Maximum Detected	0.026	Maximum Detected	-3.65
Mean of Detected	0.0228	Mean of Detected	-3.785
SD of Detected	0.00301	SD of Detected	0.131
Minimum Non-Detect	0.0021	Minimum Non-Detect	-6.166
Maximum Non-Detect	0.0203	Maximum Non-Detect	-3.898

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	15
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	88.24%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.99	Shapiro Wilk Test Statistic	0.996
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00556	Mean	-6.1
SD	0.00859	SD	1.244
95% DL/2 (t) UCL	0.0092	95% H-Stat (DL/2) UCL	0.0126
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-4.283
		SD in Log Scale	0.296
		Mean in Original Scale	0.0144
		SD in Original Scale	0.00465
		95% t UCL	0.0164
		95% Percentile Bootstrap UCL	0.0162
		95% BCA Bootstrap UCL	0.0165
		95% H-UCL	0.0165

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A
A-D Test Statistic	N/A
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0205
SD	0.00149
SE of Mean	0.0004439
95% KM (t) UCL	0.0213
95% KM (z) UCL	0.0212
95% KM (jackknife) UCL	0.0221
95% KM (bootstrap t) UCL	0.0209
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	0.026
95% KM (Chebyshev) UCL	0.0224
97.5% KM (Chebyshev) UCL	0.0233
99% KM (Chebyshev) UCL	0.0249

Potential UCLs to Use

95% KM (t) UCL	0.0213
95% KM (Percentile Bootstrap) UCL	0.026

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Arsenic

General Statistics

Number of Valid Observations 19

Number of Distinct Observations 18

Raw Statistics

Minimum	2.61
Maximum	13.3
Mean	5.819
Median	4.8
SD	2.767
Std. Error of Mean	0.635
Coefficient of Variation	0.476
Skewness	1.294

Log-transformed Statistics

Minimum of Log Data	0.959
Maximum of Log Data	2.588
Mean of log Data	1.667
SD of log Data	0.437

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.884
Shapiro Wilk Critical Value	0.901

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.971
Shapiro Wilk Critical Value	0.901

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL 6.92

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 7.065

95% Modified-t UCL (Johnson-1978) 6.951

95% H-UCL 7.121

95% Chebyshev (MVUE) UCL 8.393

97.5% Chebyshev (MVUE) UCL 9.518

99% Chebyshev (MVUE) UCL 11.73

Gamma Distribution Test

k star (bias corrected) 4.633

Theta Star 1.256

MLE of Mean 5.819

MLE of Standard Deviation 2.704

nu star 176

Approximate Chi Square Value (.05) 146.4

Adjusted Level of Significance 0.0369

Adjusted Chi Square Value 144

Anderson-Darling Test Statistic 0.393

Anderson-Darling 5% Critical Value 0.742

Kolmogorov-Smirnov Test Statistic 0.176

Kolmogorov-Smirnov 5% Critical Value 0.199

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 6.863

95% Jackknife UCL 6.92

95% Standard Bootstrap UCL 6.83

95% Bootstrap-t UCL 7.182

95% Hall's Bootstrap UCL 7.296

95% Percentile Bootstrap UCL 6.889

95% BCA Bootstrap UCL 7.171

95% Chebyshev(Mean, Sd) UCL 8.586

97.5% Chebyshev(Mean, Sd) UCL 9.784

99% Chebyshev(Mean, Sd) UCL 12.14

Assuming Gamma Distribution

95% Approximate Gamma UCL 6.999

95% Adjusted Gamma UCL 7.114

Potential UCL to Use

Use 95% Approximate Gamma UCL 6.999

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Benz(a)anthracene

General Statistics

Number of Valid Observations 18

Number of Distinct Observations 18

Raw Statistics

Minimum 0.016

Maximum 2.4

Mean 0.505

Median 0.26

SD 0.645

Std. Error of Mean 0.152

Coefficient of Variation 1.278

Skewness 1.967

Log-transformed Statistics

Minimum of Log Data -4.135

Maximum of Log Data 0.875

Mean of log Data -1.493

SD of log Data 1.445

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.741

Shapiro Wilk Critical Value 0.897

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.968

Shapiro Wilk Critical Value 0.897

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL	0.769
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	0.83
95% Modified-t UCL (Johnson-1978)	0.781

95% H-UCL	2.058
95% Chebyshev (MVUE) UCL	1.576
97.5% Chebyshev (MVUE) UCL	2.009
99% Chebyshev (MVUE) UCL	2.859

Gamma Distribution Test

k star (bias corrected)	0.655
Theta Star	0.771
MLE of Mean	0.505
MLE of Standard Deviation	0.624
nu star	23.56
Approximate Chi Square Value (.05)	13.52
Adjusted Level of Significance	0.0357
Adjusted Chi Square Value	12.79
Anderson-Darling Test Statistic	0.275
Anderson-Darling 5% Critical Value	0.779
Kolmogorov-Smirnov Test Statistic	0.117
Kolmogorov-Smirnov 5% Critical Value	0.212

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.755
95% Jackknife UCL	0.769
95% Standard Bootstrap UCL	0.752
95% Bootstrap-t UCL	0.978
95% Hall's Bootstrap UCL	0.894
95% Percentile Bootstrap UCL	0.768
95% BCA Bootstrap UCL	0.813
95% Chebyshev(Mean, Sd) UCL	1.168
97.5% Chebyshev(Mean, Sd) UCL	1.454
99% Chebyshev(Mean, Sd) UCL	2.018

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.88
95% Adjusted Gamma UCL	0.93

Potential UCL to Use

Use 95% Approximate Gamma UCL 0.88

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Benzo(a)pyrene

General Statistics

Number of Valid Observations	18
Number of Distinct Observations	18

Raw Statistics

Minimum	0.023
Maximum	2.8
Mean	0.651
Median	0.34
SD	0.819
Std. Error of Mean	0.193
Coefficient of Variation	1.259
Skewness	1.828

Log-transformed Statistics

Minimum of Log Data	-3.772
Maximum of Log Data	1.03
Mean of log Data	-1.161
SD of log Data	1.334

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.726
Shapiro Wilk Critical Value	0.897

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.978
Shapiro Wilk Critical Value	0.897

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL	0.986
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	1.057
95% Modified-t UCL (Johnson-1978)	1

95% H-UCL	2.118
95% Chebyshev (MVUE) UCL	1.815
97.5% Chebyshev (MVUE) UCL	2.297
99% Chebyshev (MVUE) UCL	3.244

Gamma Distribution Test

k star (bias corrected)	0.712
Theta Star	0.914
MLE of Mean	0.651
MLE of Standard Deviation	0.771
nu star	25.63
Approximate Chi Square Value (.05)	15.1
Adjusted Level of Significance	0.0357
Adjusted Chi Square Value	14.32
Anderson-Darling Test Statistic	0.37
Anderson-Darling 5% Critical Value	0.775
Kolmogorov-Smirnov Test Statistic	0.142
Kolmogorov-Smirnov 5% Critical Value	0.211

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	1.105
95% Adjusted Gamma UCL	1.164

Nonparametric Statistics

95% CLT UCL	0.968
95% Jackknife UCL	0.986
95% Standard Bootstrap UCL	0.956
95% Bootstrap-t UCL	1.272
95% Hall's Bootstrap UCL	1.063
95% Percentile Bootstrap UCL	1.008
95% BCA Bootstrap UCL	1.061
95% Chebyshev(Mean, Sd) UCL	1.492
97.5% Chebyshev(Mean, Sd) UCL	1.856
99% Chebyshev(Mean, Sd) UCL	2.571

Potential UCL to Use

Use 95% Approximate Gamma UCL 1.105

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Benzo(b)fluoranthene

General Statistics

Number of Valid Observations	18
Number of Distinct Observations	18

Raw Statistics

Minimum	0.029
Maximum	3.6
Mean	0.929
Median	0.45
SD	1.154
Std. Error of Mean	0.272
Coefficient of Variation	1.242
Skewness	1.602

Log-transformed Statistics

Minimum of Log Data	-3.54
Maximum of Log Data	1.281
Mean of log Data	-0.864
SD of log Data	1.422

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.725
Shapiro Wilk Critical Value	0.897

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.959
Shapiro Wilk Critical Value	0.897

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL	1.402
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	1.486
95% Modified-t UCL (Johnson-1978)	1.419

95% H-UCL	3.621
95% Chebyshev (MVUE) UCL	2.841
97.5% Chebyshev (MVUE) UCL	3.616
99% Chebyshev (MVUE) UCL	5.139

Gamma Distribution Test

k star (bias corrected)	0.667
Theta Star	1.392
MLE of Mean	0.929
MLE of Standard Deviation	1.137
nu star	24.02
Approximate Chi Square Value (.05)	13.87
Adjusted Level of Significance	0.0357
Adjusted Chi Square Value	13.13
Anderson-Darling Test Statistic	0.417
Anderson-Darling 5% Critical Value	0.778
Kolmogorov-Smirnov Test Statistic	0.144
Kolmogorov-Smirnov 5% Critical Value	0.211

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	1.61
95% Adjusted Gamma UCL	1.7

Nonparametric Statistics

95% CLT UCL	1.377
95% Jackknife UCL	1.402
95% Standard Bootstrap UCL	1.366
95% Bootstrap-t UCL	1.631
95% Hall's Bootstrap UCL	1.35
95% Percentile Bootstrap UCL	1.393
95% BCA Bootstrap UCL	1.459
95% Chebyshev(Mean, Sd) UCL	2.115
97.5% Chebyshev(Mean, Sd) UCL	2.628
99% Chebyshev(Mean, Sd) UCL	3.635

Potential UCL to Use

Use 95% Approximate Gamma UCL 1.61

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Benzo(k)fluoranthene

General Statistics

Number of Valid Observations	18
Number of Distinct Observations	18

Raw Statistics

Minimum	0.011
Maximum	2.7
Mean	0.483
Median	0.22
SD	0.704
Std. Error of Mean	0.166
Coefficient of Variation	1.458
Skewness	2.272

Log-transformed Statistics

Minimum of Log Data	-4.51
Maximum of Log Data	0.993
Mean of log Data	-1.722
SD of log Data	1.602

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.683
Shapiro Wilk Critical Value	0.897

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.962
Shapiro Wilk Critical Value	0.897

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL 0.772

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995) 0.851

95% Modified-t UCL (Johnson-1978) 0.786

95% H-UCL 2.623

95% Chebyshev (MVUE) UCL 1.658

97.5% Chebyshev (MVUE) UCL 2.132

99% Chebyshev (MVUE) UCL 3.064

Gamma Distribution Test

k star (bias corrected) 0.553

Theta Star 0.874

MLE of Mean 0.483

MLE of Standard Deviation 0.65

nu star 19.89

Approximate Chi Square Value (.05) 10.77

Adjusted Level of Significance 0.0357

Adjusted Chi Square Value 10.13

Anderson-Darling Test Statistic 0.411

Anderson-Darling 5% Critical Value 0.79

Kolmogorov-Smirnov Test Statistic 0.184

Kolmogorov-Smirnov 5% Critical Value 0.213

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL 0.756

95% Jackknife UCL 0.772

95% Standard Bootstrap UCL 0.745

95% Bootstrap-t UCL 1.001

95% Hall's Bootstrap UCL 1.068

95% Percentile Bootstrap UCL 0.755

95% BCA Bootstrap UCL 0.854

95% Chebyshev(Mean, Sd) UCL 1.206

97.5% Chebyshev(Mean, Sd) UCL 1.52

99% Chebyshev(Mean, Sd) UCL 2.135

Assuming Gamma Distribution

95% Approximate Gamma UCL 0.892

95% Adjusted Gamma UCL 0.948

Potential UCL to Use

Use 95% Approximate Gamma UCL 0.892

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Carbazole

General Statistics

Number of Valid Observations 18

Number of Distinct Observations 18

Raw Statistics

Minimum 0.0034

Maximum 0.36

Mean 0.083

Median 0.054

SD 0.097

Std. Error of Mean 0.0229

Coefficient of Variation 1.17

Skewness 1.873

Log-transformed Statistics

Minimum of Log Data -5.684

Maximum of Log Data -1.022

Mean of log Data -3.192

SD of log Data 1.364

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic 0.765

Shapiro Wilk Critical Value 0.897

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic 0.952

Shapiro Wilk Critical Value 0.897

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL	0.123
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	0.131
95% Modified-t UCL (Johnson-1978)	0.124
95% H-UCL	0.301
95% Chebyshev (MVUE) UCL	0.251
97.5% Chebyshev (MVUE) UCL	0.318
99% Chebyshev (MVUE) UCL	0.45

Gamma Distribution Test

k star (bias corrected)	0.737
Theta Star	0.113
MLE of Mean	0.083
MLE of Standard Deviation	0.0967
nu star	26.52
Approximate Chi Square Value (.05)	15.78
Adjusted Level of Significance	0.0357
Adjusted Chi Square Value	14.99
Anderson-Darling Test Statistic	0.272
Anderson-Darling 5% Critical Value	0.774
Kolmogorov-Smirnov Test Statistic	0.111
Kolmogorov-Smirnov 5% Critical Value	0.211

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.139
95% Adjusted Gamma UCL	0.147

Nonparametric Statistics

95% CLT UCL	0.121
95% Jackknife UCL	0.123
95% Standard Bootstrap UCL	0.12
95% Bootstrap-t UCL	0.155
95% Hall's Bootstrap UCL	0.152
95% Percentile Bootstrap UCL	0.122
95% BCA Bootstrap UCL	0.133
95% Chebyshev(Mean, Sd) UCL	0.183
97.5% Chebyshev(Mean, Sd) UCL	0.226
99% Chebyshev(Mean, Sd) UCL	0.311

Potential UCL to Use

Use 95% Approximate Gamma UCL 0.139

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Chromium

General Statistics

Number of Valid Observations	19
Number of Distinct Observations	19

Raw Statistics

Minimum	5.66
Maximum	52
Mean	26.03
Median	20.7
SD	14.81
Std. Error of Mean	3.397
Coefficient of Variation	0.569
Skewness	0.445

Log-transformed Statistics

Minimum of Log Data	1.733
Maximum of Log Data	3.951
Mean of log Data	3.084
SD of log Data	0.637

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.919
Shapiro Wilk Critical Value	0.901

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.953
Shapiro Wilk Critical Value	0.901

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL	31.93
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	31.99
95% Modified-t UCL (Johnson-1978)	31.98

95% H-UCL	36.97
95% Chebyshev (MVUE) UCL	44.21
97.5% Chebyshev (MVUE) UCL	51.9
99% Chebyshev (MVUE) UCL	67.01

Gamma Distribution Test

k star (bias corrected)	2.569
Theta Star	10.13
MLE of Mean	26.03
MLE of Standard Deviation	16.24
nu star	97.64
Approximate Chi Square Value (.05)	75.84
Adjusted Level of Significance	0.0369
Adjusted Chi Square Value	74.17
Anderson-Darling Test Statistic	0.345
Anderson-Darling 5% Critical Value	0.748
Kolmogorov-Smirnov Test Statistic	0.118
Kolmogorov-Smirnov 5% Critical Value	0.2

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	33.52
95% Adjusted Gamma UCL	34.27

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	31.62
95% Jackknife UCL	31.93
95% Standard Bootstrap UCL	31.49
95% Bootstrap-t UCL	32.8
95% Hall's Bootstrap UCL	31.56
95% Percentile Bootstrap UCL	31.54
95% BCA Bootstrap UCL	32.02
95% Chebyshev(Mean, Sd) UCL	40.84
97.5% Chebyshev(Mean, Sd) UCL	47.25
99% Chebyshev(Mean, Sd) UCL	59.84

Potential UCL to Use

Use 95% Student's-t UCL 31.93

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cobalt

General Statistics

Number of Valid Observations	19
Number of Distinct Observations	19

Raw Statistics

Minimum	0.94
Maximum	10
Mean	4.977
Median	3.6
SD	2.965
Std. Error of Mean	0.68
Coefficient of Variation	0.596
Skewness	0.292

Log-transformed Statistics

Minimum of Log Data	-0.0619
Maximum of Log Data	2.303
Mean of log Data	1.398
SD of log Data	0.705

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.906
Shapiro Wilk Critical Value	0.901

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.928
Shapiro Wilk Critical Value	0.901

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL	6.156
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	6.144
95% Modified-t UCL (Johnson-1978)	6.164
95% H-UCL	7.509
95% Chebyshev (MVUE) UCL	8.941
97.5% Chebyshev (MVUE) UCL	10.6
99% Chebyshev (MVUE) UCL	13.86

Gamma Distribution Test

k star (bias corrected)	2.2
Theta Star	2.263
MLE of Mean	4.977
MLE of Standard Deviation	3.356
nu star	83.59
Approximate Chi Square Value (.05)	63.52
Adjusted Level of Significance	0.0369
Adjusted Chi Square Value	61.99
Anderson-Darling Test Statistic	0.546
Anderson-Darling 5% Critical Value	0.75
Kolmogorov-Smirnov Test Statistic	0.173
Kolmogorov-Smirnov 5% Critical Value	0.2

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL	6.55
95% Adjusted Gamma UCL	6.711

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	6.096
95% Jackknife UCL	6.156
95% Standard Bootstrap UCL	6.088
95% Bootstrap-t UCL	6.228
95% Hall's Bootstrap UCL	6.053
95% Percentile Bootstrap UCL	6.031
95% BCA Bootstrap UCL	6.037
95% Chebyshev(Mean, Sd) UCL	7.942
97.5% Chebyshev(Mean, Sd) UCL	9.224
99% Chebyshev(Mean, Sd) UCL	11.74

Potential UCL to Use	Use 95% Student's-t UCL 6.156

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Dibenz(a,h)anthracene

General Statistics

Number of Valid Observations	18	Number of Distinct Observations	18

Raw Statistics

Minimum	0.0038
Maximum	0.49
Mean	0.105
Median	0.056
SD	0.143
Std. Error of Mean	0.0337
Coefficient of Variation	1.357
Skewness	2.176

Log-transformed Statistics

Minimum of Log Data	-5.573
Maximum of Log Data	-0.713
Mean of log Data	-3.033
SD of log Data	1.372

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.672
Shapiro Wilk Critical Value	0.897

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.976
Shapiro Wilk Critical Value	0.897

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

95% Student's-t UCL	0.164
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL (Chen-1995)	0.179
95% Modified-t UCL (Johnson-1978)	0.167

95% H-UCL	0.36
95% Chebyshev (MVUE) UCL	0.298
97.5% Chebyshev (MVUE) UCL	0.378
99% Chebyshev (MVUE) UCL	0.535

Gamma Distribution Test

k star (bias corrected)	0.673
Theta Star	0.156
MLE of Mean	0.105
MLE of Standard Deviation	0.128
nu star	24.23
Approximate Chi Square Value (.05)	14.02
Adjusted Level of Significance	0.0357
Adjusted Chi Square Value	13.28
Anderson-Darling Test Statistic	0.364
Anderson-Darling 5% Critical Value	0.777
Kolmogorov-Smirnov Test Statistic	0.0946
Kolmogorov-Smirnov 5% Critical Value	0.211

Data appear Gamma Distributed at 5% Significance Level

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.161
95% Jackknife UCL	0.164
95% Standard Bootstrap UCL	0.16
95% Bootstrap-t UCL	0.249
95% Hall's Bootstrap UCL	0.458
95% Percentile Bootstrap UCL	0.162
95% BCA Bootstrap UCL	0.178
95% Chebyshev(Mean, Sd) UCL	0.252
97.5% Chebyshev(Mean, Sd) UCL	0.316
99% Chebyshev(Mean, Sd) UCL	0.441

Assuming Gamma Distribution

95% Approximate Gamma UCL	0.182
95% Adjusted Gamma UCL	0.192

Potential UCL to Use

Use 95% Approximate Gamma UCL 0.182

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Dimethyl Phthalate

General Statistics

Number of Valid Data	17	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	8
		Percent Non-Detects	47.06%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.025	Minimum Detected	-3.689
Maximum Detected	0.13	Maximum Detected	-2.04
Mean of Detected	0.0711	Mean of Detected	-2.764
SD of Detected	0.0357	SD of Detected	0.534
Minimum Non-Detect	0.001	Minimum Non-Detect	-6.908
Maximum Non-Detect	0.65	Maximum Non-Detect	-0.431

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	17
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 9 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.936
5% Shapiro Wilk Critical Value	0.829
Data appear Normal at 5% Significance Level	

Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.971
5% Shapiro Wilk Critical Value	0.829
Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution	
DL/2 Substitution Method	
Mean	0.0725
SD	0.0942
95% DL/2 (t) UCL	0.112
Maximum Likelihood Estimate(MLE) Method	N/A
MLE method failed to converge properly	

Assuming Lognormal Distribution	
DL/2 Substitution Method	
Mean	-4.279
SD	2.582
95% H-Stat (DL/2) UCL	13.37
Log ROS Method	
Mean in Log Scale	-3.329
SD in Log Scale	0.795
Mean in Original Scale	0.0475
SD in Original Scale	0.0367
95% t UCL	0.0631
95% Percentile Bootstrap UCL	0.0624
95% BCA Bootstrap UCL	0.0652
95% H-UCL	0.0784

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	2.958
Theta Star	0.024
nu star	53.25
A-D Test Statistic	0.184
5% A-D Critical Value	0.724
K-S Test Statistic	0.724
5% K-S Critical Value	0.28
Data appear Gamma Distributed at 5% Significance Level	

Data Distribution Test with Detected Values Only
Data appear Normal at 5% Significance Level

Assuming Gamma Distribution	
Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.13
Mean	0.0409
Median	0.028
SD	0.0424
k star	0.209
Theta star	0.196
Nu star	7.09
AppChi2	2.22
95% Gamma Approximate UCL	0.131
95% Adjusted Gamma UCL	0.149

Note: DL/2 is not a recommended method.

Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	0.0527
SD	0.0345
SE of Mean	0.00945
95% KM (t) UCL	0.0692
95% KM (z) UCL	0.0682
95% KM (jackknife) UCL	0.0677
95% KM (bootstrap t) UCL	0.0722
95% KM (BCA) UCL	0.0781
95% KM (Percentile Bootstrap) UCL	0.0729
95% KM (Chebyshev) UCL	0.0939
97.5% KM (Chebyshev) UCL	0.112
99% KM (Chebyshev) UCL	0.147
Potential UCLs to Use	
95% KM (t) UCL	0.0692
95% KM (Percentile Bootstrap) UCL	0.0729

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Endosulfan Sulfate

General Statistics

Number of Valid Data	19	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	15
		Percent Non-Detects	78.95%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.00028	Minimum Detected	-8.181
Maximum Detected	0.00137	Maximum Detected	-6.593
Mean of Detected	0.0006025	Mean of Detected	-7.637
SD of Detected	0.0005162	SD of Detected	0.722
Minimum Non-Detect	0.00011	Minimum Non-Detect	-9.115
Maximum Non-Detect	0.034	Maximum Non-Detect	-3.381

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	19
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.74	Shapiro Wilk Test Statistic	0.838
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00143	Mean	-8.167
SD	0.00388	SD	1.604
95% DL/2 (t) UCL	0.00297	95% H-Stat (DL/2) UCL	0.00395
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-9.06
		SD in Log Scale	0.882
		Mean in Original Scale	0.0001936
		SD in Original Scale	0.0003034
		95% t UCL	0.0003143
		95% Percentile Bootstrap UCL	0.0003155
		95% BCA Bootstrap UCL	0.0003909
		95% H-UCL	0.0002854

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.766	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.0007869	

nu star	6.125
A-D Test Statistic	0.558
5% A-D Critical Value	0.66
K-S Test Statistic	0.66
5% K-S Critical Value	0.397

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum	0.000001
Maximum	0.00137
Mean	0.0001276
Median	0.000001
SD	0.0003285
k star	0.209
Theta star	0.000611
Nu star	7.937
AppChi2	2.699
95% Gamma Approximate UCL	0.0003754
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	0.0003641
SD	0.0002633
SE of Mean	7.627E-05
95% KM (t) UCL	0.0004963
95% KM (z) UCL	0.0004895
95% KM (jackknife) UCL	0.0004683
95% KM (bootstrap t) UCL	0.0007828
95% KM (BCA) UCL	0.00137
95% KM (Percentile Bootstrap) UCL	0.0005914
95% KM (Chebyshev) UCL	0.0006965
97.5% KM (Chebyshev) UCL	0.0008404
99% KM (Chebyshev) UCL	0.00112

Potential UCLs to Use

95% KM (t) UCL	0.0004963

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Endrin Aldehyde

General Statistics

Number of Valid Data	19	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	12
		Percent Non-Detects	63.16%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.00023	Minimum Detected	-8.377
Maximum Detected	0.0019	Maximum Detected	-6.266
Mean of Detected	0.0008743	Mean of Detected	-7.349
SD of Detected	0.0006794	SD of Detected	0.877
Minimum Non-Detect	0.00012	Minimum Non-Detect	-9.028
Maximum Non-Detect	0.0066	Maximum Non-Detect	-5.021

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	19
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 7 Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.864
5% Shapiro Wilk Critical Value	0.803

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	
Mean	0.0007745
SD	0.0009426
95% DL/2 (t) UCL	0.00115
Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.892
5% Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method	
Mean	-7.878
SD	1.295
95% H-Stat (DL/2) UCL	0.00223
Log ROS Method	
Mean in Log Scale	-8.45
SD in Log Scale	1.07
Mean in Original Scale	0.0004004
SD in Original Scale	0.000542
95% t UCL	0.0006161
95% Percentile Bootstrap UCL	0.000614
95% BCA Bootstrap UCL	0.0006537
95% H-UCL	0.000751

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	1.112
Theta Star	0.000786
nu star	15.57
A-D Test Statistic	0.442
5% A-D Critical Value	0.718
K-S Test Statistic	0.718
5% K-S Critical Value	0.316

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.0019
Mean	0.0003227
Median	0.000001
SD	0.0005841
k star	0.216
Theta star	0.0015
Nu star	8.196
AppChi2	2.849
95% Gamma Approximate UCL	0.0009285
95% Adjusted Gamma UCL	0.00103

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.0005116
SD	0.0005086
SE of Mean	0.0001346
95% KM (t) UCL	0.000745
95% KM (z) UCL	0.000733
95% KM (jackknife) UCL	0.0007291
95% KM (bootstrap t) UCL	0.0008133
95% KM (BCA) UCL	0.0008524
95% KM (Percentile Bootstrap) UCL	0.000758
95% KM (Chebyshev) UCL	0.0011
97.5% KM (Chebyshev) UCL	0.00135
99% KM (Chebyshev) UCL	0.00185

Potential UCLs to Use

95% KM (t) UCL	0.000745
95% KM (Percentile Bootstrap) UCL	0.000758

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

gamma-Chlordane

ProUCL Output General Area Surface Soil

General Statistics

Number of Valid Data	19	Number of Detected Data	16
Number of Distinct Detected Data	16	Number of Non-Detect Data	3
		Percent Non-Detects	15.79%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.00015	Minimum Detected	-8.805
Maximum Detected	0.045	Maximum Detected	-3.101
Mean of Detected	0.00697	Mean of Detected	-5.972
SD of Detected	0.0111	SD of Detected	1.632
Minimum Non-Detect	0.00009	Minimum Non-Detect	-9.316
Maximum Non-Detect	0.0028	Maximum Non-Detect	-5.878

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	8
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	11
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	42.11%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.608	Shapiro Wilk Test Statistic	0.942
5% Shapiro Wilk Critical Value	0.887	5% Shapiro Wilk Critical Value	0.887
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.00597	Mean	-6.295
SD	0.0104	SD	1.778
95% DL/2 (t) UCL	0.0101	95% H-Stat (DL/2) UCL	0.0452
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.00218	Mean in Log Scale	-6.399
SD	0.0139	SD in Log Scale	1.844
95% MLE (t) UCL	0.00772	Mean in Original Scale	0.0059
95% MLE (Tiku) UCL	0.00853	SD in Original Scale	0.0104
		95% t UCL	0.01
		95% Percentile Bootstrap UCL	0.0102
		95% BCA Bootstrap UCL	0.0122
		95% H UCL	0.0512

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only
k star (bias corrected)	0.54	Data appear Gamma Distributed at 5% Significance Level
Theta Star	0.0129	
nu star	17.27	
A-D Test Statistic	0.412	Nonparametric Statistics
5% A-D Critical Value	0.786	Kaplan-Meier (KM) Method
K-S Test Statistic	0.786	Mean 0.00591
5% K-S Critical Value	0.225	SD 0.0101
Data appear Gamma Distributed at 5% Significance Level		SE of Mean 0.0024
		95% KM (t) UCL 0.0101
Assuming Gamma Distribution		95% KM (z) UCL 0.00986
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL 0.01
Minimum	0.000001	95% KM (bootstrap t) UCL 0.0164

Maximum	0.045
Mean	0.00587
Median	0.003
SD	0.0104
k star	0.311
Theta star	0.0188
Nu star	11.83
AppChi2	5.115
95% Gamma Approximate UCL	0.0136
95% Adjusted Gamma UCL	0.0147

95% KM (BCA) UCL	0.0106
95% KM (Percentile Bootstrap) UCL	0.0102
95% KM (Chebyshev) UCL	0.0164
97.5% KM (Chebyshev) UCL	0.0209
99% KM (Chebyshev) UCL	0.0298

Potential UCLs to Use

95% KM (Chebyshev) UCL	0.0164

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Indeno(1,2,3-cd)pyrene

General Statistics

Number of Valid Observations	18
Number of Distinct Observations	16

Raw Statistics

Minimum	0.017
Maximum	2.1
Mean	0.45
Median	0.301
SD	0.588
Std. Error of Mean	0.139
Coefficient of Variation	1.305
Skewness	2.332

Log-transformed Statistics

Minimum of Log Data	-4.075
Maximum of Log Data	0.742
Mean of log Data	-1.487
SD of log Data	1.308

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.64
Shapiro Wilk Critical Value	0.897

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.937
Shapiro Wilk Critical Value	0.897

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	0.691

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL (Chen-1995)	0.76
95% Modified-t UCL (Johnson-1978)	0.704

Assuming Lognormal Distribution

95% H-UCL	1.43
95% Chebyshev (MVUE) UCL	1.255
97.5% Chebyshev (MVUE) UCL	1.585
99% Chebyshev (MVUE) UCL	2.234

Gamma Distribution Test

k star (bias corrected)	0.749
Theta Star	0.602
MLE of Mean	0.45
MLE of Standard Deviation	0.521
nu star	26.95
Approximate Chi Square Value (.05)	16.11
Adjusted Level of Significance	0.0357
Adjusted Chi Square Value	15.31

Data Distribution

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	0.678
95% Jackknife UCL	0.691
95% Standard Bootstrap UCL	0.673

Anderson-Darling Test Statistic	0.618	95% Bootstrap-t UCL	1.159
Anderson-Darling 5% Critical Value	0.773	95% Hall's Bootstrap UCL	2.116
Kolmogorov-Smirnov Test Statistic	0.218	95% Percentile Bootstrap UCL	0.678
Kolmogorov-Smirnov 5% Critical Value	0.211	95% BCA Bootstrap UCL	0.763
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1.054
		97.5% Chebyshev(Mean, Sd) UCL	1.315
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1.829
95% Approximate Gamma UCL	0.753		
95% Adjusted Gamma UCL	0.793		

Potential UCL to Use — Use 95% Approximate Gamma UCL 0.753

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Manganese

General Statistics

Number of Valid Observations	19	Number of Distinct Observations	18

Raw Statistics		**Log-transformed Statistics**	
Minimum	149	Minimum of Log Data	5.004
Maximum	2440	Maximum of Log Data	7.8
Mean	721.2	Mean of log Data	6.24
Median	489	SD of log Data	0.865
SD	617.8		
Std. Error of Mean	141.7		
Coefficient of Variation	0.857		
Skewness	1.453		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.841	Shapiro Wilk Test Statistic	0.945
Shapiro Wilk Critical Value	0.901	Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	966.9	95% H-UCL	1222
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1413
95% Adjusted-CLT UCL (Chen-1995)	1005	97.5% Chebyshev (MVUE) UCL	1710
95% Modified-t UCL (Johnson-1978)	974.8	99% Chebyshev (MVUE) UCL	2293

Gamma Distribution Test		**Data Distribution**
k star (bias corrected)	1.393	Data appear Gamma Distributed at 5% Significance Level
Theta Star	517.5	
MLE of Mean	721.2	
MLE of Standard Deviation	610.9	
nu star	52.95	
Approximate Chi Square Value (.05)	37.24	**Nonparametric Statistics**
Adjusted Level of Significance	0.0369	95% CLT UCL 954.3
Adjusted Chi Square Value	36.08	95% Jackknife UCL 966.9
		95% Standard Bootstrap UCL 952

Anderson-Darling Test Statistic	0.444	95% Bootstrap-t UCL	1051
Anderson-Darling 5% Critical Value	0.756	95% Hall's Bootstrap UCL	1118
Kolmogorov-Smirnov Test Statistic	0.151	95% Percentile Bootstrap UCL	969.2
Kolmogorov-Smirnov 5% Critical Value	0.202	95% BCA Bootstrap UCL	998.2
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1339
		97.5% Chebyshev(Mean, Sd) UCL	1606
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	2131
95% Approximate Gamma UCL	1026		
95% Adjusted Gamma UCL	1058		
Potential UCL to Use		Use 95% Approximate Gamma UCL	1026

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Thallium

General Statistics

Number of Valid Data	19	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	15
		Percent Non-Detects	78.95%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.279	Minimum Detected	-1.277
Maximum Detected	0.7	Maximum Detected	-0.357
Mean of Detected	0.445	Mean of Detected	-0.866
SD of Detected	0.179	SD of Detected	0.38
Minimum Non-Detect	0.4	Minimum Non-Detect	-0.916
Maximum Non-Detect	2.5	Maximum Non-Detect	0.916

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	19
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 4 Distinct Detected Values in this data
Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.868	Shapiro Wilk Test Statistic	0.925
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.356	Mean	-1.219
SD	0.281	SD	0.556
95% DL/2 (t) UCL	0.467	95% H-Stat (DL/2) UCL	0.452

Maximum Likelihood Estimate(MLE) Method	N/A

MLE method failed to converge properly

Log ROS Method	
Mean in Log Scale	-1.231
SD in Log Scale	0.308
Mean in Original Scale	0.307
SD in Original Scale	0.113
95% t UCL	0.352
95% Percentile Bootstrap UCL	0.352
95% BCA Bootstrap UCL	0.371
95% H-UCL	0.35

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	2.434
Theta Star	0.183
nu star	19.47
A-D Test Statistic	0.394
5% A-D Critical Value	0.657
K-S Test Statistic	0.657
5% K-S Critical Value	0.395

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data	
Minimum	0.000001
Maximum	0.7
Mean	0.299
Median	0.298
SD	0.15
k star	0.735
Theta star	0.406
Nu star	27.94
AppChi2	16.88
95% Gamma Approximate UCL	0.495
95% Adjusted Gamma UCL	N/A

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method	
Mean	0.323
SD	0.104
SE of Mean	0.03
95% KM (t) UCL	0.375
95% KM (z) UCL	0.372
95% KM (jackknife) UCL	0.4
95% KM (bootstrap t) UCL	0.377
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	0.453
95% KM (Chebyshev) UCL	0.454
97.5% KM (Chebyshev) UCL	0.51
99% KM (Chebyshev) UCL	0.621

Potential UCLs to Use

95% KM (t) UCL	0.375
95% KM (Percentile Bootstrap) UCL	0.453

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Vanadium

General Statistics

Number of Valid Observations	19
Number of Distinct Observations	18

Raw Statistics

Minimum	12.2
Maximum	62.7
Mean	28.12
Median	27.3
SD	10.76
Std. Error of Mean	2.47

Log-transformed Statistics

Minimum of Log Data	2.501
Maximum of Log Data	4.138
Mean of log Data	3.276
SD of log Data	0.354

Coefficient of Variation 0.383
Skewness 1.768

Relevant UCL Statistics

Normal Distribution Test
Shapiro Wilk Test Statistic 0.859
Shapiro Wilk Critical Value 0.901
Data not Normal at 5% Significance Level

Lognormal Distribution Test
Shapiro Wilk Test Statistic 0.968
Shapiro Wilk Critical Value 0.901
Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution
95% Student's-t UCL 32.4

95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL (Chen-1995) 33.25
95% Modified-t UCL (Johnson-1978) 32.57

Assuming Lognormal Distribution
95% H-UCL 32.98
95% Chebyshev (MVUE) UCL 38.22
97.5% Chebyshev (MVUE) UCL 42.6
99% Chebyshev (MVUE) UCL 51.22

Gamma Distribution Test
k star (bias corrected) 7.108
Theta Star 3.956
MLE of Mean 28.12
MLE of Standard Deviation 10.55
nu star 270.1
Approximate Chi Square Value (.05) 233
Adjusted Level of Significance 0.0369
Adjusted Chi Square Value 230

Anderson-Darling Test Statistic 0.351
Anderson-Darling 5% Critical Value 0.742
Kolmogorov-Smirnov Test Statistic 0.142
Kolmogorov-Smirnov 5% Critical Value 0.199
Data appear Gamma Distributed at 5% Significance Level

Data Distribution
Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics
95% CLT UCL 32.18
95% Jackknife UCL 32.4
95% Standard Bootstrap UCL 32.16
95% Bootstrap-t UCL 34.11
95% Hall's Bootstrap UCL 42.87
95% Percentile Bootstrap UCL 32.48
95% BCA Bootstrap UCL 33.53
95% Chebyshev(Mean, Sd) UCL 38.89
97.5% Chebyshev(Mean, Sd) UCL 43.54
99% Chebyshev(Mean, Sd) UCL 52.69

Assuming Gamma Distribution
95% Approximate Gamma UCL 32.59
95% Adjusted Gamma UCL 33.02

Potential UCL to Use
Use 95% Approximate Gamma UCL 32.59

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Dioxin TEQ

General Statistics
Number of Valid Observations 22
Number of Distinct Observations 22

Raw Statistics
Minimum 5.37E-06
Maximum 0.00636
Mean 0.00143
Median 0.000593
SD 0.00189
Std. Error of Mean 0.0004019

Log-transformed Statistics
Minimum of Log Data -12.13
Maximum of Log Data -5.057
Mean of log Data -7.873
SD of log Data 2.231

Coefficient of Variation 1.32
Skewness 1.801

Relevant UCL Statistics

Normal Distribution Test
Shapiro Wilk Test Statistic 0.736
Shapiro Wilk Critical Value 0.911
Data not Normal at 5% Significance Level

Lognormal Distribution Test
Shapiro Wilk Test Statistic 0.886
Shapiro Wilk Critical Value 0.911
Data not Lognormal at 5% Significance Level

Assuming Normal Distribution
95% Student's-t UCL 0.00212
95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL (Chen-1995) 0.00225
95% Modified-t UCL (Johnson-1978) 0.00215

Assuming Lognormal Distribution
95% H-UCL 0.0428
95% Chebyshev (MVUE) UCL 0.0122
97.5% Chebyshev (MVUE) UCL 0.016
99% Chebyshev (MVUE) UCL 0.0235

Gamma Distribution Test
k star (bias corrected) 0.448
Theta Star 0.00319
MLE of Mean 0.00143
MLE of Standard Deviation 0.00213
nu star 19.69
Approximate Chi Square Value (.05) 10.63
Adjusted Level of Significance 0.0386
Adjusted Chi Square Value 10.13

Anderson-Darling Test Statistic 0.315
Anderson-Darling 5% Critical Value 0.808
Kolmogorov-Smirnov Test Statistic 0.112
Kolmogorov-Smirnov 5% Critical Value 0.196
Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution
95% Approximate Gamma UCL 0.00265
95% Adjusted Gamma UCL 0.00278

Data Distribution
Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics
95% CLT UCL 0.00209
95% Jackknife UCL 0.00212
95% Standard Bootstrap UCL 0.00209
95% Bootstrap-t UCL 0.00246
95% Hall's Bootstrap UCL 0.00243
95% Percentile Bootstrap UCL 0.00211
95% BCA Bootstrap UCL 0.00218
95% Chebyshev(Mean, Sd) UCL 0.00318
97.5% Chebyshev(Mean, Sd) UCL 0.00394
99% Chebyshev(Mean, Sd) UCL 0.00543

Potential UCL to Use

Use 95% Adjusted Gamma UCL 0.00278

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

HCX

General Statistics

Number of Valid Observations 4
Number of Distinct Observations 4

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable HCX was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Part II

INTERIM FINAL

Supplemental Baseline Human Health and Ecological Risk Assessment: Oxbow Area Floodplain Soil and Sediment

Centredale Manor Restoration Project Superfund Site North Providence, Rhode Island

Part II: Ecological Risk Assessment

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Battelle
The Business *of* Innovation

EXECUTIVE SUMMARY

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The Supplemental Baseline Human Health and Ecological Risk Assessment: Oxbow Area Floodplain Soil and Sediment, Part II: Ecological Risk Assessment (Supplemental BERA) presents an assessment of complete exposure pathways and ecological risks from exposure to chemicals that are potentially related to releases and subsequent contaminant migration from the Centredale Manor Restoration Project Superfund Site (hereinafter referred to as the "Site"), located in North Providence, Rhode Island. This Supplemental BERA supplements the *Interim Final Baseline Ecological Risk Assessment* that was previously performed at the Site (MACTEC, 2004) and is a follow-on investigation to the screening-level ecological risk assessment (SLERA) conducted for the Oxbow Area (Battelle and MACTEC, 2006). The Oxbow Area is a forested wetland area located immediately downstream of the Allendale Dam and approximately one-half mile downstream from the source area for the Site (Figure ES-1). The southernmost section of the wetland is characterized by scrub-shrub and emergent marsh habitat, most of which is submerged throughout the year and is extensively cut by small, unvegetated channels. The majority of the Oxbow Area lies to the west of the Woonasquatucket River and within the 100-year floodplain, and is bisected by a remnant of the former river channel. The abandoned channel previously received flow at its eastern end and flowed westward and then in a southerly direction to Lyman Mill Pond. Currently the channel remnant receives flow from flood waters overtopping the bank at the eastern side of the Oxbow and typically holds water averaging about a meter in depth.

Available information indicates that flooding of the Woonasquatucket River may have deposited contaminants released from the Site in and on the surficial soils and sediment in the Oxbow Area, potentially resulting in exposure of various ecological receptors, including wildlife, amphibians, macroinvertebrates, and plants that reside or forage in this relatively undisturbed habitat. Site-related contaminants include dioxin (particularly 2,3,7,8-tetrachlorodibenzo-*p*-dioxin [TCDD]), some pesticides, polychlorinated biphenyls (PCBs) (primarily Aroclor 1254), and selected inorganic analytes (Battelle, 2004a), and these contaminants have been detected at elevated levels (i.e., above typical background conditions) in the Oxbow Area (Battelle and MACTEC, 2006). Figure ES-2 shows the ecological conceptual site model (CSM) for the Oxbow Area; a Site-wide ecological CSM is presented in the BERA (MACTEC, 2004).

The SLERA conducted for the Oxbow Area (Battelle and MACTEC, 2006) determined that there is a potential for adverse effects to the soil macroinvertebrate community and to vermivorous mammal and bird populations (i.e., populations whose diet includes a significant percentage of earthworms) from exposure to dioxins (particularly 2,3,7,8-TCDD) and pesticides in floodplain soil and prey (MACTEC, 2004). The SLERA concluded that additional investigation was warranted to address uncertainties identified during the process, one of the most significant issues being the limited analytical data available to estimate contaminant exposures throughout the extensive Oxbow Area, leaving portions of the Oxbow Area completely uncharacterized. Additional data were collected in 2010 to (1) better characterize risks to ecological receptors from exposures to floodplain soil in the Oxbow Area using the same approach that was used for the SLERA (Battelle and MACTEC, 2006), and (2) characterize potential sediment exposures within the Oxbow Area for comparison with Allendale and Lyman Mill Pond exposures and cleanup goals proposed in the Feasibility Study (FS). Although Site-specific tissue and toxicity data are typically useful components of BERAs, existing data from the BERA are available for comparison (including characterization of ecological risks for floodplain habitat in other areas of the Site) and lessened the need for these data for this Supplemental BERA.

PROBLEM FORMULATION

The problem formulation establishes the ecological issues of concern. It includes the identification of: 1) contaminants of potential ecological concern (COPECs); 2) ecological populations potentially exposed to site-related contaminants in environmental media (e.g. floodplain soil); 3) exposure pathways (e.g., ingestion of contaminated prey); and 4) exposure levels of COPECs that ecological receptors may receive through the identified exposure pathways.

Summary of Data. This Supplemental BERA is based on floodplain soil data collected at the Site to support the Remedial Investigation (RI) and Feasibility Study (FS) reports (Battelle, 2004a and 2010) and on additional floodplain soil and sediment data collected in 2010 to support characterization of the nature and extent of contamination in the Oxbow Area. Data used for this Supplemental BERA were collected from 73 locations (15 sediment locations and 58 floodplain soil locations) within the Oxbow Area and similar nearby wetland areas within the Lyman Mill Pond floodplain. Sediment data was collected from sampling locations within the small channels throughout the scrub-shrub and emergent marsh habitat at the southern end of the Oxbow Area. Sampling and analysis within the Oxbow Area detected dioxin (particularly 2,3,7,8-TCDD), some

pesticides, and selected inorganic analytes that are elevated above typical background conditions (Battelle, 2004a). These results are consistent with the findings from other areas within the Site, as described in the Interim Final BERA (MACTEC, 2004).

Refinement of COPECs. The SLERA for the Oxbow Area used data from seven floodplain soil samples to evaluate risks to ecological receptors. The COPECs identified included inorganic compounds (metals), pesticides, PCBs (Aroclors), polycyclic aromatic hydrocarbons (PAHs) and dioxins and furans. For this Supplemental BERA, the COPECs were refined using the expanded data set described above based on a comparison of maximum detected concentrations in floodplain soil and sediment samples to ecological screening benchmarks. COPECs selected for the environmental media evaluated include the following:

- Floodplain soil: inorganic compounds, pesticides, PCBs (Aroclors), PAHs, and dioxins and furans.
- Earthworm tissue: inorganic compounds, pesticides, PCBs (Aroclors), and dioxins and furans
- Sediment: inorganic compounds, pesticides, PCBs (Aroclors), PAHs, and dioxins and furans.

Consistent with the CSM presented in the Oxbow Area SLERA (Battelle and MACTEC, 2006), which describes a linkage among the historical source area and contaminated upgradient Woonasquatucket River sediments and Oxbow Area floodplain soils, the Oxbow Area COPECs are comparable to those identified in the BERA (MACTEC, 2004).

Potential Ecological Receptors. Potential ecological receptor species considered in this Supplemental BERA include floodplain soil and aquatic macroinvertebrates, amphibians, birds, and terrestrial mammals that may utilize the Oxbow Area habitat. Aquatic macroinvertebrates and amphibians may be directly exposed to contaminants in sediment. Soil macroinvertebrates and wildlife may be exposed to contaminants in floodplain soil directly or by ingesting contaminated prey. Consistent with the BERA, exposures by floodplain plant species were considered to be of secondary concern and were not evaluated in this Supplemental BERA.

Species representing various trophic levels were selected as representative receptor species to evaluate the assessment endpoints developed for this Supplemental BERA. The selected species are intended to be representative of other species at the same trophic level that share similar ecological characteristics. These groups of species are generally referred to as guilds. By

evaluating a representative member of a guild and by accounting for the predominant guilds, the uncertainty associated with missing an important species group or pathway is reduced. In addition to the general category of floodplain soil and aquatic macroinvertebrates, the following terrestrial wildlife receptors of concern were evaluated in this Supplemental BERA:

- Vermivorous birds (represented by the American woodcock)
- Vermivorous mammals (represented by the short-tailed shrew)
- Omnivorous mammals (represented by the raccoon)

Ecological Exposure Pathways. Ecological receptors may be exposed to site-related contaminants via a variety of exposure pathways. A complete exposure pathway involves a potential for contact between a given receptor and contamination either through direct exposure to an abiotic medium or indirectly through prey consumption. Pathways are evaluated by considering information on contaminant fate and transport, ecosystems potentially affected, and the magnitude and extent of contamination (USEPA, 1997).

This Supplemental BERA evaluates the following three exposure pathways: 1) direct contact with floodplain soils and Oxbow Area sediment by macroinvertebrate receptors; 2) ingestion of biota by vermivorous and omnivorous wildlife receptors; and 3) incidental ingestion of floodplain soil by wildlife receptors.

Because of difficulty accessing aquatic habitats within the Oxbow Area scrub-shrub and emergent marsh, fish exposures are expected to be limited to early life stages and small fish. This area is covered by dense vegetation and is inundated or saturated throughout most of the year, limiting access and use by wildlife receptors. Therefore, direct exposure of aquatic macroinvertebrates is considered to be the most significant exposure pathway for Oxbow Area sediments.

Ecotoxicology of Selected COPECs. The BERA (MACTEC, 2004) summarized the available toxicological literature for all classes of compounds identified as COPECs for each receptor category evaluated in this Supplemental BERA (macroinvertebrates, birds, and mammals). Consistent with the BERA, a toxic equivalency (TEQ) approach (Van den Berg et al., 1998, 2005) was employed for this Supplemental BERA to overcome the difficulty in assessing the overall toxicity of complex dioxin mixtures. Specific toxicity equivalency factors (TEFs) have been developed for humans/mammals, birds, and fish. A TEF is a congener-specific weighting term used to express the concentration of a dioxin or furan congener in terms of a toxicologically equivalent concentration of 2,3,7,8-TCDD (considered to be the most toxic

congener). TEFs for dioxin and furan congeners range from 0.0001 (e.g., octachlorodibenzodioxin [OCDD]) to 1 (e.g., 2,3,7,8-TCDD) (Van den Berg, et al., 1998, 2005). A TEQ concentration is derived for a given environmental sample by summing the products of the individual congener concentrations and their corresponding TEFs. The TEQ values presented in this Supplemental BERA are reported as the sum of dioxin and furan congeners.

Analytical chemistry data for PCB congeners in floodplain soil are only available for two sample locations, and TEQs were not calculated for this class of compounds. Instead, PCBs were evaluated as Aroclors. In addition, only a few floodplain soil samples were analyzed for hexachloroxanthene (HCX), and HCX was not evaluated in this Supplemental BERA; however, chemical structure and potential mode of toxic action of this Site-related compound are similar to dioxin and furan compounds, which were evaluated. Hexachloroxanthene is estimated to have a TEF of approximately 10^{-6} based on an Ah-receptor affinity screening bioassay performed by the Woods Hole Oceanographic Institute laboratory of Dr. Mark Hahn (MACTEC 2004). Consequently, the BERA concluded that HCX and PCB congeners contribute far less than 2,3,7,8-TCDD to the overall risks posed to ecological receptors at the Site (MACTEC, 2004).

Assessment Endpoints and Measures of Effects. The assessment endpoints evaluated in this Supplemental BERA consist of the following:

1. Protection and maintenance (i.e., survival, growth, reproduction) of floodplain macroinvertebrate communities which serve as a forage base for wildlife.
2. Protection and maintenance of vermivorous mammal and bird populations.
3. Protection and maintenance of omnivorous mammal populations.
4. Protection and maintenance (i.e., survival, growth, reproduction) of aquatic macroinvertebrate communities which serve as a forage base for aquatic fish and wildlife.

Risk questions and measures of effects were identified for each of these four assessment endpoints:

Assessment Endpoint 1: Protection and maintenance (i.e., survival, growth, reproduction) of floodplain macroinvertebrate communities (as represented by the earthworm), which are a forage base for wildlife.

The following risk questions were established for this assessment endpoint:

- Do concentrations of COPECs in floodplain soil exceed appropriate guidelines for the

protection of floodplain soil macroinvertebrate populations?

- Do modeled concentrations of COPECs in the tissues of floodplain soil macroinvertebrates (such as earthworms) exceed benchmarks for residue effects on survival, growth, or reproduction?

The following measures of effects were selected to evaluate risk to this endpoint receptor group:

- Comparison of floodplain soil COPEC concentrations to benchmarks/guidelines.
- Comparison of estimated COPEC concentrations in floodplain soil macroinvertebrates to critical body residues (CBRs).

Assessment Endpoint 2: Protection and maintenance of vermivorous mammal populations (as represented by the short-tailed shrew) and bird populations (as represented by the American woodcock).

The following risk questions were established for this assessment endpoint:

- Do ingestion doses of COPECs in vermivorous wildlife exceed toxicity reference values (TRVs) or TEQs for adverse effects on survival, growth, or reproduction?
- Do residues of COPECs in eggs and/or tissues of vermivorous wildlife exceed benchmarks for adverse effects on survival, growth, reproduction, or embryo development?

The following measures of effects were selected to evaluate risk to this endpoint receptor group:

- Comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs.
- Comparison of estimated vermivorous wildlife tissue and egg residues with Site-specific CBR data.

Assessment Endpoint 3: Protection and maintenance of omnivorous mammal populations (as represented by the raccoon).

The following risk question was established for this assessment endpoint:

- Do ingestion doses of COPECs in omnivorous wildlife exceed TRVs or TEQs for adverse effects on survival, growth, or reproduction?

The following measure of effects was selected to evaluate risk to this endpoint receptor group:

- Comparison of estimated ingestion doses in omnivorous wildlife with TRVs and TEQs.

Assessment Endpoint 4: Protection and maintenance (i.e., survival, growth, reproduction) of aquatic macroinvertebrate communities which are a forage base for aquatic fish and wildlife.

The following risk questions were established for this assessment endpoint:

- Do concentrations of COPECs in Oxbow Area sediment exceed appropriate guidelines for the protection of benthic macroinvertebrate populations?

The following measure of effects was selected to evaluate risk to this endpoint receptor group:

- Comparison of Oxbow Area sediment COPEC concentrations to screening-level benchmarks.

No assessment endpoints were developed for fish and aquatic wildlife exposures to Oxbow Area sediment due to conditions that likely limit use of the scrub-shrub habitat where the majority of Oxbow Area sediments is located. Although aquatic macroinvertebrates, early life stages for fish, amphibians, and small fish may have exposure to Oxbow Area sediments, the dense vegetation and saturated conditions within the scrub-shrub and emergent marsh habitat either restricts or significantly limits access and use by wildlife and larger fish. Furthermore, the primary concern for this Supplemental BERA was to compare concentrations of contaminants in Oxbow Area sediments with concentrations in Lyman Mill Pond sediments, as there may be a potential for transport of sediment between the Oxbow Area and the pond. For this Supplemental BERA, concentrations of COPECs in Oxbow Area sediment were compared with risk-based screening benchmarks to determine whether Oxbow Area sediments pose risk to aquatic receptors, particularly aquatic macroinvertebrates. COPEC concentrations were also compared to those identified for Lyman Mill and Allendale Pond sediments, to determine how exposures vary among these habitats, and to proposed cleanup goals (Battelle, 2010), to determine whether sediment concentrations within the Oxbow Area exceed cleanup goals for the Site that have been established based on the BERA and background levels.

EXPOSURE ASSESSMENT

The primary objectives of the exposure assessment for this Supplemental BERA were to more fully characterize the relevant exposure area and estimate relevant exposure concentrations. A single exposure area, the Oxbow Area, was evaluated in this Supplemental BERA, whereas the BERA conducted for the Site-wide assessment evaluated four additional exposure areas (the Allendale Pond, Lyman Mill Pond, Manton Pond, and the former Dyerville Pond exposure areas),

along with an upstream background area (Greystone Mill Pond) and a reference area (Assapumpset Pond and Brook). The BERA exposure areas are referenced in this Supplemental BERA as necessary to place the ecological findings in the general spatial context of the CSM and, to the extent possible, to provide an integrated risk analysis.

Maximum concentrations of COPECs were used to estimate risks to macroinvertebrates from direct exposure to COPECs in floodplain soil and Oxbow Area sediments. For each COPEC identified, the 95 percent upper confidence limit (95% UCL) of the arithmetic mean concentration in floodplain soil samples was also estimated to derive an exposure point concentration (EPC) for the wildlife exposure assessment. EPCs were also developed for biological tissue by multiplying sediment EPCs by Site-derived uptake factors as described in the Oxbow Area SLERA (Battelle and MACTEC, 2006) to estimate risks from body burdens of COPECs and ingestion of contaminated prey. Estimated daily intake of COPECs for wildlife were calculated as the daily dose received from each environmental exposure medium from the incidental ingestion of sediment and ingestion of contaminated prey pathways.

EFFECTS ASSESSMENT

The purpose of the effects assessment is to characterize the relationship between the exposure concentration or dose of COPEC administered or received and the incidence of adverse effects in the ecological endpoint receptor at the appropriate level of ecological organization (usually population- or community-level). The information used to estimate the potential for adverse ecological effects for this Supplemental BERA are consistent with those used for the Oxbow Area SLERA (Battelle and MACTEC, 2006). This includes site-specific measures of effects derived specifically for the BERA but which are also relevant to the evaluation of the Oxbow Area.

SUMMARY OF UNCERTAINTIES

Table ES-1 summarizes the major sources of uncertainty identified for this Supplemental BERA. Uncertainties that likely resulted in risk estimates being underestimated include:

- Lack of evaluation of floodplain plant exposures;
- Limited evaluation of seasonal aquatic exposures (e.g., aquatic macroinvertebrates, amphibians);
- Lack of or limited analytical floodplain soil data for certain chemical groups evaluated in the BERA, including HCX and coplanar PCBs; and,
- Lack of toxicity benchmark values and uptake factors (i.e., bioaccumulation factors) for some COPECs.

Uncertainties that may have resulted in the risk estimates being overestimated include:

- Assumption that complete exposure pathways and suitable habitat for vermivorous wildlife exist;
- Potential sampling bias to more depositional locations within the area for sampling events prior to 2010;
- Unclear functional relationship between the measurement and assessment endpoints (i.e., it is unclear how observed effects are related to the degree to which effect concentrations are exceeded by exposure concentrations, body burdens, and exposure doses).

Uncertainties that may have resulted in either an under- or overestimate of risk include:

- The potential that concentrations of contaminants do not accurately represent exposure concentrations.

Overall, it is believed that the risk estimates reasonably represent ecological exposures to most Site-related contaminants. However, the approach is still somewhat conservative and may have overestimated risks for the COPECs evaluated, particularly for soil invertebrate exposures.

SUMMARY OF MAJOR FINDINGS

Table ES-2 summarizes the results of this Supplemental BERA for each of the assessment endpoints. A summary of the ecological risks from exposure to floodplain soil at Lyman Mill Pond (LPX), Allendale Pond (APB), and Greystone Mill Pond (GMP) reported for the BERA are presented as well for comparison with the Oxbow Area (OXB). The findings are summarized as follows:

Assessment Endpoint 1, Protection and Maintenance of the Floodplain Soil Invertebrate Community.

- Based on a comparison of maximum and average floodplain soil concentrations to invertebrate screening benchmarks, the soil macroinvertebrate community occurring within the Oxbow Area may be at risk of harm due to direct exposure to pesticides (including 4,4'-DDT, 4,4-DDE, 4,4'-DDD, dieldrin, lindane (gamma-chlordane), and endrin), metals (including chromium, copper, manganese, mercury, vanadium, zinc, and potentially aluminum) and PAHs in floodplain soil. Risk is similar to direct exposure risks for soil macroinvertebrates in Allendale Pond floodplain soils and two times lower than those estimated in the BERA for Lyman Mill Pond. Risks to soil macroinvertabrates at all three areas are below background risks at Greystone Mill Pond.
- Body burdens of bioaccumulated metals, primarily cadmium, lead, manganese, nickel, vanadium, and zinc appear to pose a substantial risk of harm to soil macroinvertebrates. However, risks are substantially lower than risks from body burdens of metals for soil macroinvertebrates exposed to floodplain soil at Allendale Pond, Lyman Mill Pond, and Greystone Mill Pond estimated for the BERA.

- An evaluation of the soil invertebrate community study conducted to support the BERA suggests that the invertebrate fauna is most likely comparable to other exposure areas at the Site and is not distinguishable from the upriver background area.

Assessment Endpoint 2, Protection and Maintenance of Vermivorous Wildlife Populations.

- Vermivorous mammal and bird populations that occur within the Oxbow Area appear to be at risk of harm due to direct exposure to Site-related contaminants in floodplain soil and prey items. 2,3,7,8-TCDD is the most substantial contributor to the estimated total risks to vermivorous mammals. Pesticides are the most substantial contributor to the estimated total risks to vermivorous birds, followed by 2,3,7,8-TCDD. In addition, based on modeled tissue concentrations, consumption of contaminated earthworm prey may result in elevated tissue residues in these receptors, potentially resulting in adverse reproductive effects (i.e., bioaccumulation hazard). Although risks to vermivorous wildlife in the exposure areas evaluated for the BERA are also from exposure to dioxins and metals, risks from dietary exposure estimated for Allendale Pond and Lyman Mill Pond for the BERA are up to two times lower than risks at the Oxbow Area. Risks to vermivorous mammals in the Oxbow Area are 2.5 times higher than background; however, risks to vermivorous birds are similar to background.
- Modeled tissue burdens pesticides and 2,3,7,8-TCDD in avian eggs and 2,3,7,8-TCDD in mammal liver tissue as a result of potential dietary exposures pose a substantial risk of harm to vermivorous wildlife species. Risks are similar to those at Allendale Pond, but are two to three times higher than previously estimated risks from exposure to Lyman Mill Pond sediment. Estimated background risks are insignificant.

Assessment Endpoint 3, Protection and Maintenance of Omnivorous Wildlife Populations.

- Omnivorous mammal populations that forage within the study area are not at substantial risk of harm from exposure to Site-related contaminants in floodplain soil and terrestrial prey items. This is consistent with risks from exposure to Allendale Pond and Lyman Mill Pond floodplain soil estimated for the BERA.

Assessment Endpoint 4, Protection and Maintenance of the Aquatic macroinvertebrate Community.

- Based on a comparison of maximum and average Oxbow Area sediment concentrations to screening benchmarks, the aquatic macroinvertebrate community occurring within the Oxbow Area may be at risk of harm due to exposure to dioxins/furans, pesticides (including dieldrin, lindane, chlordane, endosulfan, 4,4-DDE, 4,4'-DDD, and 4,4'-DDT), PCBs (primarily Aroclors 1254 and 1268), metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, silver, vanadium, and zinc), and PAHs in Oxbow Area sediments.

Oxbow Area Sediment Evaluation.

- The same COPECs were identified for Oxbow Area sediments as for Oxbow Area floodplain soil and Lyman Mill Pond sediments.

- Except for metals, concentrations of COPECs in Oxbow Area sediments for at least half of the sample locations are higher than mean or median concentrations in Allendale and Lyman Mill Pond sediments. For example, 2,3,7,8-TCDD concentrations were approximately three times higher in Oxbow Area sediment than in Lyman Mill Pond sediments and twice as high as concentrations in Allendale Pond sediments, suggesting that the Oxbow Area scrub-shrub habitat is a net depositional environment and has a potential to serve as a sink for sediment-bound contaminants.
- Mean concentrations of 2,3,7,8-TCDD, dioxin TEQs, dieldrin and Aroclor 1254 exceed proposed sediment cleanup goals (Battelle, 2010); however, concentrations of other contaminants that are key risk drivers in sediment do not.

NEXT STEPS

The RI and FS for the Site have been completed (Battelle, 2005 and 2010). In support of the FS, preliminary remediation goals (PRGs) have been estimated for COPECs posing an incremental risk to wildlife. Following an evaluation of the applicability of the existing ecological PRGs for floodplain habitats, specific PRGs for the Oxbow Area may be discussed in further detail in a separate document. The calculated risks for the reference area and background area will also be a consideration in the derivation of PRGs and the selection of remedial alternatives. The results of the RI/FS will be used to formulate a Proposed Plan for the Site, including the Oxbow Area. The Proposed Plan will recommend remedial actions that will result in overall protection of human health and the environment, fulfill Superfund requirements, be acceptable to stakeholders, and satisfy USEPA remedial guidelines.

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TABLE ES-1. SUMMARY OF UNCERTAINTIES.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under-estimation (-) of Risk	Rationale
Problem Formulation		
Selection of Receptors of Concern	+	The urbanized and industrialized nature of the landscape in the vicinity of the Oxbow Area may limit habitat suitability for sensitive receptors such as the American woodcock
	-	Plants were not specifically evaluated in the Addendum. Although inorganic analytes were generally consistent with upgradient background concentrations, reported levels in floodplain soils could adversely affect these receptors.
	-	The Oxbow Area was considered to provide primarily floodplain (i.e., terrestrial) habitat for ecological receptors. However, seasonal ponding could result in exposures to aquatic invertebrates and amphibians. These exposures were not evaluated because surface water data are not available.
	+	The availability of soil invertebrates as a forage base for vermivorous wildlife was assumed but not verified. Depositional regions of the Oxbow Area may contain saturated hydric soils for sufficient periods of time to exclude or reduce the numbers of soil invertebrates. In these areas, the bioaccumulation hazard to vermivorous wildlife would be less than assumed.
Identification and Selection of COPECs	-	HCX and coplanar PCBs were not included in the analytical parameters for soil samples collected at the Oxbow Area. Although this may result in exposures (and hazards) being under-estimated, it is unlikely that the risk conclusions drawn would have been significantly affected had these additional data been available. Based on the toxicological assessment conducted in the BERA, HCX and coplanar PCBs are most likely relatively poor aryl hydrocarbon (Ah) receptor agonists compared to TCDD and exposure to the most elevated concentrations detected in Centredale Site media posed minimal ecological risk. TCDD is the risk driver.
	+	It is assumed that measured concentrations of contaminants in soil are 100% bioavailable. This could lead to identification of chemicals as COPECs even if they are not available for exposure and uptake. For example, even at concentrations detected onsite, aluminum is not bioavailable and toxic at soil pH above 5.0.

TABLE ES-1. SUMMARY OF UNCERTAINTIES.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under-estimation (-) of Risk	Rationale
Exposure Assessment		
Measured Concentrations of Contaminants	+/-	Inaccuracies in analytical measurements due to sample moisture content, instrument calibration exceedences and spatial heterogeneity in the field could result underestimating or overestimating exposure concentrations.
Exposure Parameters	+/-	Uncertainty is inherent in the use of literature-derived exposure parameters because they were not empirically measured at the site. The general use of conservative values likely resulted in wildlife hazards being over-estimated.
Exposure Concentrations	+/-	There is a possibility that ecological receptors may preferentially utilize areas of higher habitat quality (i.e., better food or other resources) or avoid areas where resources are limited. Because of the heterogeneous distribution of contaminant concentrations in the floodplain, it is possible that preferential use or avoidance of some areas could result in higher or lower exposures to contaminants, depending on COPEC concentrations at those locations. Furthermore, measured concentrations of contaminants represent exposures within the 0 - 4, 0 - 6 and 0 - 12 inch soil horizon. There may be differences in concentrations on a finer scale over depth such that layers of higher concentrations occur deeper or closer to the surface. Because most ecological exposures occur closer to the surface, invertebrates or wildlife receptors may be exposed to concentrations that are higher or lower than those measured for the depth intervals sampled. Also, while exposures for burrowing soil invertebrates may be integrated across this soil horizon, exposures for leaf litter invertebrates and wildlife receptors is limited to the upper layers. If there are differences in contamination between finer resolution layers within the 0 – 1-foot soil horizon, this could result in an overestimate of risk if contamination is greater in deeper soil layers or an underestimate of risk if contamination is greater (i.e., more concentrated) in surface soil layers. This also reflects on the accuracy of the site-specific biota-soil accumulation factors (BSAFs), and BSAFs could be higher or lower depending on whether measured soil concentrations used for developing the BSAFs represent actual earthworm exposures. Consequently, these uncertainties are carried through the exposure models in the estimates of exposures through the incidental ingestion of soil and the ingestion of soil invertebrates, for which body burdens of COPECs are estimated using site-specific BSAFs.

TABLE ES-1. SUMMARY OF UNCERTAINTIES.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under-estimation (-) of Risk	Rationale
Exposure Assessment		
Exposure Concentrations	+/-	Earthworm tissue concentrations were estimated using BSAFs that were normalized based on the average organic carbon concentration detected in the 2010 Oxbow Area floodplain soils. Floodplain soil carbon content is variable (1 -36%); the average is almost 8 times the minimum value and use of the average TOC would have resulted in estimated earthworm tissue concentrations being reduced by this same factor. Conversely, the average is also more than 4 times less than the maximum concentration, and bioaccumulation under conditions of greater TOC would result in lower body burdens.
Bioaccumulation Factors	-	The lack of soil/plant uptake factors for TCDD may have resulted in an underestimation of dietary exposures to omnivorous wildlife (raccoon).
	-	The lack of BMFs necessary to estimate wildlife tissue concentrations for certain COPECs may have resulted in an underestimation of risks.
Effects Assessment		
Toxicity Reference Values	+	The use of conservative application factors to derive benchmark doses may have resulted in risks being over-estimated for some COPECs.
	-	Avian toxicological data for antimony and cobalt were not available and, as a result, potential risks for these COPECs could not be quantified.
	+/-	CBRs were not available for all COPECs. In addition, the relatively high percentage of studies reporting unbounded results contributed significant uncertainty to the residue-based analysis. The general methodology employed likely resulted in the selection of conservative measures of effect.
Dioxin, Furan, and PCB Congeners	-	The TEQ approach does not explicitly account for antagonistic or synergistic interactions between congeners and may underestimate risk to wildlife; however, because TCDD was the primary risk driver this uncertainty is likely of little consequence.
Risk Characterization		
Hazard Quotients/ Hazard Indices	+/-	Uncertainty exists regarding the interpretation of the HQ or HI value of one as a definitive indicator of population level impacts to wildlife. The magnitude of this uncertainty is bounded because the likelihood of classification errors in the evaluation of the assessment endpoints based on the results of the risk characterization decreases as hazard ratios become smaller or greater than one.

TABLE ES-2. SUMMARY OF ECOLOGICAL RISKS WITHIN THE OXBOW AREA AND OTHER EXPOSURE AREAS[a]

Receptor	Contaminant Group	Hazard Indicies[b]							
		OXB		LPX		APB		GMP	
		NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Soil invertebrates (soil screen)[a]	Pesticides	62		24		51		29	
	PCBs	-		-		-		-	
	Metals	94		150		37		620	
	Dioxin TEQ	-		-		-		-	
	SVOCs (PAHs)	- (13)[c]		57 (12)		78 (13)		210 (41)	
	Total	170		230		170		850	
Soil invertebrates (tissue screen)[a]	Pesticides	-	-	-	2.2	-	4.8	-	2.1
	PCBs	-	-	-	-	-	-	-	-
	Metals	770 (30)[d]	120 (18)[d]	2400	460	4400	700	2700	490
	Dioxin TEQ	-	-	-	-	-	-	-	-
	Total	770 (30)[d]	120(18)[d]	2400	460	4400	710	2700	490
Short-tailed shrew (dietary exposure)	Pesticides	-	-	-	-	-	-	-	-
	PCBs	-	-	-	-	-	-	-	-
	Metals	160	16	58	9.8	43	5.9	92	12
	TEQ/TCDD	190	19	38	3.8	140	14	4.2	-
	Total	350	37	110	16	200	22	130	16
Short-tailed shrew (liver residues)[a]	Pesticides	-	-	-	-	-	-	-	-
	Dioxin TEQ	14	8.9	4.2	2.8	19	13	-	-
	Total	14	8.9	7.0	4.6	19	13	2.0	1.3
American woodcock	Pesticides	22	2.2	-	-	-	-	-	-
	PCBs	-	-	-	-	-	-	-	-
	Metals	11	1.5	22	3	9.7	1.4	33	5.2
	TEQ/TCDD	13	1.3	2.5	-	7.1	-	-	-
	Total	49	5.9	31	4.3	22	3.1	41	6.7
Vermivorous birds (egg residues)[a]	Pesticides	-	2.6	-	1.4	-	-	-	-
	Dioxin TEQ	31	1.8	8.6	-	45	2.6	-	-
	Total	31	4.4	10	1.9	45	3	-	-
Raccoon	Pesticides	-	-	-	-	-	-	-	-
	PCBs	-	-	-	-	-	-	1.1	-
	Metals	-	-	-	-	-	-	10	1.5
	TEQ/TCDD	2.1	-	-	-	-	-	-	-
	Total	3.3	-	-	-	-	-	14	2.3

a. Exposure areas include the Oxbow (OXB), Lyman Mill Pond (LPX), Allendale Pond (APB), and Greystone Mill Pond (GMP); the latter represents an upgradient background area not impacted by the Source Area.
b. Hazard indices (HI) based on average COPEC concentrations at the Oxbow Area.
c Only risks from exposure to PAHs were evaluated for the Oxbow Area.
d HI without the HQ for aluminum.
\- Indicates that the HI is below 1.

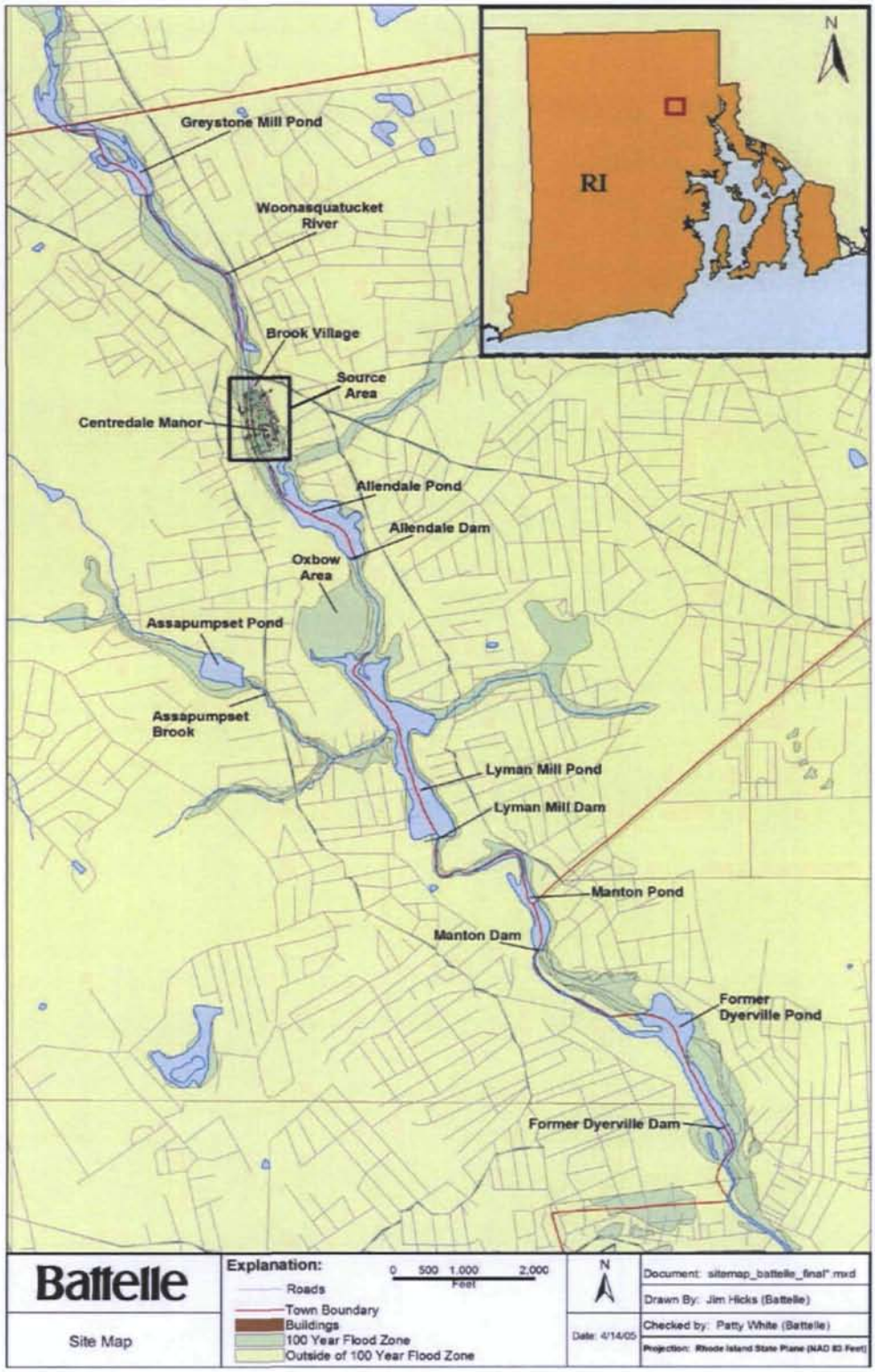

Figure ES-1. Site Locus Map
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

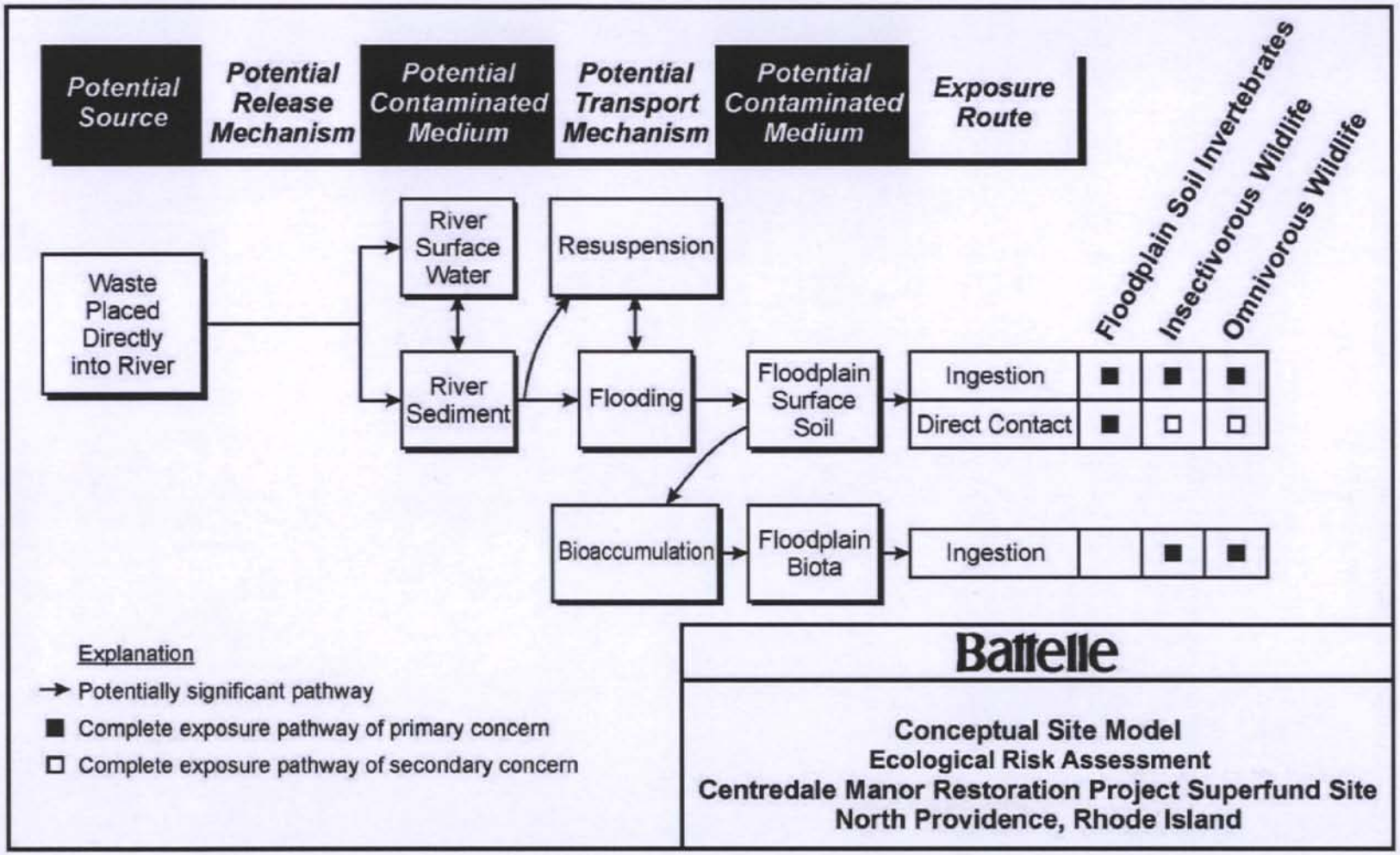

Figure ES–2. Conceptual Site Model
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North Providence, Rhode Island

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ACRONYMS AND ABBREVIATIONS

Ah	Aryl hydrocarbon
APB	Allendale Pond
BAF	Bioaccumulation factor
BERA	Baseline Ecological Risk Assessment
bgs	Below ground surface
BHC	Benzene hexachloride
BHHRA	Baseline Human Health Risk Assessment
BMF	Biomagnification factor
BSAF	Biota-soil accumulation factor
BW	Body weight
CBR	Critical body residue
CMRP	Centredale Manor Restoration Project
COPEC	Contaminant of potential ecological concern
CSM	Conceptual Site Model
dw	dry weight
DYR	Dyerville
Eco-SSL	Ecological Soil Screening Level
EDI	Estimated daily intake
EPC	Exposure point concentration
ER-L	Effects range-low
ERAGS	Ecological Risk Assessment Guidance for Superfund
FS	Feasibility Study
ft	Foot
GMP	Greystone Mill Pond
HCX	Hexachloroxanthene
HI	Hazard index
HMW	High molecular weight
HQ	Hazard quotient
INCHEM	International Chemical Program
IRIS	Integrated Risk Information System
LC_{50}	Lethal concentration to cause mortality to 50% of test organisms
LEL	Lowest effect level
LMW	Low molecular weight
LOAEL	Lowest observable adverse effects level

LPX	Lyman Mill Pond
MAP	Manton Pond
mg/kg	milligrams per kilogram
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No observable adverse effects level
OCDD	Octachlorodibenzodioxin
OME	Ontario Ministry of the Environment
ORNL	Oak Ridge National Laboratory
PAHs	Polycyclic aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PeCDF	pentachlorodibenzofuran
pg/g	picograms per gram
PRG	Preliminary remediation goal
QA	Quality assurance
RI	Remedial Investigation
RIDEM	Rhode Island Department of Environmental Management
SLERA	Screening Level Ecological Risk Assessment
SQC	Sediment quality criteria
SUF	Site use factor
SVOC	Semi-volatile organic compound
TCDD	Tetrachlorodibenzo-*p*-dioxin
TEF	Toxic equivalency factor
TEQ	Toxic equivalency
TMDL	Total maximum daily load
TOC	Total organic carbon
TRV	Toxicity reference value
µg/g	micrograms per gram
µg/kg	micrograms per kilogram
UCL	Upper confidence limit
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VOC	Volatile organic compound
ww	wet weight

MAIN REPORT

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) Region I and U.S. Army Corps of Engineers, New England District (USACE) are preparing this Supplemental Baseline Ecological Risk Assessment (BERA) for the Oxbow Area at the Centredale Manor Restoration Project Superfund Site located on the Woonasquatucket River in North Providence, Rhode Island (hereinafter referred to as "the Site"). Although the BERA (MACTEC, 2004) evaluated floodplain habitat associated with Lyman Mill Pond, the possibility that flood stage conditions could periodically result in river water overtopping the western bank of the Woonasquatucket River below Allendale Dam was not fully appreciated until after the BERA had been developed. Consequently, ecological exposures within the Oxbow Area were not identified in the original Conceptual Site Model (CSM), and ecological (and human health) risks in this area were not evaluated as part of that investigation.

A Screening Level Ecological Risk Assessment (SLERA) conducted for the Oxbow Area (Battelle and MACTEC, 2006) determined that there is a potential for adverse effects to the soil macroinvertebrate community and to vermivorous mammal and bird populations (i.e., populations whose diet includes a significant percentage of earthworms) from exposure to dioxins (particularly 2,3,7,8-tetrachlorodibenzo-*p*-dioxin [TCDD]) and pesticides in floodplain soil and prey. Maximum analytical concentrations of contaminants were compared to conservative screening benchmarks to confirm that the contaminants of potential ecological concern (COPECs) for the Oxbow Area are comparable to those identified in the Interim Final BERA (MACTEC, 2004), and complete exposure pathways and receptors of concern were identified. The SLERA concluded that additional investigation was warranted to address uncertainties identified during the process, one of the most significant issues being the limited analytical data available to estimate contaminant exposures throughout the extensive Oxbow Area, leaving portions of the Oxbow Area completely uncharacterized.

This Supplemental BERA is being conducted as a follow-on investigation to better characterize ecological risks from exposures to Site-related contaminants that have migrated to the Oxbow Area and to supplement the Interim Final BERA. Additional data were collected in 2010 to (1) better characterize risks to ecological receptors from exposures to floodplain soil in the Oxbow Area, (2) characterize potential sediment exposures within the Oxbow Area, and (3) compare concentrations of contaminants in Oxbow Area sediments with concentrations in

Allendale and Lyman Mill Pond and cleanup goals proposed in the Feasibility Study (FS). The approach used in this Supplemental BERA follows elements of the USEPA guidance for ecological risk assessment, *Ecological Risk Assessment Guidance for Superfund, Process Document for Designing and Conducting Ecological Risk Assessments* (ERAGS) (USEPA, 1997). The scope and objective of this effort involved more fully characterizing ecological risks in the Oxbow Area using the additional data collected in 2010. Although Site-specific tissue and toxicity data are typically useful components of BERAs, existing data from the BERA are available for comparison (including characterization of ecological risks for floodplain habitat in other areas of the Site) and lessened the need for these data for this Supplemental BERA.

In accordance with USEPA guidance, this Supplemental BERA, which includes elements of ERAGS Steps 3 through 7, presents the problem formulation, including the CSM, ecological receptors, and exposure pathways. The available data from the Oxbow Area are then summarized and compared to ecological screening benchmarks to identify the COPECs. Each assessment endpoint is evaluated and potential risk is summarized. Finally, the uncertainties associated with the risk assessment are discussed. The groundwork for the BERA has already been laid in the Oxbow Area SLERA (Battelle and MACTEC, 2006). The approach for the SLERA provides the framework for this Supplemental BERA, and the details of the approach are not reintroduced. For details on the problem formulation and risk evaluation, refer to the SLERA (Battelle and MACTEC, 2006).

2.0 PROBLEM FORMULATION

The problem formulation establishes the goals, scope, and major issues for consideration in the risk assessment (USEPA, 1997; 1998). Although the majority of specific information on the environmental setting and resources potentially at risk, the selection of COPECs and receptors of concern, a CSM with complete exposure pathways, and assessment endpoints and measures of effects are presented elsewhere (Battelle and MACTEC, 2006), information specific to this Supplemental BERA are presented below.

2.1 ENVIRONMENTAL SETTING

This Supplemental BERA focuses on the Oxbow Area floodplain within the Site (Figure 1). The area covers approximately 27 acres and is characterized as a palustrine forested wetland dominated by mature red maple (*Acer rubrum*) bordered to the south by fringing palustrine emergent and scrub-shrub wetland habitats. Although approximate acreage for the palustrine forested and emergent wetland habitat types has not been measured, the USACE New England District has conducted a wetland delineation and functional assessment of the Oxbow Area (USACE, 2008), which provided acreage estimates (summarized in Table 2-5 of the FS report [Battelle, 2010]). According to USACE (2008):

> ...the Oxbow is among the largest areas of forested riparian habitat remaining along the Woonasquatucket River downstream of the Smithfield town line. The vegetated wetlands exhibit functions that are typical of freshwater palustrine systems. The most important function provided by the Oxbow wetlands is wildlife habitat. Other wetland functions and values provided by the wetlands to a notable degree include flood flow alteration, fish habitat, sediment/toxicant reduction, nutrient removal/transformation, production export, uniqueness/heritage value, and carbon sequestration.

Some small potential vernal pools are also located within the Oxbow; as described in the USACE (2008) report, although these pools lack some of the features characteristic of classic vernal pools they may be permanent fishless pools as defined by Colburn (2004). Because fish are excluded from these types of habitats (either because of their ephemeral nature or the lack of connectivity with larger aquatic habitat), they are important to regionally rare animals such as salamanders and certain invertebrates, whose aquatic stages are susceptible to fish predation.

The sediment substrate found in the palustrine emergent and scrub-shrub wetland habitats consists of Adrian muck in depressions and drainage channels within an outwash plain. Dominant vegetation around the depressions and drainage channels associated with the scrub-shrub habitat includes dogwood (*Cornus amomum*) and black willow (*Salix nigra*), with some yellow birch (*Betula alleghaniensis*) and gray birch (*Betula populifolia*) found at slightly higher elevations. The palustrine emergent wetland is dominated by jewel weed (*Impatiens capensis*), smart weed (*Polygonum* spp.), nettle (*Laporteas* sp.), cattails (*Typha* sp.), wool grass (*Scirpus cyperinus*), and purple loosestrife (*Lythrum salicaria*). Wildlife expected to utilize these habitats include red-winged blackbirds (*Agelaius phoeniceus*) and other insectivorous species. Reptiles and amphibians likely include snapping turtles (*Chelydra serpentina*) and green frogs (*Rana clamitans*). Swamp loosestrife (*Decodon verticillatus*) and red maple (*Acer rubrum*) are also present. Photographs of the Oxbow Area showing various aspects of this habitat are presented in Appendix A.

2.1.1 Current and Reasonably Foreseeable Uses of the Oxbow Area

The Oxbow Area is a relatively undisturbed and extensive wooded habitat that is protected from development by both federal and state statutes. As such, it provides some unique ecological benefits in an otherwise urbanized portion of the State. In addition, the area could provide other natural resource values with potentially significant education and recreation opportunities.

2.2 CONCEPTUAL SITE MODEL

The CSM identifies the source of contamination, transport pathways, contaminated media, and routes of exposures evaluated, and shows the relationship between the assessment endpoints and measures of effects (USEPA, 1997). It serves as a communication tool that illustrates the major pathways by which ecological receptors may be exposed to COPECs associated with releases of contaminants from the source area. Figure 2 presents a general CSM for the Oxbow Area.

Anthropogenic influences are evident in the Woonasquatucket River channel immediately below the Allendale Dam. The river channel has been straightened at the point where water from the former Allendale Mill entered the river immediately below the Allendale Dam (refer to Figure 3-2 in Battelle, 2005). Historical aerial photography and field mapping revealed an abandoned channel in the forested wetland southwest of Allendale Dam (mapped as floodplain deposits in Figure 3-3 in Battelle, 2005). The area within the meander contains fine-grained sediment deposited as the river adjusted to its new path and the meander cut-off was filled.

During flooding, overbank deposits still may be introduced into the abandoned channel. The most recent meander loop still connects with the river during times of high water (as evident in the 1995 aerial photography).

2.2.1 Potential Ecological Receptors

Terrestrial macroinvertebrates and wildlife may be exposed to COPECs in floodplain soil by direct contact, direct ingestion, or consumption of prey items that have bioaccumulated COPECs. Potential ecological receptors identified in the Oxbow Area include soil macroinvertebrates, amphibians, reptiles, birds, and mammals. Further information for each receptor is provided in the Oxbow Area SLERA (Battelle and MACTEC, 2006). Responses from the Rhode Island Department of Environmental Management (RIDEM) and U.S. Fish and Wildlife Service (USFWS) indicates that no state or federally listed rare, threatened, or endangered species are located the vicinity of the Site (Appendix B); however, there are potential vernal pools in the Oxbow Area (USACE, 2008) that could support regionally rare animals.

2.2.2 Complete Exposure Pathways

Ecological receptors may be exposed to Site-related contaminants through a variety of exposure pathways. A complete exposure pathway involves a potential for contact between a receptor and contaminants, either through exposure to an abiotic medium (e.g., soil) or indirectly through prey consumption. Pathways are evaluated using available information on contaminant fate and transport, the ecosystems that are potentially affected, and the magnitude and extent of the contamination (USEPA, 1997).

Terrestrial animals, such as soil macroinvertebrates, birds, and mammals, may be exposed to contaminants that have migrated to the floodplain soils of the Oxbow Area. Potential exposure pathways include food intake, surface water ingestion, incidental soil ingestion, dermal contact, and possibly inhalation. However, due to the anticipated insignificance of the dermal and inhalation exposure routes (as compared to the other exposure routes), as well as substantial uncertainties associated with estimating ecological exposures for these pathways, they were not evaluated in this Supplemental BERA.

2.3 SUMMARY OF DATA

The data used for this Supplemental BERA include data for 58 floodplain surface soil samples and 15 Oxbow Area sediment samples (Figure 3 and Table 1). Both the floodplain soil and

sediment data sets include samples collected to support the RI and specifically to support the risk assessment exposure estimates. Photographs of representative soil and sediment sampling locations are provided in Appendix A.

Data were collected for 34 RI surface soil sample locations in 1999 (February, July, October, November, and December), 2001 (July), and 2004 (June). RI samples from 1999 were collected at three surface intervals: 0-0.25 foot (ft) below ground surface (bgs), 0-0.5 ft bgs, and 0-1 ft bgs (Table 1). RI samples from 2001 and 2004 were collected at 0-0.5 ft bgs (Table 1). The 24 floodplain soil sample locations sampled for this Supplemental BERA were sampled from September through November 2010, and most were within the 100-year floodplain. Four samples collected in 2010 were excluded from the evaluation because they were collected from areas of artificial fill (Table 1). Data from the other 54 sample locations were used to evaluate ecological risks in the Oxbow Area. Although both surface (0-1 ft bgs) and subsurface samples were collected, only data for surface samples were used for this Supplemental BERA.

The floodplain soil samples were collected from four areas within the Lyman Mill reach, with the majority of samples from within the Oxbow Area (Figure 3). Samples collected from the old mill raceway near the former Allendale Mill just northeast of the Oxbow were included in the evaluation because they also represent floodplain soil samples in an area where similar ecological exposures could occur (see Figure i in Appendix A). Samples from two small wooded wetland areas on the west bank of Lyman Mill Pond at the mouth of Assapumpset Brook and on the east bank near a residential area that represent fragments of the Oxbow Area habitat were also included in the evaluation. Consistent with the CSM, Site-related contaminated sediments from Allendale Pond and Lyman Mill Pond could be transported into each of these areas under flood conditions. Although ecological risks are evaluated for the area as a whole, the remedial approach will address contamination within each of these areas separately.

In addition to the soil samples, twelve sediment samples were also collected in November 2010 from the southern portion of the Oxbow Area within the scrub-shrub habitat at 0-1 ft bgs for comparison with Allendale Pond and Lyman Mill Pond sediment concentrations and to determine the potential for adverse ecological effects from exposure to sediments within the Oxbow. Only three sediment samples collected for the RI were included in this sediment evaluation. The RI

samples were collected in June 2004 at 0-0.5 ft bgs and were originally evaluated as floodplain soil because of the limited amount of data available for the Oxbow SLERA. However, these samples were collected from locations within a remnant of the former Woonasquatucket River bed that remains in the Oxbow and are typically submerged. All other sediment samples collected for the RI have been evaluated previously, the remedial approach for these areas has been determined, and none of the other RI sediment samples were included in this Supplemental BERA except for comparison with sediment concentrations within the Oxbow Area.

All samples were analyzed for dioxins/furans, and some samples were also analyzed for PCBs, pesticides/herbicides, metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), total organic carbon (TOC), pH, and grain size distribution (Table 1). Although two samples were analyzed for PCB congeners, most samples analyzed for PCBs were analyzed for Aroclors. Field duplicate samples collected were used only for quality assurance (QA) and were not used to quantify ecological exposures.

General observations regarding the nature and extent of contamination for each contaminant group are presented Appendix C. Because this work has occurred after the FS, this information is presented here to update the site characterization that was performed previously.

2.4 CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN

COPECs in Oxbow Area floodplain surface soil and sediment were identified by comparing maximum concentrations of contaminants with conservative soil and sediment screening benchmarks. All sediment screening benchmarks and most soil screening benchmarks used for comparison were the same as those used for the BERA (MACTEC, 2004; Tables D-2 and D-3). Consistent with USEPA Region 1 policy, all analytes selected as COPECs in environmental media (based on screening benchmark exceedances) for Site exposure areas were retained to estimate total Site risks. Individual dioxin and furan congeners and homologue groups were not specifically identified as COPECs because a TEQ approach, based on 2,3,7,8-TCDD, was employed in the assessment.

A total of 17 metals, 8 pesticides, 3 Aroclors plus Total Aroclors, high molecular weight (HMW) and low molecular weight (LMW) PAHs and Total PAHs, and TEQs for birds and mammals were retained as COPECs for the Oxbow Area floodplain surface soil (Table 2a). A total of 16

metals, 13 pesticides, 2 Aroclors plus Total Aroclors, HMW and LMW PAHs and Total PAHs, 5 other organic compounds, and TEQs for fish, birds, and mammals were identified as COPECs for the Oxbow surface sediment (Table 2b). A discussion of the COPEC screening process is presented below.

2.4.1 Development of Exposure Estimates for COPEC Screening

Table 2 presents summary statistics for each analytical parameter, including minimum and maximum detected concentrations, detection frequency, location of maximum detected concentration, and various measures of central tendency of the distribution (arithmetic mean, geometric mean, and median). Consistent with USEPA guidance, the maximum detected concentration was used as the point estimate of exposure for the purpose of the COPEC screening process.

2.4.2 Screening Benchmarks and Toxicity Reference Values

Screening benchmarks and toxicity reference values (TRVs) used to evaluate the potential hazard to soil and aquatic macroinvertebrates and wildlife associated with exposure to the surface sediment and surface soil exposure point concentrations (EPCs) were generally the same as those used for the BERA (MACTEC, 2004) and are presented in Appendix D of the BERA (MACTEC, 2004). However, because of their strong scientific and statistical basis, Ecological Soil Screening Levels (Eco-SSLs) developed by EPA since the BERA was conducted were selected as the primary source of soil and macroinvertebrate benchmarks. Including Eco-SSLs as the first source in the hierarchy of potential sources of screening benchmarks resulted in changes to the soil screening benchmarks previously employed in the BERA for a number of contaminants, including manganese (SSL=450 mg/kg), nickel (SSL=130 mg/kg), silver (SSL=4.2 mg/kg), antimony (SSL=0.27 mg/kg), arsenic (SSL=43 mg/kg), barium (SSL=330 mg/kg), beryllium (SSL=21 mg/kg), cadmium (SSL=0.36 mg/kg), chromium (SSL=26 mg/kg), cobalt (SSL=120 mg/kg), copper (SSL=28 mg/kg), vanadium (SSL=7.8 mg/kg), zinc (SSL=46 mg/kg), and selenium (SSL=0.63 mg/kg). This also affected the invertebrate benchmarks for iron (SSL=1,700 mg/kg), manganese (SSL=450 mg/kg), nickel (SSL=280 mg/kg), antimony (SSL=78 mg/kg), barium (SSL=330 mg/kg), beryllium (SSL=40 mg/kg), cadmium (SSL=140 mg/kg), copper (SSL=80 mg/kg), zinc (SSL=120 mg/kg), and selenium (SSL=4.1 mg/kg).

2.4.3 COPECs in Floodplain Soil

COPECs were identified by comparing the maximum detected concentration of each analytical parameter to the selected screening benchmark (Table 2a). A summary of the COPEC screening process is summarized for each category of contaminants.

Dioxins/Furans

Only 2,3,7,8-TCDD was analyzed at all sample locations, and this congener was detected at 54 of the 56 Oxbow Area floodplain soil locations where it was analyzed (two of the 58 soil samples were field duplicates for dioxin/furan analysis and were not used for the evaluation). For all locations, more than half of the dioxin congeners analyzed were detected, with an average detection frequency of 87% for all congeners analyzed. The only COPECs retained for further evaluation were 2,3,7,8-TCDD, which was detected at a maximum concentration that is significantly higher than the conservative screening benchmark for floodplain soil, and the bird and mammal TEQs.

Polychlorinated Biphenyls

Each of the three detected Aroclors (Aroclor 1254, Aroclor 1260, and Aroclor 1268) had maximum detected concentrations that are greater than the conservative screening benchmark values; therefore, they were retained as COPECs. Aroclor 1254 was detected with the highest frequency at 65%. Aroclor 1260 and Aroclor 1268 were detected in approximately 16 and 22% of the samples, respectively.

Pesticides/Herbicides

Of the 22 pesticide compounds analyzed, 8 were retained as COPECs: 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, aldrin, endrin, dieldrin, lindane, and technical chlordane. Only beta-BHC and toxaphene were not detected in any sample. Maximum concentrations of endrin, dieldrin, and lindane were all detected at location SS_G-01 at the north end of the Oxbow Area near Allendale Dam and the west bank of the Woonasquatucket River (Figure 3). 4,4'-DDT and 4,4'-DDE each had maximum detected concentrations at sampling location RES-12-556 located in the old mill raceway. The maximum concentration of technical chlordane was detected at SS_G-23 located in the eastern portion of the Oxbow Area behind the Boys and Girls Club.

Metals

Seventeen of the metals that were analyzed for were identified as COPECs. The maximum detected concentration of only four potentially toxic metals (barium, beryllium, cobalt, and

methyl mercury) did not exceed the conservative screening benchmarks for floodplain soils. Maximum concentrations of most metals were detected at location RES-10-042 in the wooded wetland area on the east bank of Lyman Mill Pond (Figure 3).

Polycyclic Aromatic Hydrocarbons

Thirteen PAHs analyzed were identified as COPECs. The aggregate chemical parameters Total HMW PAHs, total LMW PAHs, and Total PAHs also exceeded screening benchmarks and were retained as COPECs. Maximum concentrations of most individual PAHs were detected at location SS_G-29 in the eastern portion of the Oxbow Area behind the Boys and Girls Club and at RES-12-556 located in the old mill raceway. Maximum concentrations of HMW, LMW, and Total PAHs were detected at RES-12-556 in the old mill raceway (Figure 3).

2.4.4 COPECs in Oxbow Area Surface Sediment

COPECs were identified by comparing the maximum detected concentration of each analytical parameter to the selected screening benchmark (Table 2b). Similar to floodplain soil exposures, exposure to sediment occurring within the Oxbow Area may pose risk of harm to aquatic receptors due to exposure to dioxins/furans, pesticides, PCBs (primarily Aroclors 1254 and 1268), metals, and PAHs in Oxbow Area sediments.

Dioxins/Furans

All analyzed dioxin congeners were detected at nearly all 15 Oxbow Area sediment sample locations. 2,3,7,8-TCDD was detected at all locations. As with Oxbow Area floodplain surface soil, the only COPECs retained for sediment were 2,3,7,8-TCDD and the fish, bird and mammal dioxin TEQs. With the exception of 1,2,3,7,8-pentachlorodibenzofuran (PeCDF), 2,3,4,7,8-PeCDF and octachlorodibenzo-p-dioxin (OCDD), the maximum concentrations for all dioxin/furan congeners (along with the highest fish, bird, and mammal TEQs) were detected at SD_G-01 located at the south end of the Oxbow Area fragment along the north bank of Lyman Mill Pond (Figure 3).

Polychlorinated Biphenyls

The maximum detected concentrations of each of the two detected Aroclors (1254 and 1268) along with Total Aroclors exceed the conservative screening benchmark values and were retained as COPECs. The remaining Aroclors were not detected in any sample. As with Oxbow Area floodplain soil, Aroclor 1254 (the Aroclor most frequently detected at the Site) was the predominant contributor to the concentration of Total Aroclors in Oxbow Area sediment, and

maximum concentrations of both (Aroclor 1254 and Total Aroclors) were detected at LPX-SD-4402 located in the remnant of the Woonasquatucket River bed in the Oxbow Area (Figure 3). The maximum concentration of Aroclor 1268 was detected at SD_G-01 located at the south end of the Oxbow Area along the north bank of Lyman Mill Pond. Aroclor 1268 was detected at all but one location (where analyzed) in the Oxbow.

Pesticides/Herbicides

Of the 23 pesticide compounds analyzed, 13 (including 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, endrin, dieldrin, gamma-BHC (lindane), technical chlordane, alpha- and gamma-chlordane, endrin aldehyde and endrin ketone, and endosulfan I and II) were retained as COPECs. Five of the 23 compounds analyzed were not detected in any sample. Maximum concentrations of many of the pesticides were detected at location SD_G-01 at the south end of the Oxbow Area along the north bank of Lyman Mill Pond (Figure 3).

Metals

With the exception of thallium, all metals analytes were identified as COPECs. Maximum concentrations of most metals were detected either in the remnant of the Woonasquatucket River bed within the Oxbow Area (locations LPX-SD-4401 and LPX-SD-4402) or at SD_G-01 at the south end of the Oxbow Area along the north bank of Lyman Mill Pond (Figure 3).

Polycyclic Aromatic Hydrocarbons

Seventeen PAHs analyzed were identified as COPECs, along with HMW PAHs, LMW PAHs, and Total PAHs. Maximum concentrations of almost all of the individual PAHs were detected either at location SD_G-01 or at SD_G-03, both in the southern portion of the Oxbow Area at the north end of Lyman Mill Pond (Figure 3). The maximum concentration for LMW PAHs was detected at SD_G-03, and maximum concentrations for HMW and Total PAHs were detected at SD_G-01.

2.4.5 COPECs for Earthworm Tissue

Table 3 summarizes maximum and average earthworm tissue concentrations estimated using biota-soil accumulation factors (BSAFs) developed during the BERA (MACTEC, 2004). Earthworm tissue concentrations were developed for all COPECs identified for floodplain soil. In addition, earthworm tissue concentrations of detected dioxin and furan congeners were derived for exposure modeling and TEQ calculations used in the residue-based analysis of wildlife tissue.

2.5 EXPOSURE CONCENTRATIONS

To evaluate the risks to ecological receptors exposed to contaminants in Oxbow Area floodplain soil, EPCs were developed for the COPECs identified. EPCs for Oxbow Area sediment were derived using maximum concentrations of COPECs because only risks to aquatic macroinvertebrates were evaluated, and macroinvertebrates could experience maximum exposure concentrations because of their sedentary life-style. Although this may not result in population-level effects if concentrations are not consistently high across a large area, this conservative approach ensures protection of the vermivores forage base and is consistent with the approach used for earlier assessments. The floodplain soil EPCs used for the risk assessment were either (1) the 95% upper confidence limit (UCL) of the mean for all COPECs with five or more detected concentrations or (2) the maximum concentration for COPECs with detected concentrations at fewer than five locations. ProUCL software (V. 4.1.00) (USEPA, 2010) was used to calculate 95% UCL values. The maximum detected concentration was selected as the EPC statistic for COPECs that were detected in less than five samples (i.e., aldrin, Aroclor 1268, and lindane). In accordance with protocol specified in the ProUCL guidance, the 95% UCL value was not selected in these cases due to concerns about reliability of the 95% UCL estimates.

In some cases, clusters of samples or replicate samples were collected to better characterize small-scale spatial heterogeneity in contaminant concentrations. Replicate samples were collected as part of the overall sampling QA assessment and were not used to derive exposure estimates. To avoid biasing results toward locations where multiple samples were collected to characterize contaminant concentrations at that location, replicate and clustered samples collected within a given sampling event were averaged before calculating 95% UCLs. With the exception of the CMS samples, replicate and clustered samples are typically identified as -01, -02, and -03. Data for the following samples were averaged:

- CMS samples-217, -218, -219, -458, and -459 (although CMS-458 and -459 were sampled during a different sampling event than CMS-217, -218 and -219, these samples were averaged because of their close proximity and because they were only analyzed for 2,3,7,8-TCDD)
- RES-12-556 samples RES-12-556-01 and RES-12-556-02
- SS_G-01 samples SS_G-01, SS_G-01-01, SS_G-01-02, and SS_G-01-03 (SS_G-01-04 was eliminated from the evaluation because it was located in a fill area)
- SS_G-29 samples SS_G-29, SS_G-29-01 and SS_G-29-02
- RES-11-011 samples RES-11-011-01 and RES-11-011-02 ((RES-11-011-03 was not included in summary statistics because it is a field duplicate and was only use for QA)

- RES-10-005 samples RES-10-005-01, RES-10-005-02, and RES-10-005-03
- RES-10-042 samples RES-10-042-01, RES-10-042-02, and RES-10-042-03
- RES-10-044 samples RES-10-044-02 and RES-10-044-03 (RES-10-044-01 was not included in summary statistics because it is a field duplicate and was only use for QA)
- RES-10-604 samples RES-10-604-02 and RES-10-604-03 (RES-10-604-01 was not included in summary statistics because it is a field duplicate and was only use for QA)
- RES-11-012 samples RES-11-012-01, RES-11-012-02, and RES-11-012-03

Prior to averaging, data were reviewed to ensure that it was appropriate to average, with respect to physical characteristics and chemical composition. Analytical results for RES-12-560-01 and RES-12-560-02 samples were not averaged because they were collected about 200 ft apart and on opposite sides of the old mill raceway channel.

EPCs were developed for COPECs in floodplain soil to evaluate wildlife exposures to dioxins/furans, PCB Aroclors, pesticides/herbicides, and metals. Wildlife exposures to PAHs were not evaluated because the potential for PAHs to bioaccumulate through the floodplain terrestrial food web is considered to be low, and the toxicity of PAHs to wildlife is not well-understood. Therefore, reliable TRVs are not available for quantifying risks. EPCs also were not developed for individual dioxin/furan congeners because risks were evaluated as 2,3,7,8-TCDD toxicity equivalents.

EPCs were not calculated for either iron or aluminum. Iron occurs in soil at naturally high concentrations and is an essential element. Aluminum is the most abundant element in the earth's crust (Press and Siever, 1974, as cited in USEPA, 2003), and soil concentrations are naturally high. The typical range of aluminum in soils is from 1 to 30% (10,000 to 300,000 mg/kg) (Lindsay, 1979, and Dragun, 1988, as cited in USEPA, 2003), with naturally occurring concentrations varying over several orders of magnitude. The maximum concentration of aluminum in the Oxbow Area falls at the low end of this range. Aluminum was not evaluated for wildlife exposures because is not considered to be bioavailable at pH levels above 5.0 (USEPA, 2003). The average soil pH measured in 2010 for the Oxbow Area is 5.2 (range 3.5-6.4). Although the soil pH was below 5.0 at 7 of 24 locations, aluminum was not analyzed at these locations, and where aluminum was analyzed and elevated, soil pH was greater than 5.0. Furthermore, the Supplemental BERA focuses on evaluating "typical" exposures, and the average pH concentration in floodplain soil exceeds 5.0, indicating that aluminum is not generally anticipated to be bioavailable to wildlife. However, because it may be bioavailable at some

locations, it was included in the macroinvertebrate exposure assessment because of their limited mobility.

2.6 ASSESSMENT ENDPOINTS AND MEASURES OF EFFECTS

Assessment endpoints are explicit expressions of actual environmental values (i.e., ecological resources) that are to be protected at the Site (USEPA, 1997). Valuable ecological resources are those resources that, if adversely affected, could impair overall ecosystem function from either a biological or social perspective. Appropriate selection and definition of assessment endpoints are critical to development of a heuristic risk assessment because they focus the risk assessment design and analysis. Adverse risks to assessment endpoints generally drive any potentially necessary risk management decisions. Because it is neither practical nor possible to directly evaluate potential risks to all of the individual components of the ecosystem at the Site, assessment endpoints are used to focus the risk assessment on particular components of the ecosystem that could be adversely affected by the contaminant's release to the Site (e.g., terrestrial populations). The following endpoints were developed to support the objectives established for this Supplemental BERA:

1. Protection and maintenance (i.e., survival, growth, and reproduction) of floodplain soil macroinvertebrate communities that serve as a forage base for wildlife.
2. Protection and maintenance of vermivorous bird and mammal populations.
3. Protection and maintenance of omnivorous mammal populations.

Measures of effects are quantifiable ecological characteristics that are linked to the valued characteristic chosen as the assessment endpoint (USEPA, 1997). They are related to assessment endpoints by the mechanism of toxicity and the route of exposure. Measures of effects are used to derive a quantitative estimate of potential effects and to form a basis for extrapolation to the assessment endpoints. There are three general types of measures of effects: (1) comparison of concentrations of COPECs to concentrations known to cause adverse effects, generally from the literature, (2) toxicological testing using bioassays of site and background media, and (3) comparison of observed population and community-level effects at the site and at background or reference areas.

2.6.1 Floodplain Soil Macroinvertebrate Community

Assessment Endpoint 1: Protection and maintenance of floodplain soil macroinvertebrate communities that serve as a forage base for wildlife.

The following risk questions were established for this assessment endpoint:

- Do concentrations of COPECs in floodplain soil exceed appropriate guidelines for the protection of the floodplain soil macroinvertebrate community?
- Do measured and modeled concentrations of COPECs in the tissues of floodplain soil macroinvertebrates (as represented by earthworms) exceed benchmarks for residue effects on survival, growth, or reproduction?
- Do the available floodplain soil macroinvertebrate data indicate the presence or absence of ecological integrity?

The following measures of effects were selected to evaluate risk to this endpoint receptor group:

- Comparison of floodplain soil COPEC concentrations to benchmarks/guidelines.
- Comparison of Site-specific COPEC concentrations in floodplain soil macroinvertebrates to critical body residue (CBR) values from the literature.
- Site-specific study of floodplain soil macroinvertebrate community structure/function.

2.6.2 Vermivorous Wildlife Populations

Assessment Endpoint 2: Protection and maintenance of vermivorous bird and mammal populations.

The following risk questions were established for this assessment endpoint:

- Do doses of COPECs ingested by vermivorous wildlife (as represented by the American woodcock and short-tailed shrew) exceed TRVs or TEQs for adverse effects on survival, growth, or reproduction?
- Do residues of COPECs in eggs and/or tissues of vermivorous wildlife (as represented by the American woodcock and short-tailed shrew) exceed benchmarks for adverse effects on survival, growth, reproduction, or embryo development?

The following measures of effects were selected to evaluate risk to this endpoint receptor group:

- Comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs.
- Comparison of measured and estimated vermivorous wildlife tissue and egg residues with CBR data.

Dietary exposures to the woodcock and shrew were estimated using contaminant concentrations in floodplain soil and earthworms. Contaminant exposures in the plant diet of the shrew were estimated using literature-derived uptake factors. Exposure modeling was conducted using the inputs presented in Table 20 of the BERA (MACTEC, 2004).

2.6.3 Omnivorous Wildlife Populations

Assessment Endpoint 3: Protection and maintenance of omnivorous mammal populations.

The following risk question was established for this assessment endpoint:

- Do doses of COPECs ingested by omnivorous wildlife (as represented by the raccoon) exceed TRVs or TEQs for adverse effects on survival, growth, or reproduction?

The following measure of effects was selected to evaluate risk to this endpoint receptor group:

- Comparison of estimated ingestion doses in omnivorous mammals with TRVs and TEQs.

Risks to omnivorous mammals (raccoons) were evaluated by comparing estimated dietary doses, associated with the consumption of contaminated drinking water and prey and incidental ingestion of soil, with TRVs and TEQs.

2.6.4 Aquatic macroinvertebrate Community

Assessment Endpoint 1: Protection and maintenance of aquatic macroinvertebrate communities that serve as a forage base for aquatic fish and wildlife.

The following risk question was established for this assessment endpoint:

- Do concentrations of COPECs in Oxbow Area surface sediment exceed appropriate guidelines for the protection of the aquatic macroinvertebrate community?

The following measure of effects was selected to evaluate risk to this endpoint receptor group:

- Comparison of sediment COPEC concentrations to benchmarks/guidelines.

This is intended to be a qualitative assessment to determine the potential for adverse ecological effects from exposure to Oxbow Area sediments and for these sediments to recontaminate Lyman Mill Pond over time following remedial action. Although many of the TRVs used for comparison are based on macroinvertebrate exposures, some of the TRVs are based on microinvertebrate or bioaccumulative wildlife exposures, resulting in more conservative effects concentrations that would also be protective of the macroinvertabrate community. COPEC concentrations were also compared to those identified for Lyman Mill Pond and Allendale Pond sediments, to assess how ecological exposures vary among these areas, and to proposed cleanup goals (Battelle, 2010), to determine whether they are exceeded by sediment concentrations within the Oxbow Area.

Other assessment endpoints were not developed for Oxbow Area sediment exposures due to conditions that likely limit wildlife exposures in the scrub-shrub habitat where the majority of Oxbow Area sediments are located. Receptor groups that may have some exposure to Oxbow Area sediments include aquatic invertebrates, early life stages for fish, amphibians, and small fish. The dense vegetation and saturated conditions within the scrub-shrub and emergent marsh habitat either restricts or significantly limits access and use by wildlife and larger fish. Furthermore, the primary concern for this Supplemental BERA was to compare concentrations of contaminants in Oxbow Area sediments with concentrations in Lyman Mill Pond sediments, as there may be a potential for transport of sediment between the Oxbow Area and the pond.

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3.0 ECOLOGICAL RISK EVALUATION

This section provides an ecological risk evaluation for the floodplain soil and sediment macroinvertebrate communities, vermivorous bird and mammal populations, and omnivorous mammal populations that may be present in the Oxbow Area of the Site. The risk evaluation uses the measures of effects described in Section 2.6. For each receptor category, results of the benchmark screening are presented along with a summary of applicable Site-specific data collected to support the BERA (MACTEC, 2004). In addition, average COPEC concentrations were used to derive preliminary risk estimates to allow a more complete comparison to the associated findings in the BERA.

For each assessment endpoint, the components of the exposure and effect evaluations are described, followed by the risk characterization analysis and a summary of the assessment findings.

3.1 FLOODPLAIN SOIL MACROINVERTEBRATE COMMUNITY

Potential risks to the floodplain soil macroinvertebrate community were evaluated using the measures of effects discussed in Section 2.6. These include (1) a comparison of floodplain soil COPEC concentrations to benchmarks/guidelines; (2) a comparison of estimated COPEC concentrations (derived using Site-specific BSAFs) in floodplain soil macroinvertebrates to literature-derived CBR values; and (3) a Site-specific study of floodplain soil macroinvertebrate community structure/function conducted to support the BERA of other floodplain habitat within the Site.

3.1.1 Exposure Assessment

Exposure of soil macroinvertebrates to COPECs in floodplain soil was evaluated using Oxbow Area floodplain soil data, estimated earthworm tissue data (derived using Site-specific BSAFs), and historical data collected in 2001 to support the BERA. Table 2a summarizes the maximum and average COPEC concentrations that were used to estimate exposure to floodplain macroinvertebrates in this evaluation. Maximum and average concentrations were evaluated because of the lower mobility of many soil macroinvertebrates and the lower likelihood that exposures will be integrated over the range of concentrations.

Table 3 presents the estimated maximum and average concentrations of COPECs in earthworm tissue based on uptake modeling using the Site-derived BSAFs. As described in the BERA (MACTEC, 2004), analytical chemistry data for co-located earthworm tissue and associated soil samples were used to develop BSAFs for predictive uptake modeling of bioaccumulating COPECs. Table A-1 of the Interim Final BERA (MACTEC, 2004) presents a summary of the analytical samples for floodplain soil and earthworm tissue that were used to develop the earthworm tissue BSAFs. Table J-8 in the Interim Final BERA (MACTEC, 2004) presents the earthworm BSAFs developed for the Site.

The following equation was used to estimate concentrations in earthworm tissue based on concentrations in floodplain soil:

$$C_{earthworm} = \frac{BSAF * C_{soil} * \%lipid}{\%TOC} \qquad \text{(Equation 1)}$$

where:

$C_{earthworm}$	=	chemical concentration in earthworm tissue (µg/g - ww)
BSAF	=	biota soil accumulation factor derived using Site-specific data (expressed as $g_{organic\ carbon}$ - dw/g_{lipid} - ww)
C_{soil}	=	maximum chemical concentration in floodplain soil (µg/g – dw)
% lipid	=	lipid content of earthworm (g_{lipid}/g; both ww basis)
%TOC	=	total organic carbon content of floodplain soil ($g_{organic\ carbon}$/g; both ww basis)

Table 3 summarizes estimated maximum and average tissue concentrations for COPECs in Oxbow Area earthworms. For this Supplemental BERA, the average earthworm lipid content (2.7%) from the three earthworm samples collected from the Lyman Mill Pond exposure area during the June 2001 field sampling program was used to estimate Oxbow Area earthworm lipid content. TOC was analyzed in 28 floodplain surface soil samples collected in the Oxbow Area; as indicated in Table 2a, concentrations range from 0.9 to 36%. The average TOC (8.1%) was selected as the representative input parameter in Equation 1 for the purposes of modeling COPEC uptake into floodplain macroinvertebrates.

3.1.2 Effects Assessment

The measures of effects selected to evaluate AE1, protection of the floodplain soil macroinvertebrate community, are:

- Comparison of floodplain soil COPEC concentrations to exposure benchmarks;
- Comparison of estimated body burdens of COPECs in earthworms to CBRs; and
- An assessment of soil macroinvertebrate community structure and function.

Comparison of floodplain soil COPEC concentrations to benchmarks/guidelines. TRVs used to evaluate the potential hazard associated with macroinvertebrate exposure to surface soil are presented in Table D-3 of the Interim Final BERA (MACTEC, 2004). For this Supplemental BERA, the TRVs were compared to the maximum and average COPEC concentrations for floodplain soil (Table 2a) to derive hazard quotients (HQs) as ratios of the exposure estimate to the TRV (Table 4). An HQ of 1.0 or greater indicates that there is a potential for adverse effects on macroinvertebrate populations.

Comparison of estimated Site-specific COPEC concentrations in floodplain soil macroinvertebrates to literature-derived CBR values. CBR data, as described in the BERA (MACTEC, 2004), were compiled from various sources. LOAELs and NOAELs were selected for each contaminant class and general effect category (i.e., mortality, growth, and reproduction). Occasionally, neither a NOAEL nor a LOAEL could be established from the information in the database, resulting in an unbounded estimator of the effect threshold for a given taxon/effect category (Table G-1 of the BERA). CBRs (Table G-1 of the BERA) were compared to the estimated earthworm tissue concentrations to derive HQs as ratios of the exposure estimate (either maximum or average estimated earthworm tissue concentration) to the CBR estimate (either based on the NOAEL or LOAEL) (Table 5). An HQ of 1.0 or greater indicates that there is a potential for adverse effects on macroinvertebrate populations.

Site-specific study of floodplain soil macroinvertebrate community structure/function. In 2001, the floodplain soil community associated with the Woonasquatucket River was surveyed at 11 sampling stations. At each location, the soil macroinvertebrate community was sampled and a representative floodplain soil sample was collected. A total of 19 soil macroinvertebrate taxa, including seven species of earthworms, were identified in Allendale Pond, Lyman Mill Pond, and Greystone Mill Pond floodplain soil samples. Earthworms numerically dominated the taxonomic community samples, representing approximately 73% of the overall fauna collected. *Aporrectoda rosea* dominated the upriver background stations, and *Lumbricus rubellus* was

dominant in the Site sampling locations. Other macroinvertebrates included arthropods, gastropods, and nematodes. Additional details are presented in Appendix E of the BERA (MACTEC, 2004).

No specific information regarding the status of the floodplain soil community associated with the Oxbow Area is available. However, the relationships between floodplain soil chemistry and the findings of the 2001 macroinvertebrate community study were used in this Supplemental BERA to make inferences about the status of the Oxbow Area macroinvertebrates (see Section 3.1.3).

3.1.3 Risk Characterization

This section evaluates each of the measures of effects established to characterize risk to the floodplain soil macroinvertebrate community.

Comparison of floodplain soil COPEC concentrations to benchmarks/guidelines. TRVs were compared to the maximum COPEC concentrations for floodplain soils and an HQ was determined. Results are presented in Table 4 and Figure 4. The HQs derived using the maximum detected COPEC concentrations for all eight pesticides exceed 1.0. 4,4'-DDT has the highest exceedance level, with an HQ of 520. The total pesticide hazard index (HI) (the sum of all the HQs) is 1000. The HQs for Aroclor 1254, Aroclor 1260, and Aroclor 1268 are all less than 1.0. The HQs for HMW and LMW PAHs exceed 1.0, and the HI for Total PAHs is 51. Of the 16 metals analyzed (iron was not evaluated), nine have HQs based on maximum concentrations that exceed 1.0. Chromium and copper pose the highest risk, with HQs at 230 and 29, respectively. The total metals HI is 320. The HQ for the maximum concentration of 2,3,7,8-TCDD is 3.0.

HQs were also derived by comparing the average exposure to the TRVs to provide a better point of reference to the results of this Supplemental BERA. For pesticides, the HQs derived using mean concentrations also exceed 1.0 for all pesticides except aldrin and technical chlordane. Aldrin also had a low detection frequency in floodplain soil samples (2/37). The average total pesticide HI is 62. The HQs for HMW and LMW PAHs exceed 1.0, as well, and the HI for Total PAHs is 13. For metals, HQs for average concentrations of aluminum, chromium, copper, manganese, mercury, vanadium and zinc in floodplain soil exceed 1.0, and the HI for all metals is 94. The HQ for average concentrations of 2,3,7,8-TCDD in floodplain soil does not exceed 1.0. As with the maximum concentration HQs, the average concentration HQs do not exceed 1.0 for any Aroclor.

Total Oxbow Area risks to soil macroinvertebrates, as represented by the HI for all COPECs, are 1,400 using the maximum soil concentrations and 170 using the average soil concentrations. The majority of risk to soil macroinvertebrates is attributed to pesticides and metals (see histograms identified as "OXB" in Figure 4).

Comparison of estimated COPEC concentrations in floodplain soil macroinvertebrates to literature-derived CBR values. The CBRs obtained from the summary of tissue effects data presented in Table G-1 of the Interim Final BERA (MACTEC, 2004) were compared to soil EPCs to determine potential risk to soil macroinvertebrates. Results are presented in Table 5 and Figure 5. Risks from body burdens of some COPECs could not be calculated because of limited data (BSAFs, LOAELs, or NOAELs were not available).

Based on maximum concentrations of pesticides in floodplain soil, body burdens of 4,4'-DDE exceed the NOAEL (HQ = 4.3) and may have adverse effects on soil macroinvertebrate populations. The estimated body burden for the maximum concentration of technical chlordane also exceeds the LOAEL. Body burdens from exposure to average concentrations of all pesticides are less than NOAELs and LOAELs (i.e., HQs are less than 1.0). The total HI for body burdens of pesticides ranges from 0.3 to 5.8. The body burden from exposure to concentrations of Aroclors and dioxin do not exceed available NOAELs or LOAELs, indicating negligible risk for soil macroinvertebrate populations from floodplain soil exposures to PCBs and dioxin.

For the maximum soil concentration of metals, the HQs for body burdens of 11 metals (aluminum, antimony, arsenic, cadmium, copper, lead, manganese, nickel, selenium, vanadium, and zinc) exceed their respective NOAELs. HQs for body burdens of these metals range from 1.8 (antimony) to 140 (nickel). Maximum body burdens of eight metals also exceeded the LOAELs. Metals for which maximum and average concentrations exceed both NOAELs and LOAELs include aluminum, lead, nickel and zinc. The total HI for body burdens of all metals ranges from 120 to 1500.

Total Oxbow Area risks are 1500 for NOAEL-based HQs and 370 for LOAEL-based HQs using body burdens derived from the maximum soil concentration. For the average soil concentration, the NOAEL-based HI is 770 and the LOAEL-based HI is 120. Inorganic metal contaminants are the major contributor to risk (Figure 5).

Site-specific study of floodplain soil macroinvertebrate community structure/function. According to the Interim Final BERA (MACTEC, 2004), the floodplain soil macroinvertebrate community along the Woonasquatucket River consists of organisms that are typically found in forested habitats along stream banks. The number of taxa found at sampling stations downstream of the Site was generally greater than the number of taxa found in the background area. Organisms found at upstream background stations were also found at downstream stations, and no organisms were restricted to upstream stations exclusively. Based on a comparison of the relative abundance of organisms, the species diversity, and the overlap of shared fauna, no adverse effects were evident in the floodplain macroinvertebrate communities associated with Allendale Pond and Lyman Mill Pond, relative to the upstream background locations. Further details are provided in Appendix E of the BERA (MACTEC, 2004).

Based on the similarity of soil chemistry, the findings of the BERA suggest that the macroinvertebrate fauna should be comparable to other exposure areas within the Site and not distinguishable from the upriver background area.

3.1.4 Risk Assessment Summary for Soil Floodplain Macroinvertebrates

Tables 6 and 7 present the results of the incremental risk evaluation for the soil and earthworm tissue media. Incremental risk is the risk above background, calculated as the Oxbow Area risk estimates minus the risk estimates for the Greystone Mill background area. Regarding the comparison to soil benchmarks, the incremental risks for the Oxbow Area are dominated by pesticide compounds. The risk associated with 4,4'-DDT and 4,4'-DDE exposure dominates the incremental risk estimates (Table 6). Pesticides also dominate the incremental risk estimates for the Allendale Pond floodplain area in the BERA (Table 77, MACTEC, 2004), although the magnitude of the incremental risk is somewhat higher for the Oxbow Area. The incremental risk for the residue-based assessment of estimated earthworm tissue concentrations is relatively low (8.3), with only nickel contributing to the incremental risk significantly (NOAEL-based incremental risk estimate of 8.3) (Table 7).

Based on a comparison of maximum and average floodplain soil concentrations to screening benchmarks and a comparison of estimated body burdens with CBRs, the soil macroinvertebrate community occurring within the Oxbow Area may be at potential risk of harm due to exposure to Site-related contaminants in floodplain soils associated with exposure to a number of pesticides (including dieldrin, lindane, 4,4'-DDE, and 4,4'-DDD) and zinc. However, an evaluation of the

soil macroinvertebrate community study that was conducted to support the BERA also provides less indication of risk to this receptor group.

3.2 VERMIVOROUS WILDLIFE POPULATIONS

This section evaluates risk to vermivorous bird populations (as represented by the American woodcock) and mammal populations (as represented by the short-tailed shrew). Two measures of effects were selected to evaluate the assessment endpoint for these receptors (Section 2.6): (1) a comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs; and (2) a comparison of measured and estimated vermivorous wildlife tissue and/or egg residues with CBR data. Section 3.2.1 describes the estimation of vermivorous wildlife tissue and development of a food web model to predict exposure and the data used in the assessment.

3.2.1 Exposure Assessment

Comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs. To predict the exposure of vermivorous wildlife to COPECs from the ingestion of soil macroinvertebrates, a food web model was used to calculate a daily dose of COPECs as a result of consumption by the representative species. Estimated daily intakes (EDIs) of COPECs were calculated as the measure of exposure for each selected wildlife receptor. The EDIs are expressed as milligrams of contaminant per kilogram bodyweight ingested on a daily basis (mg/kg-day). The following dose model was used to estimate daily exposure of contaminants to wildlife receptors:

$$\text{EDI} = \{[(C_{soil} \times IR_{soil}) + \Sigma(C_{food} \times IR_{food})] \times SUF\}/BW \qquad \text{(Equation 2)}$$

where:

EDI	=	daily dose resulting from ingestion of soil and food (µg/g - day)
C_{soil}	=	concentration of COPEC in surface soil (µg/g; dw basis)
IR_{soil}	=	estimate of receptor's daily ingestion rate of surface soil (kg/day)
C_{food}	=	concentration of COPEC in food tissue (µg/g; ww basis)
IR_{food}	=	estimate of daily ingestion rate of food tissue (kg/day)
SUF	=	site use factor (unitless)
BW	=	body weight (kg)

As discussed in Section 3.1.1, Site-specific BSAFs were used to estimate the uptake of bioaccumulating COPECs into earthworm tissue (Table 3), which was assumed to be the primary

prey type consumed by vermivorous wildlife that forage in the Oxbow Area. Consumption of plants was assumed to be a minor contribution to the exposure of vermivorous mammals (3%), and concentrations of COPECs in plant tissue were estimated as the average concentration in floodplain soil multiplied by literature-derived bioaccumulation factors (BAFs). The exposure parameter values summarized in Tables 8 and 9 are consistent with those employed in the BERA (MACTEC, 2004).

Dose estimates to wildlife receptors were estimated using the 95% UCL of the mean for EPCs. Exposure dose estimates for the woodcock and short-tailed shrew 95% UCL of the mean COPEC concentrations in the Oxbow Area are presented in Appendix E. Exposures were estimated for the Oxbow Area based on a receptor's assumed typical foraging range (rather than assuming 100% site utilization), and concentrations of COPECs in biota were estimated using the 95% UCL of the mean concentrations in soil.

Comparison of estimated vermivorous avian egg and mammalian tissue concentrations with CBR data. Literature-derived biomagnification factors (BMFs) were used to estimate the TCDD TEQs in vermivorous mammal and avian egg tissues. The development of BMFs is discussed in Section 7.1.2 of the BERA (MACTEC, 2004). The following equation was used to estimate receptor tissue concentrations (either eggs for the woodcock or whole body tissue for the short-tailed shrew) based on prey tissue concentrations:

$$C_{avian_egg} = \frac{BMF * C_{earthworm} * \%lipid_{avian_egg}}{\%lipid_{earthworm}} \qquad \text{(Equation 3)}$$

where:

C_{avian_egg}	=	estimated chemical concentration in avian egg tissue (mg/kg - ww)
BMF	=	literature-based biota magnification factor (expressed as $kg_{earthworm\ lipid}/kg_{avian_egg\ lipid}$)
$C_{earthworm}$	=	estimated chemical concentration in earthworm prey (mg/kg ww)
$\%\ lipid_{avian_egg}$	=	lipid content of avian egg tissue (ww basis)
$\%\ lipid_{earthworm}$	=	lipid content of earthworm tissue (ww basis)

A similar transfer factor was used to estimate small mammal tissue concentrations based on dietary exposure to contaminated earthworms. BMFs for vermivorous wildlife were estimated using transfer factors obtained from the literature that were derived for gull egg tissue (based on adult consumption of fish) (Braune and Norstrom, 1989) and otter liver (based on consumption of fish) (Leonards et al., 1997). Estimated woodcock egg tissue concentrations for 4,4'-DDE and dieldrin (the only pesticide COPECs with both available BMFs and egg tissue CBRs) and TCDD TEQ are presented in Table 10. Table 11 presents the TCDD TEQ estimate for whole body shrew tissue.

3.2.2 Effects Assessment

The data used to establish the relationship between exposure and adverse effects to vermivorous receptors for both measures of effects are discussed below.

Comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs. Dose estimates were compared to TRVs compiled to support the BERA to derive HQs based on both NOAEL and LOAEL effect levels. TRVs used to derive hazard estimates are presented, along with the exposure estimates, in the E.1 tables for the woodcock receptor and E.2 tables for the shrew receptor. The selected TRVs were based on studies that reported effects on the key demographic endpoints of mortality, growth, or reproduction (Table D-4 of the Interim Final BERA [MACTEC, 2004]). No avian bird TRV for either antimony or cobalt is available, and the potential risks to birds associated with exposure to these two floodplain soil COPECs is discussed in the uncertainty evaluation.

Comparison of estimated vermivorous avian egg and mammalian tissue concentrations with CBR data. CBRs based on NOAEL and LOAEL values for avian egg and mammal tissue concentrations are presented in Table G-1 of the Interim Final BERA (MACTEC, 2004). Wildlife tissue concentrations derived using both the maximum and average estimated earthworm tissue concentrations were compared to both NOAEL- and LOAEL-based CBRs to estimate potential for adverse effects associated with the bioaccumulation of COPECs to wildlife receptors.

3.2.3 Risk Characterization

The results of the exposure and effects evaluations were combined to characterize potential risks to vermivorous wildlife receptors exposed to contaminated food and soil at the Oxbow Area. Results from the dose modeling and tissue residue analyses are discussed separately.

Comparison of estimated ingestion doses in vermivorous wildlife with TRVs and TEQs. The HQs for the woodcock and short-tailed shrew receptors based on 95%UCL exposure estimates are presented in the E.1 and E.2 Tables, respectively. Tables E.1-2 and E.1-4 present estimated doses to the woodcock receptor from exposure to 95% UCL of the mean COPEC concentrations in floodplain soil and estimated earthworm tissue concentrations, respectively; Tables E.2-3, E.2-5, and E.2-7 present estimated doses to the shrew receptor from exposure to 95% UCL of the mean concentrations in floodplain soil, estimated concentrations in plants, and estimated earthworm tissue concentrations, respectively. NOAEL- and LOAEL-based hazard estimates are combined across all exposure pathways for the woodcock (Tables E.1-5 and E.1-6, respectively) and shrew (Tables E.2-8 and E.2-9, respectively).

For the American woodcock, six COPECs exceed the NOAEL-based HQ: dioxins/furans (presented as bird dioxin TEQ), 4,4'-DDE, 4,4'-DDT, lead, zinc, and chromium (Table E.1-5). Risk from exposure to antimony could not be determined because neither a NOAEL nor a LOAEL TRV was identified. The total risk (HI) to vermivorous birds is 49, with the majority of risk attributed to dioxins/furans (26%), followed by 4,4'DDE (24%), 4,4'-DDT (21%), lead (13%), zinc (4%), and chromium (4%) (Figure 6). The remaining COPECs contribute 5% to the total risk. Of the total risk to the woodcock, 59% can be attributed to the incidental ingestion of soil during foraging and preening activities, while 41% can be attributed to the ingestion of soil macroinvertebrates. The estimated exposure dose of only three COPECs exceed the LOAEL-based TRVs (i.e., HQ greater than 1.0): dioxins/furans, 4,4'-DDE, and 4,4'-DDT. The total risk is 5.9, with the majority from dioxins/furans (22%), followed by 4,4'-DDE (20%), 4,4'-DDT (17%), lead (11%), copper (9%), chromium (7%), selenium (4%), and zinc (4%). Total Aroclor, nickel, arsenic, cadmium and mercury each contribute approximately 1% to the total risk (Table E.1-6, Figure 6).

For the short-tailed shrew, the dose estimates for eight COPECs exceed the NOAEL-based TRVs: dioxins/furans (presented as mammal dioxin TEQ), copper, antimony, arsenic, vanadium, selenium, cadmium, and molybdenum. The total HI is 350. The majority of risk (54%) is attributed to dioxins/furans, followed by copper (21%), antimony (20%), arsenic (1%), vanadium (1%), and selenium (1%) (Figure 7). The remaining COPECs contribute less than 1% to the total risk. Of the total risk to the shrew, 61% can be attributed to the ingestion of macroinvertebrates, while the ingestion of soil comprises 36% of the risk and the ingestion of plants accounts for only 3% of the total risk (Table E.2-8). For the LOAEL-based risk estimates, the HQs of only four

COPECs exceed 1.0: dioxins/furans, copper, antimony, and selenium (Table E.2-9, Figure 7). The total HI is 37. Dioxin accounts for the majority of the risk (51%), followed by copper (20%), antimony (19%), selenium (4%), and vanadium (2%). The remaining COPECs each contributed 1% or less to the total risk (Table E.2-9, Figure 7).

Figures 6 and 7 present the NOAEL- and LOAEL-based HQ estimates for the American woodcock and short-tailed shrew receptors, respectively. The HQs based on average exposure estimates are presented to facilitate comparison with the result from the Interim Final BERA for the other exposure areas containing floodplain habitat (i.e., Allendale Pond [APB] and Lyman Mill Pond [LPX]) along with results for the upriver background area (i.e., Greystone Mill Pond [GMP]). Only the subset of COPECs contributing most substantially to the overall HI is presented. In both Figures 6 and 7, the primary contribution of the dioxin TEQ (and specifically 2,3,7,8-TCDD [Figure C-2a, Appendix C]) to the overall risk estimate for the Oxbow Area, Lyman Mill Pond, and Allendale Pond is evident, as is the substantial risk relative to background conditions for this COPEC. While various pesticides (for vermivorous birds) and metals (vermivorous birds and mammals) also contribute to the overall risk estimates, their significance is less than that of dioxin TEQ. Moreover, hazard estimates at the Oxbow Area based on vermivorous wildlife exposure to inorganic COPECs are similar to or lower than the estimates derived for the Greystone background area.

Relative to the risk findings presented in the Interim Final BERA (MACTEC, 2004), potential risks to both vermivorous wildlife receptors exposed in the Oxbow Area appear to be somewhat higher than either for Allendale Pond and Lyman Mill Pond (Figures 6 and 7).

Comparison of estimated vermivorous avian egg and mammalian tissue concentrations with CBR data. Tables 10 and 11 summarize the HQs derived by comparing estimated woodcock egg tissue and shrew liver concentrations, based on exposure to maximum and average soil concentrations, to NOAEL- and LOAEL-based CBRs.

Joint estimated egg tissue residue and CBR values were only available for two pesticides (LOAEL-based CBRs only): 4,4'-DDE and dieldrin. For the maximum soil concentrations, both HQs exceed 1.0, with a combined HI of 70 (Table 10). For the average soil concentration, only the HQ for 4,4'-DDE exceeds 1.0 (2.5). For total dioxin (bird TEQ) all HQs exceed 1.0 (range

1.8-350). Thus, dioxin contributes the majority of the total risk to the avian egg tissue endpoint (Figure 8).

Estimated mammalian liver tissue concentrations for pesticides and dioxins were compared to NOAEL- and LOAEL-based CBRs to determine any potential risks to mammals (Table 11). Only risk from dioxin was calculated because combined tissue residues and CBRs were not available for pesticides. For the maximum dioxin TEQ soil concentration, the NOAEL-based HQ is 160, and the LOAEL-based HQ is 100; for the average soil concentration, the NOAEL-based HQ is 14, and the LOAEL-based HQ is 8.9 (Figure 9).

3.2.4 Risk Assessment Summary for Vermivorous Wildlife Populations

Tables 12 and 13 present the results of the incremental risk evaluation for the woodcock and shrew receptors, respectively. Only those COPECs with calculated NOAEL-based incremental HQs exceeding 1.0 are presented. In both cases, the incremental risks are dominated by the dioxin TEQ estimates (and specifically 2,3,7,8-TCDD [Figure C-2a, Appendix C]). For the woodcock receptor, the NOAEL- and LOAEL-based incremental risk HQs for the dioxin TEQ are 12 and 1.2, respectively, and contribute 35% of the total risk (Table 12). 4,4'-DDE also has NOAEL- and LOAEL-based HQs for incremental risks that both exceed 1.0 (11 and 1.1, respectively); the NOAEL-based HQ for 4,4'-DDT (9.9) is greater than 1.0, while the LOAEL-based HQ is below 1.0. Incremental risks were not calculated for lead, zinc, and chromium, because risks to vermivorous birds exposed in the Oxbow Area are lower than background. The incremental risks for the woodcock are somewhat higher than those derived for the Allendale Pond reach (NOAEL- and LOAEL-based incremental HQs of 6.6 and 0.6) and the Lyman Mill Pond reach (NOAEL- and LOAEL-based incremental HQs of 2.0 and 0.2) for the Interim Final BERA (Table 150 of MACTEC, 2004).

The results of the incremental risk evaluation for the shrew receptor suggest that risks to vermivorous mammals from estimated body burdens of Site-related contaminants are higher than for vermivorous birds (Table 13). Again, dioxins/furans make the most substantial contribution to the overall incremental risks (67%), with NOAEL-based and LOAEL-based HQs of 190 and 19 respectively. For the BERA, the incremental risks for the Allendale Pond reach for this COPEC are 130 and 13 for the NOAEL- and LOAEL-based HQs, respectively (Table 151 of MACTEC, 2004). Incremental risk estimates (34 and 3.4 for NOAEL- and LOAEL-based HQs, respectively) for Lyman Mill Pond reach are approximately one-third less than those observed for

the Allendale Pond reach (Table 151 of MACTEC, 2004) and six times lower than the Oxbow Area, indicating a potential for contaminated sediments to become trapped in the Oxbow during periods of high water or flood. Other COPECs contributing to the incremental risks include antimony and copper. Incremental risks to vermivorous mammals from all other COPECs are negligible (i.e., less than 1.0). The NOAEL- and LOAEL-based HQs for copper are 30 and 3.0, respectively, and 63 and 6.3, respectively, for antimony (Table 13). Nonetheless, 2,3,7,8-TCDD makes by far the most substantial contribution to the overall incremental risks determined for the Oxbow Area.

Vermivorous mammal and bird populations that occur within the Oxbow Area appear to be at substantial risk of harm due to direct exposure to Site-related contaminants in floodplain soil and prey items. 2,3,7,8-TCDD is the most substantial contributor to the estimated risks to vermivorous receptors. In addition, consumption of contaminated earthworm prey may result in elevated tissue residues in these receptors, resulting in adverse reproductive effects (i.e., bioaccumulation hazard). In addition to dietary exposures, modeled tissue burdens in avian eggs and mammal liver tissue also indicate a substantial risk of harm to vermivorous wildlife species.

These results assume that complete exposure pathways exist for these wildlife receptors in the Oxbow Area. The uncertainties associated with this assumption (including the presence of sensitive receptors in an urbanized setting and adequate forage base) are discussed in Section 4.2.

3.3 OMNIVOROUS MAMMAL POPULATIONS

This section evaluates risk to omnivorous mammal populations (as represented by the raccoon) from exposure to COPECs. The single measure of effects selected to evaluate the assessment endpoint for this receptor was the comparison of ingestion dose estimates to TRVs and TEQs. No comparison of CBRs to estimated omnivorous mammal tissue was conducted due to the uncertainties associated with tissue residues in receptors that consume a wide variety of food types. Section 3.3.1 presents the approach used to model COPEC exposures by omnivorous mammals.

3.3.1 Exposure Assessment

Daily dose estimates were derived for the raccoon receptor using the procedures described in Section 3.2.1. The exposure parameters presented in Table 14 (which are consistent with those

employed for the BERA) were used to estimate daily exposures associated with the incidental soil ingestion and consumption of contaminated food pathways.

As was done for the vermivorous receptors, dose estimates to the omnivorous wildlife receptor were estimated using 95% UCL of the mean concentrations of COPECs in Oxbow Area floodplain soil. Table C.3-1 presents the estimated plant tissue concentrations that were derived using literature BAFs, as was done in the BERA (MACTEC, 2004). The estimated doses for floodplain soil, floodplain plants, and contaminated earthworms are presented in Tables E.3-3, E.3-5, and E.3-7, respectively. Tables E.3-2, E.3-4, and E.3-6, document the exposure parameter assumptions used to derive the exposure estimates for each of these three environmental media. Exposures were estimated for the Oxbow Area based on a receptor's assumed typical foraging range (rather than assuming 100% site utilization), and concentrations in contaminated biota were estimated based on the 95% UCL of the mean concentrations in soil, rather than maximum, concentrations in contaminated biota.

3.3.2 Effects Assessment

Dose estimates were compared to TRVs compiled to support the BERA to derive HQs based on both NOAEL and LOAEL effect levels. TRVs used to derive hazard estimates are presented in the E.3 Tables along with the exposure estimates. The selected TRVs were based on studies that reported effects on the key demographic endpoints of mortality, growth, or reproduction (Table D-4 of the Interim Final BERA [MACTEC, 2004]).

3.3.3 Risk Characterization

The results of the exposure and effects evaluations were combined to characterize potential risks to omnivorous mammal receptors exposed to contaminated food and soil at the Oxbow Area.

The HQs for the raccoon are presented in Appendix E. Tables E.3-3, E.3-5, and E.3-7 present estimated doses to the raccoon receptor based on 95% UCL of the mean concentrations in floodplain soil and on estimated tissue concentrations in floodplain plants and earthworms. NOAEL- and LOAEL-based hazard estimates are combined across all exposure pathways and are presented in Tables E.3-8 and E.3-9, respectively.

For the raccoon, only the dioxin TEQ exceeds 1.0 for the NOAEL-based maximum soil HQ (Table E.3-8). The total risk is 3.3, with 64% of the risk attributed to dioxins/furans (presented as

the mammal dioxin TEQ). Another 20% is attributed to antimony, but the HQ for antimony does not exceed 1.0. The soil ingestion pathway contributes the majority of the risk (57%), followed by the ingestion of terrestrial macroinvertebrates (40%). For the LOAEL-based HQs, no COPEC exceeds 1.0, and the total risk is 0.42, suggesting that there are no unacceptable risks to omnivorous wildlife from exposure to soil contaminants in the Oxbow Area.

Figure 10 shows the NOAEL- and LOAEL-based HQ estimates for the raccoon receptor exposed to floodplain soils in the Oxbow Area. The HQs are presented to facilitate comparison with the results derived in the Interim Final BERA for the other exposure areas containing floodplain habitat (i.e., Allendale Pond [APB] and Lyman Mill Pond [LPX]) along with results for the upriver background area (i.e., Greystone Mill Pond [GMP]). Only the subset of COPECs contributing most substantially to the overall HI is presented. Although the NOAEL-based HQ for TCDD TEQ (i.e., 2,3,7,8-TCDD) exceeds 1.0, the LOAEL-based HQ does not exceed 1.0, nor do the HQs for any other COPEC. The risk estimates for the Oxbow Area appear to be elevated relative to the Interim Final BERA findings for Allendale Pond and Lyman Mill Pond; however, the Oxbow Area findings appear to support a similar conclusion that omnivorous wildlife is not at substantial risk of harm associated with foraging activities within this area. As discussed further in the Interim Final BERA (MACTEC, 2004), the exposure modeling for the raccoon assumed that an individual raccoon spends only 50% of its time foraging within the Woonasquatucket River floodplain; the aquatic exposures were found to pose more significant risks to this receptor (MACTEC, 2004).

3.3.4 Risk Assessment Summary for Omnivorous Mammal Populations

Table 15 presents the results of the incremental risk evaluation for the raccoon. Dioxins/furans were the only COPECs with calculated NOAEL-based incremental HQs exceeding 1.0, and this only slightly (1.6). These findings support a conclusion that the raccoon population (and other receptors with similar diets) is not likely at substantial risk of harm as a result of foraging within the Oxbow Area. Omnivorous mammal populations that forage within the study area are not at substantial risk of harm due to exposure to Site-related contaminants in floodplain soil and terrestrial prey items.

3.4 AQUATIC MACROINVERTEBRATE COMMUNITY

Potential risks to the aquatic macroinvertebrate community were evaluated using the measure of effects discussed in Section 2.6. This included a comparison of Oxbow Area sediment COPEC concentrations to benchmarks/guidelines.

3.4.1 Exposure Assessment

Exposure of macroinvertebrates to COPECs in Oxbow Area sediments was evaluated qualitatively using Oxbow Area sediment data. Table 2b summarizes the maximum and average COPEC concentrations that were used to estimate exposure of aquatic macroinvertebrates in this evaluation. Maximum and average concentrations were evaluated because of the lower mobility of many aquatic macroinvertebrates and the lower likelihood that exposures will be integrated over the range of concentrations.

3.4.2 Effects Assessment

The measure of effects selected to evaluate AE4, protection of the aquatic macroinvertebrate community, is:

- Comparison of sediment COPEC concentrations to exposure benchmarks;

TRVs used to evaluate the potential hazard associated with macroinvertebrate exposure to surface sediment are presented in Table D-2 of the Interim Final BERA (MACTEC, 2004). For this Supplemental BERA, the TRVs were compared to the maximum and average COPEC concentrations for Oxbow Area sediment (Table 2b) to determine whether contaminant concentrations pose any threat to aquatic macroinvertebrates. When contaminant concentrations exceed sediment benchmarks, there is a potential for adverse effects. Concentrations were also compared with sediment concentrations in adjacent Lyman Mill Pond, as well as upstream Allendale Pond and sediment PRGs.

3.4.3 Risk Characterization

This section evaluates the measure of effects established to characterize risk to the aquatic macroinvertebrate community. Sediment occurring within the Oxbow Area may pose risk of harm to aquatic receptors due to exposure to dioxins/furans, pesticides (including dieldrin, lindane, chlordane, endosulfan, 4,4-DDE, 4,4'-DDD, and 4,4'-DDT), PCBs (primarily Aroclors 1254 and 1268), metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt,

copper, lead, manganese, molybdenum, nickel, silver, vanadium, and zinc), and PAHs in Oxbow Area sediments (Table 2a).

Total dioxin congener concentrations in Oxbow Area sediments at nearly half of the sediment sample locations exceed mean concentrations in Lyman Mill and Allendale Pond sediments (Figure C-1b, Appendix C). Mean dioxin TEQs also exceed proposed sediment cleanup goals by more than an order of magnitude, and mean concentrations of 2,3,7,8-TCDD exceed the sediment cleanup goal by more than two orders of magnitude (Table 2b). Concentrations of Aroclor 1254 in Oxbow Area sediments at nearly half of the sediment sample locations are also greater than mean concentrations in Allendale and Lyman Mill Pond sediments (Figure C-3b, Appendix C). Mean concentrations of Aroclor 1254 exceed proposed sediment cleanup goals; however, mean concentrations of Aroclor 1268 do not (Table 2b). For pesticides, only concentrations of chlordane in Oxbow Area sediments are similar to median concentrations in Allendale and Lyman Mill Pond sediments, and endrin concentrations are lower for the Oxbow Area (Figure C-4b, Appendix C). Concentrations of most other pesticides exceed the median concentration for Allendale and Lyman Mill Pond sediments for at least half of the sediment sampling locations. Proposed cleanup goals for 4,4'-DDD, 4,4'-DDE, technical chlordane and dieldrin have been developed for sediments. Mean concentrations of dieldrin in Oxbow Area sediments exceed the proposed cleanup goals, but mean concentrations of 4,4'-DDE, 4,4'-DDD and technical chlordane are below cleanup goals (Table 2b). Total PAH concentrations at most locations for Oxbow Area sediments are greater than median concentrations in Allendale and Lyman Mill Pond sediments (Figure C-5b, Appendix C). Proposed PAH cleanup goals were developed for benzo(a)pyrene and dibenzo(a,h)anthracene, and mean concentrations of benzo(a)pyrene in Oxbow Area sediments exceed the cleanup goal but concentrations of dibenzo(a,h)anthracene do not. Lastly, concentrations of select metals in Oxbow Area sediment are similar to median concentrations of the same metals in Allendale and Lyman Mill Pond sediments (Figure C-6b, Appendix C). Proposed sediment cleanup goals have been developed for arsenic, barium, selenium, vanadium and zinc. Only mean concentrations of arsenic and zinc exceed sediment cleanup goals (Table 2b). However, medium and geometric mean concentrations of these metals do not.

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4.0 ECOLOGICAL RISK UNCERTAINTY ANALYSIS

This section discusses major limitations of the analyses, any sources of uncertainties, and, if possible, any indication as to whether these uncertainties and limitations may have resulted in an over-estimation or under-estimation of risk. The uncertainty section may also include unusual Site conditions or extenuating circumstances that may be pertinent to risk management decisions. Uncertainties in the quantification of risk associated with the Site are identified and their impacts on risk estimates are discussed below.

Uncertainties associated with the selection of COPECs, exposure assessment, effects assessment, and overall risk characterizations are discussed. The major uncertainties are summarized in Table 16.

4.1 PROBLEM FORMULATION

The main problem formulation uncertainties are associated with the selection of receptors, the identification and selection of COPECs, and the spatial boundary of the exposure area.

4.1.1 Selection of Receptors of Concern

The receptor species that were selected to represent vermivorous and omnivorous wildlife were selected because they would be expected to receive elevated exposures to contaminants that bioaccumulate in floodplain habitat. Although considerable time was spent by trained biologists in the study area during the 2001 field sampling program and wildlife and signs of wildlife have been observed, no quantitative census of wildlife populations occurred, and the presence of the selected wildlife receptor species in the Oxbow Area has not been confirmed. It is possible that the available habitat, which is located within an urbanized area, is not capable of supporting sensitive species such as the woodcock, for instance.

Consistent with the approach employed for the BERA, this Supplemental BERA did not specifically evaluate plant species as a receptor group; however, there is no indication that plants are sensitive to TCDD and other COPECs with dioxin-like effects as they lack an aryl hydrocarbon (Ah) receptor, which is the mode of action for dioxins/furans. Although certain inorganic analytes are known to have phytotoxic effects, levels of inorganic COPECs at the Oxbow Area appear to be generally consistent with background conditions for the watershed.

As noted during Site visits in April 2006 and March 2011, portions of the Oxbow Area are ponded throughout part of the year. While exposures to floodplain soil by soil macroinvertebrates and wildlife are evaluated in this Supplemental BERA, aquatic macroinvertebrates and amphibians may also be seasonally exposed. An amphibian call survey conducted at the Site confirmed the presence of these sensitive receptors in the Oxbow Area (USFWS, 2001; 2002). These receptors are not evaluated in this Supplemental BERA because surface water data were not available. Further toxicity data for amphibians is lacking. Additional work, including a vernal pool survey, could provide additional information necessary to evaluate the significance of these other exposures.

Furthermore, one of the assumptions for the wildlife exposure modeling is that the habitat provides a soil macroinvertebrate forage base adequate to support populations of vermivorous wildlife such as woodcock and shrews. If surface hydrology results in Oxbow Area soils remaining saturated throughout a substantial portion of the year, this assumption may result in exposures for these receptors being overestimated, as utilization of more low-lying areas by terrestrial receptors could be limited. This would particularly be the case if COPEC concentrations are positively correlated with the more depositional, higher organic carbon areas that would be more prone to prolonged flooding conditions. However, the level of uncertainty associated with this assumption cannot be determined without a soil macroinvertebrate survey.

4.1.2 Identification and Selection of COPECs

The extensive environmental investigations have provided a substantial body of information that has been utilized in the BERA and Supplemental BERA. The identification of COPECs was done in a conservative manner to ensure that the quantification of risk to ecological receptors included all relevant potential stressors. The use of conservative screening benchmarks that considered both macroinvertebrate and wildlife protectiveness ensured that all relevant contaminants were retained for the analysis.

It is also assumed that the total measured concentrations of contaminants are 100% bioavailable. In reality, only a fraction of the total concentrations is available for uptake by ecological receptors. The fraction that is bioavailable depends on a variety of environmental conditions, including pH and organic carbon content of soils and sediment, as well as the presence of ligands.

Although Oxbow Area floodplain soil samples were not evaluated for exposures to certain analytical parameters evaluated in the BERA (including coplanar PCB congeners and hexachloroxanthene [HCX]), it is unlikely that the conclusions drawn in this report would have been significantly affected had these additional data been available. Based on the toxicological assessment conducted in the BERA, HCX is most likely a relatively poor Ah receptor agonist compared to TCDD, and exposure to the most elevated concentrations detected in Site media posed minimal ecological risk. The risk findings presented in this Supplemental BERA are very much in accordance with the Interim Final BERA findings (in both nature and magnitude of the hazards posed) (MACTEC, 2004), and there is no reason to suspect that general fate and transport characteristics of Site-related contaminants would somehow operate differently in the Oxbow Area compared to other portions of the Site. Given the predominant role of TCDD as the primary risk contributor to wildlife in both assessments, the conclusions presented appear to be robust.

4.1.3 Area Boundary Delineation

An additional uncertainty relates to the determination of the boundary of the Oxbow Area. Consistent with the CSM, the 100-year flood elevation was used to determine the spatial boundaries of the Oxbow Area. Although there may be some uncertainty regarding the most appropriate elevation for boundary determination, this boundary is appropriate because it accounts for the area that could be affected by transport of Site-related contaminants from flood events that have occurred during and since the period of historical Site operations. Sample locations that appear to fall outside of this boundary (SS_G-01-04 and possibly SS_G-12 [see Figure 3]) have a different contamination "signature" (particularly with regard to dioxins/furans), with TCDD representing a smaller fraction of the total TEQ concentration and OCDD representing a relatively larger fraction. This may indicate the lack of a complete contaminant migration pathway from the source area. However, there is also some uncertainty associated with the spatial resolution of the boundary for the 100-year floodplain, and the differences in the contaminant signature may be due primarily to these sample locations being in areas of fill. Theoretically, areas that are less prone to flooding are less likely to be impacted by contaminant migration from the Site, and inclusion of data for sample locations that appear to be outside of the 100-year floodplain may result in underestimating risks to wildlife from exposure to Site-related contaminants because of the reduced importance of 2,3,7,8-TCDD, the most toxic dioxin/furan, in these areas. Risk estimates for soil macroinvertebrates would likely be unaffected because risks to this receptor group are driven primarily by pesticides and metals, and concentrations of these contaminants within the floodplain are similar to upgradient levels.

4.2 EXPOSURE AND MODELING UNCERTAINTIES

The major exposure-related uncertainties are associated with the selection of exposure parameters and estimation of BAFs for various environmental media.

4.2.1 Measured Concentrations of Contaminants

Some issues were identified with the data used for the exposure estimates that could affect the accuracy and precision of measured exposure concentrations, potentially leading to an overestimate or underestimate of risk. For this evaluation, field duplicate samples were not used to estimate exposure concentrations and were only used for QC. In most cases, concentrations of contaminants in duplicate samples were similar to concentrations in the original sample; however, in some cases concentrations in duplicate samples were higher or lower than the sample used for exposure concentrations. For example, pesticide/herbicide and PCB concentrations in the LPX-FP-4004 duplicate were 6 to 7 times higher than concentrations in the original sample, suggesting that exposure concentrations at this location may have been underestimated.

Some samples collected needed to be reanalyzed because of low percent solids. The precision and accuracy of results for samples with less than 30% solids is considered to be low. Sediment and soil samples from sample locations LPX-SD-4402 and LPX-SD-4407 for PCB/pesticide analysis contained less than 30% solids (Battelle, 2004a). Additional processing was performed on the LPX-SD-4402 and LPX-SD-4407 samples to meet EPA Region 1 guidance that the solids content be 30% or higher. Specifically, the samples were centrifuged, the overlying water decanted, and the moisture content determined again. However, the solids content remained below 30% for both of these samples. The freeze-dried counterparts to these samples were used for PCB/pesticide analysis. Both the wet and freeze-dried samples were extracted and analyzed for PCB/pesticides.

Analytical data for the wet and freeze-dried samples from location LPX-SD-4407 were similar, and data from the freeze-dried sample was used in this evaluation. PCB/pesticide data did not compare well, however, for the wet and dry samples from location LPX-SD-4402. For example, the concentration of Aroclor 1254 in the freeze-dried sample was approximately 20 times higher compared to the Aroclor concentration in the wet sample. A field duplicate, which was not freeze-dried, was also collected from this location (LPX-SD-4402). PCB/pesticide data for the field duplicate was more comparable to data for the wet sample than for the freeze-dried sample.

However, the results from the freeze-dried sample are comparable to samples collected by Tetra Tech NUS (2000a) in 1999 in the vicinity of the Oxbow Area. It appeared that sample heterogeneity was the most reasonable explanation for the differences. Overall, data from the freeze-dried sample were used to ensure a conservative estimate of exposure and to ensure that EPA Region 1 specific guidance regarding percent solids content was met. This may have resulted in an overestimate of the exposure concentration at this location. Further discussion regarding this sampling event and the analyses performed are available in the *Task RI-12 Oxbow Area Sediment Investigation, Chemistry Data Report* (Battelle, 2004a).

Some exposure concentrations may be underestimated because of limited analysis at some locations. For example, only 2,3,7,8-TCDD was analyzed for the CMS samples collected from the old mill raceway. This likely resulted in an underestimate of the dioxin TEQ, but because 2,3,7,8-TCDD is the largest contributor to the total dioxin TEQ in the Oxbow Area and because data for the CMS samples were averaged, the impacts to the risk estimates are expected to be minimal. Total Aroclor concentrations at location SS_G-01-02 at the north end of the Oxbow Area may also be underestimated because some of the Aroclor data were rejected during data validation and the Total Aroclor calculation is based on fewer Aroclors. Although the Total Aroclor exposure concentration may be slightly underestimated, the impacts to the risk estimate are expected to be minimal because the data for the dominant Aroclors (Aroclor 1254 and Aroclor 1268) were not rejected.

Dioxins/furans were reanalyzed for some sample locations (e.g., SS_G-01-01) because concentrations exceeded instrument calibration limits. For location SS_G-01-01 at the north end of the Oxbow Area, data for the reanalyzed sample also exceeded the calibration limit, and dioxin/furan concentrations may be underestimated.

4.2.2 Exposure Parameters

The relationship between receptor size and dietary intake is a critical factor in estimating exposure. In addition, dietary composition affects exposure because different food sources contain varying levels of COPECs. Although literature information exists for dose calculation inputs such as body weight, ingestion rate, and dietary composition for each receptor evaluated in this Supplemental BERA, natural populations may exhibit considerable variability in these parameters. Use of literature-derived exposure parameters increases uncertainty, which could result in an overestimate or underestimate of the typical exposures encountered by receptors at the

Oxbow Area. The wildlife exposure models were parameterized using available information for adult females for each selected receptor species, and average values were selected for the parameter values where a range of data were provided.

4.2.3 Exposure Concentrations

Exposure concentrations used for soil macroinvertebrates were maximum and average (arithmetic mean) concentrations of COPECs in Oxbow Area floodplain soils. This approach is appropriate because of the low mobility of many soil macroinvertebrates and lower ability of soil macroinvertebrates to actively avoid areas of elevated contamination. However, depending on the finer scale distribution of contaminants in Oxbow Area soils, this may have resulted in an overestimate of risk because it is likely that most points within the Oxbow have lower exposure concentrations. Even the average concentrations of COPECs are likely to overestimate risk because contaminant concentrations are unlikely to follow a normal probability distribution; the geometric mean or median concentration is more representative of the distribution of contaminants.

Exposure concentrations of contaminants for wildlife are estimated as the 95% UCL of the mean concentration. This statistic is used to ensure with 95% certainty that the average exposure integrated over the exposure area is represented, based on the available data. How accurately this value represents the average exposure depends on how well the data collected characterize exposure concentrations in the exposure area and whether receptor exposures are uniform across the exposure area. For COPECs with low detection frequencies (aldrin, lindane, and endrin), maximum detected concentrations were used for EPCs, likely resulting in an overestimate of risk from these COPECs.

Sampling events conducted prior to 2010 targeted low-lying areas to determine whether deposition of contaminated sediment within the floodplain during periods of high water or flood resulted in transport of Site-related contaminants into the Oxbow Area, consistent with the CSM. Targeting areas where contamination is likely to be elevated may result in an overestimate of risk. The 2010 sampling event, for which there is the greatest amount of data, took a less biased approach to fully characterize contamination across the Oxbow Area; however, there is the potential to miss areas of elevated concentrations using this approach (depending on the size of areas where contamination may be elevated), which could result in an underestimate of risk.

During some sampling events, replicate samples or clusters of samples were collected in some areas to characterize the spatial heterogeneity of contamination. This has the potential to bias exposure estimates toward contamination in a particular area, resulting in an overestimate or underestimate of risk, depending on whether COPEC concentrations in that area are elevated. To reduce the potential for biasing exposure concentrations, clusters of samples and replicate samples were averaged before being used to calculate 95% UCLs. In several cases, there was high variability in COPEC concentrations for samples collected from the same location or area due to high spatial heterogeneity. It is possible that the average concentration does not accurately represent exposure concentrations for that location, and the average concentrations of COPECs may have been biased high or biased low. Had a more conservative approach been used and the maximum concentration for a location been included in the 95% UCL estimates, 95% UCLs would have been biased high. This is because the maximum concentrations of COPECs at some locations (e.g., SS_G-01 at the north end of the Oxbow Area and SS_G-29 on the east bank of the Woonasquatucket River behind the Boys and Girls Club), particularly 2,3,7,8-TCDD, were extremely elevated. However, the use of mean concentrations for replicate samples and clusters of samples would not affect the conclusion that there is actionable risk in the Oxbow Area.

One of the major exposure assumptions is that there is an equal likelihood for wildlife receptors to utilize any location within the Oxbow Area (i.e., exposures across the Oxbow Area are uniform). Typically, wildlife receptors will favor some areas over others for several reasons, including availability of food and shelter. If there is a lower abundance of food and prey items or shelter at a particular location where there is elevated contamination, a wildlife receptor may be less likely to utilize that area, reducing its exposure to contamination. This may be the case for the old mill raceway, where contamination is elevated but habitat is less available and of lower quality. Alternatively, if elevated concentrations of contaminants do not impact food availability and there is an abundance of food and prey items as well as shelter, a wildlife receptor may preferentially utilize that area, resulting in greater exposure to contaminants. This may be the case for Oxbow Area locations SS_G-01 and SS_G-29 (Figure 3), where dioxin concentrations are elevated and high-quality habitat appears to occur. There is uncertainty associated with assuming uniform exposure of wildlife receptors across an exposure area, and risk may be either overestimated or underestimated.

Furthermore, there is some distance between habitat and exposure area patches in the Oxbow Area. The old mill raceway is located east of the Woonasquatucket River about 300 ft north of

the northernmost point of the Oxbow Area. The wooded wetland area on the west bank of Lyman Mill Pond at the mouth of Assapumpset Brook is approximately 700 ft south of the southernmost point of the Oxbow Area. The wooded wetland area on the east bank of Lyman Mill Pond is approximately 1,600 ft from the southernmost point of the Oxbow Area and approximately 600 ft across Lyman Mill Pond from the wooded wetland area on the west bank. Without connectivity and habitat corridors between the Oxbow Area and smaller wooded wetland areas, it is unlikely that exposures across the Oxbow Area are uniform, especially for smaller receptors such as the shrew. Depending on where a receptor spends the majority of its time, risks may be overestimated or underestimated. However, the objective of the risk assessment was to evaluate risks to soil macroinvertebrates and wildlife for the Oxbow Area as a whole to determine whether there is a potential for adverse effects due to migration of Site-related contaminants into the floodplain as a result of high water and flood events, and each of the floodplain areas on Lyman Mill Pond has the potential to be impacted by such events. Any remedial alternatives that are implemented will address contamination in each of these areas separately. This is because the process of quantifying risks (and the uncertainties associated with various assumptions involved) considers average population exposures across an exposure area while that followed to determine a remedial footprint involves a point-by-point comparison to proposed cleanup goals.

4.2.4 Contaminant Distribution with Soil Depth

Oxbow Area floodplain soil analytical data used for this Supplemental BERA were for samples collected from the topmost (predominantly 0-0.5 ft bgs and 0-1 ft bgs) soil layer only. Samples were also collected at 1-2 ft bgs and 2-3 ft bgs at a limited number of locations. Although surface soil is most relevant to the exposure pathways evaluated for ecological risk, the vertical resolution of the distribution of COPECs is still relatively coarse. It is not known whether contaminants are evenly distributed over this soil depth or concentrated in a particular layer of the 0 – 1-ft soil horizon. While burrowing soil macroinvertebrates may be exposed to contaminants at any depth within this soil layer, macroinvertebrates associated with leaf litter and non-burrowing wildlife receptors are likely to be exposed only to the uppermost surface soils. It is not clear how this uncertainty affects the magnitude of exposure to the primary risk contributors. Concentrations of contaminants in deeper soil are also not well-characterized because deeper soils samples have been collected only at a limited number of locations. Therefore, potential exposures related to removal of surface soil are not well-understood. Additional soil sampling may be required to support the remedial design.

4.2.5 Bioaccumulation Factors

Site-specific prey tissue data were available to estimate exposures to most of the wildlife receptor species evaluated in the BERA, which minimized uncertainties associated with this aspect of exposure estimation for this Supplemental BERA. Derived BSAFs were used to estimate earthworm tissue concentrations because no measured biota data were available.

Literature uptake factors were used to estimate plant tissue concentrations because no Site-specific tissue data were collected. There is greater uncertainty associated with the use of literature values. In addition, although TCDD is known to bioaccumulate in the tissue of some aquatic plant species (e.g., Yockim et al., 1978), no attempt to model the uptake of dioxin, furan, or PCB congeners into plant tissue was made in the wildlife exposure modeling. As a result, dietary exposures to omnivorous wildlife (e.g., raccoon) may be underestimated.

Exposure estimates for avian egg and mammal tissue were likely underestimated because BMF values were available for only a subset of COPECs. For instance, no BMF is available for estimating uptake of Aroclor mixtures or bioaccumulating inorganic analytes into avian egg tissue; for mammal tissue, the only non-dioxin/furan congener BMF available was for total Aroclors. The lack of BMFs resulted in risks for this endpoint being underestimated.

4.3 ECOLOGICAL EFFECTS

The major effects-related uncertainties are associated with the selection of TRVs; the BERA provides a detailed discussion of those related to the Site-derived data (i.e., floodplain soil community study) that was referenced in this Supplemental BERA.

4.3.1 Toxicity Reference Values

Potential uncertainties are related to the appropriateness of literature-derived toxicity data. TRVs used in this Supplemental BERA are based on an extensive search of both primary peer-reviewed literature and secondary literature, such as government reports and technical conference proceedings. The number and types of information sources reviewed is believed to be adequate to capture the majority of relevant sources of ecotoxicological literature.

Chronic toxicological data were selected preferentially in developing TRVs. However, available toxicological data are not always associated with chronic exposure duration. Therefore, there are uncertainties in extrapolating the results of shorter-term exposures to the chronic exposures

assumed for receptors at the Oxbow Area. Chronic NOAELs were the preferred toxicity endpoint for selection of TRVs; however, ecological toxicity data were limited for some COPECs and some wildlife guilds. Therefore, other endpoints (e.g., subchronic NOAELs or LC_{50} values) were selected for use as TRVs. When an endpoint other than a chronic NOAEL was selected as a TRV, an uncertainty factor was applied to the reported value to provide an additional level of conservatism in the risk estimation process. The use of conservative application factors may result in risks being overestimated.

There are little or no toxicological data available for some COPECs. For instance, no avian effects data were available for antimony or cobalt, and there was no information available to establish CBRs for some of the analytes estimated in earthworm and wildlife tissue. As a result, ecological hazards posed by certain COPECs could not be quantified. This may underestimate ecological risks at the Oxbow Area. Another uncertainty related to the CBRs involves the use of unbounded study results (i.e., cases where studies that only reported an effect or lack of effect to an organism over the tissue concentration range evaluated). Use of unbounded data occasionally resulted in a LOAEL-based CBR being lower than the corresponding NOAEL-based value. This counterintuitive artifact of the method used to derive the CBRs highlights the uncertainties associated with the available tissue residue effects data.

In general, uncertainty is also associated with the extrapolation of literature-derived toxicity endpoints (especially laboratory-based studies) to equivalent endpoints for measures of effects for receptors at the Site because of discrepancies in exposure conditions. The majority of the toxicity data evaluated and used in the BERA were derived from laboratory studies. Laboratory settings do not necessarily mimic field conditions and exposures and typically are designed to control various factors in order to isolate one parameter in particular. Although controlled experiments result in a more valid interpretation of the isolated parameters, uncertainty is associated with the assumption that field exposures are equivalent to laboratory exposure conditions.

4.3.2 Dioxin and Furan Congeners

Wildlife exposures to dioxin and furan congeners were estimated using TRVs similar to those recommended in USEPA (1993f) and the consensus-based toxicity equivalency factors (TEFs) from Van den Berg et al. (1998, 2005). This approach represents the most recent risk assessment approach for evaluating dioxins and furans. This approach has been employed because there is not adequate toxicity testing for each of the hundreds of dioxin and furan congeners. Although

the use of TEFs has a sound scientific basis, there is some uncertainty (including assumption of additivity and methods used to determine relative potency) associated with their use in estimating the ecological effects from exposure to dioxin-like compounds. However, the predominant congener detected in Oxbow Area floodplain soils is 2,3,7,8-TCDD. Because this congener is considered to be the most toxic of the dioxin and furan congeners, the issue is relatively unimportant for this particular assessment.

The TEQ approach also does not account for toxicity of dioxin/furan and PCB congeners that have a non AhR-mediated toxicological mechanism. However, risk associated with exposure to compounds that exhibit non-dioxin like effects was separately considered using toxicological data for PCB mixtures.

4.4 RISK CHARACTERIZATION UNCERTAINTIES

In addition to the uncertainties introduced as a result of the data availability and representativeness issues discussed above, the major source of uncertainty associated with risk characterization involves the interpretation of HQ results. Due to the conservative assumptions that were made in developing both exposure and effects assessments, HQs that are greater than 1.0 do not indicate that substantial population- or community-level harm has occurred. Attempts were made to bound these uncertainties in this Supplemental BERA by considering risk associated with both chronic NOAELs and LOAELs and evaluating risks using both maximum and average exposure estimates.

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5.0 CONCLUSIONS

The main objectives of this Supplemental BERA were to refine the COPECs based on a more complete and representative data set for the Oxbow Area; quantify risks to soil macroinvertebrates, vermivorous wildlife receptors, and omnivorous wildlife receptors that could potentially be exposed to COPECs in the Oxbow Area; and qualitatively evaluate contaminant concentrations in sediments for the Oxbow Area scrub-shrub habitat, where ecological exposures are limited. A comparison of maximum contaminant concentrations in floodplain soil generally identified the same COPECs that were identified during the BERA (MACTEC, 2004). These included 17 metals, 8 pesticides, 3 Aroclors plus Total Aroclors, HMW and LMW PAHs and Total PAHs, and TEQs for birds and mammals. Risks to wildlife were evaluated for a refined list of COPECs that focuses on the most significant exposures. Table 17 summarizes the results for each of the assessment endpoints. The findings for each endpoint receptor are summarized below.

Assessment Endpoint 1, Protection and Maintenance of the Floodplain Soil Macroinvertebrate Community.

- Based on a comparison of maximum and average floodplain soil concentrations to macroinvertebrate screening benchmarks, the soil macroinvertebrate community occurring within the Oxbow Area may be at risk of harm (i.e., hazard index [HI] exceeds 1.0) due to direct exposure to pesticides (including 4,4'-DDT, 4,4-DDE, 4,4'-DDD, dieldrin, lindane [gamma-chlordane], and endrin) (HI = 62), metals (including chromium, copper, manganese, mercury, vanadium, zinc, and potentially aluminum [depending on soil pH]) (HI = 94), and PAHs (HI=13) in floodplain soil. The total risk (HI=170) is similar to direct exposure risks for soil macroinvertebrates in Allendale Pond floodplain soils (HI=170) and two times lower than those estimated in the BERA for Lyman Mill Pond (HI=230) for the BERA, and risks to soil macroinvertabrates at all three areas are below background risks at Greystone Mill Pond (HI=850).
- Body burdens of bioaccumulated metals, primarily cadmium, lead, manganese, nickel, vanadium, zinc, and possibly aluminum (depending on soil pH) appear to pose a substantial risk of harm to soil macroinvertebrates (no observable adverse effects level [NOAEL]-based HI = 770 and lowest observable adverse effects level [LOAEL]-based HI = 120 with aluminum, and HIs = 30 and 18 without HQs for alumunim). However, risks are substantially lower than risks from body burdens of metals for soil macroinvertebrates exposed to floodplain soil at Allendale Pond, Lyman Mill Pond, and Greystone Mill Pond.
- An evaluation of the soil macroinvertebrate community study conducted to support the BERA suggests that the macroinvertebrate fauna is most likely comparable to other exposure areas at the Site and is not distinguishable from the upriver background area.

Assessment Endpoint 2, Protection and Maintenance of Vermivorous Wildlife Populations.

- Vermivorous mammal and bird populations that occur within the Oxbow Area appear to be at risk of harm due to direct exposure to Site-related contaminants in floodplain soil and prey items. 2,3,7,8-TCDD is the most substantial contributor to the estimated total risks to vermivorous mammals, contributing approximately 51% of the total risk, followed by metals. Pesticides are the most substantial contributor to the estimated total risks to vermivorous birds, followed by 2,3,7,8-TCDD, contributing approximately 46% and 26% to the estimated total risk, respectively. In addition, based on modeled tissue concentrations, consumption of contaminated earthworm prey may result in elevated tissue residues in these receptors, potentially resulting in adverse reproductive effects (i.e., bioaccumulation hazard). Although risks to vermivorous wildlife in the exposure areas evaluated for the BERA are also from exposure to dioxins and metals, risks from dietary exposure estimated for Allendale Pond and Lyman Mill Pond for the BERA are up to two times lower than risks at the Oxbow Area. Risks to vermivorous mammals in the Oxbow Area are 2.5 times higher than background; however, risks to vermivorous birds are similar to background.
- Modeled tissue burdens pesticides and 2,3,7,8-TCDD in avian eggs and 2,3,7,8-TCDD in mammal liver tissue as a result of potential dietary exposures pose a substantial risk of harm to vermivorous wildlife species. Risks are similar to those at Allendale Pond, but are two to three times higher than previously estimated risks from exposure to Lyman Mill Pond sediment. Estimated background risks are insignificant.

Assessment Endpoint 3, Protection and Maintenance of Omnivorous Wildlife Populations.

- Omnivorous mammal populations that forage within the study area are not at substantial risk of harm from exposure to Site-related contaminants in floodplain soil and terrestrial prey items. This is consistent with risks from exposure to Allendale Pond and Lyman Mill Pond floodplain soil estimated for the BERA.

Assessment Endpoint 4, Protection and Maintenance of the Aquatic Macroinvertebrate Community.

- Based on a comparison of maximum and average Oxbow Area sediment concentrations to screening benchmarks, the aquatic macroinvertebrate community occurring within the Oxbow Area may be at risk of harm due to exposure to dioxins/furans, pesticides (including dieldrin, lindane, chlordane, endosulfan, 4,4-DDE, 4,4'-DDD, and 4,4'-DDT), PCBs (primarily Aroclors 1254 and 1268), metals (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, silver, vanadium, and zinc), and PAHs in Oxbow Area sediments. The same COPECs were identified for Oxbow Area sediments as for Oxbow Area floodplain soil and Lyman Mill Pond sediments.

Oxbow Area Sediment Evaluation.

- Except for metals, concentrations of COPECs in Oxbow Area sediments for at least half of the sample locations are higher than mean or median concentrations in Allendale and Lyman Mill Pond sediments. For example, 2,3,7,8-TCDD concentrations were approximately three times higher in Oxbow Area sediment than in Lyman Mill Pond

sediments and twice as high as concentrations in Allendale Pond sediments, suggesting that the Oxbow Area scrub-shrub habitat is a net depositional environment and has a potential to serve as a sink for sediment-bound contaminants.

- Mean concentrations of 2,3,7,8-TCDD, dioxin TEQs, dieldrin and Aroclor 1254 exceed proposed sediment cleanup goals (Battelle, 2010); however, concentrations of other contaminants that are key risk drivers in sediment do not.

NEXT STEPS

The RI and FS for the Site have been completed (Battelle, 2005 and 2010). In support of the FS, preliminary remediation goals (PRGs) have been estimated for COPECs posing incremental risk to wildlife. Following an evaluation of the applicability of the existing ecological PRGs for floodplain habitats, specific PRGs for the Oxbow Area may be discussed in further detail in a separate document. The calculated risks for the reference area and background area will also be a consideration in the derivation of PRGs and the selection of remedial alternatives. The results of the RI/FS will be used to formulate a Proposed Plan for the Site, including the Oxbow Area. The Proposed Plan will recommend remedial actions that will result in overall protection of human health and the environment, fulfill Superfund requirements, be acceptable to stakeholders, and satisfy USEPA remedial guidelines.

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TABLES

TABLE 1. FLOODPLAIN SURFACE SOIL AND SEDIMENT SAMPLES COLLECTED FROM THE OXBOW AREA
Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Boring Location (depth in feet)	Dioxins/ Furans	2,3,7,8-TCDD only	Grain Size Analysis	Metals	VOCs/ SVOCs	Pesticides/ PCBs	TOC	pH
Sediment Sample Locations								
LPX-SD-4401 (0-0.5)	X			X				
LPX-SD-4402 (0-0.5)	X			X		X[a]	X	
LPX-SD-4403 (0-0.5)	X							
SD_G-01 (0-1)	X		X	X	X	X	X	X
SD_G-02 (0-1)	X		X	X	X	X	X	X
SD_G-03 (0-1)	X		X	X	X	X	X	X
SD_G-04 (0-1)	X		X	X	X	X	X	X
SD_G-05 (0-1)	X		X	X	X	X	X	X
SD_G-06 (0-1)	X		X	X	X	X	X	X
SD_G-07 (0-1)	X		X	X	X	X	X	X
SD_G-09 (0-1)	X		X	X	X	X	X	X
SD_G-10 (0-1)	X		X	X	X	X	X	X
SD_G-11 (0-1)	X		X	X	X	X	X	X
SD_G-12 (0-1)	X		X	X	X	X	X	X
SD_G-17 (0-1)	X		X	X	X	X	X	X
Soil Sample Locations								
CMS-217 (0-0.25)		X						
CMS-218 (0-0.25)		X						
CMS-219 (0-0.25)		X						
CMS-458 (0-0.25)		X						
CMS-459 (0-0.25)		X						
LPX-FP-4004 (0-0.5)	X		X	X	X	X	X	
LPX-FP-4007 (0-0.5)	X		X	X	X	X[b]	X	
LPX-SD-4405 (0-0.5)	X							
LPX-SD-4406 (0-0.5)	X							
LPX-SD-4407 (0-0.5)	X			X		X	X	
RES-10-005-01 (0-1)	X			X	X	X		
RES-10-005-02 (0-1)	X							
RES-10-005-03 (0-1)	X							
RES-10-042-01 (0-1)	X			X	X	X		
RES-10-042-02 (0-1)	X							
RES-10-042-03 (0-1)	X							
RES-10-044-01 (0-1)				X	X	X		
RES-10-044-02 (0-1)	X							
RES-10-044-03 (0-1)	X							
RES-10-604-01 (0-1)	X			X	X	X		
RES-10-604-02 (0-1)	X							
RES-10-604-03 (0-1)	X							
RES-11-011-01 (0-1)	X			X	X	X		
RES-11-011-02 (0-1)	X							
RES-11-011-03 (0-1)	X							
RES-11-012-01 (0-1)	X			X	X	X		
RES-11-012-02 (0-1)	X							
RES-11-012-03 (0-1)	X							
RES-11-419-02 (0-1)	X							
RES-12-556-01 (0-1)	X			X	X	X		
RES-12-556-02 (0-1)	X							
RES-12-560-01 (0-1)				X	X	X		
RES-12-560-02 (0-1)				X	X	X		
SS_G-01 (0-1)	X		X	X	X	X	X	X
SS_G-01-01 (0-1)	X		X	X	X	X	X	X
SS_G-01-02 (0-1)	X		X	X	X	X	X	X
SS_G-01-03 (0-1)	X		X	X	X	X	X	X

TABLE 1. FLOODPLAIN SURFACE SOIL AND SEDIMENT SAMPLES COLLECTED FROM THE OXBOW AREA
Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Boring Location (depth in feet)	Dioxins/ Furans	2,3,7,8-TCDD only	Grain Size Analysis	Metals	VOCs/ SVOCs	Pesticides/ PCBs	TOC	pH
SS_G-02 (0-1)	X		X	X	X	X	X	X
SS_G-03 (0-1)	X		X	X	X	X	X	X
SS_G-04 (0-1)	X		X	X	X	X	X	X
SS_G-05 (0-1)	X		X	X	X	X	X	X
SS_G-06 (0-1)	X		X	X	X	X	X	X
SS_G-07 (0-1)	X		X	X	X	X	X	X
SS_G-08 (0-1)	X		X	X	X	X	X	X
SS_G-09 (0-1)	X		X	X	X	X	X	X
SS_G-14 (0-1)	X		X	X	X	X	X	X
SS_G-15 (0-1)	X		X	X	X	X	X	X
SS_G-18 (0-1)	X		X	X	X	X	X	X
SS_G-23 (0-1)	X		X	X	X	X	X	X
SS_G-26 (0-1)	X		X	X	X	X	X	X
SS_G-29 (0-1)	X		X	X	X	X	X	X
SS_G-29-01 (0-1)	X		X	X	X	X	X	X
SS_G-29-02 (0-1)	X		X	X	X	X	X	X
SS_G-30 (0-1)	X		X	X	X	X	X	X
SS_G-31 (0-1)	X		X	X	X	X	X	X
SS_G-32 (0-1)	X		X	X	X	X	X	X
SS_G-33 (0-1)	X		X	X	X	X	X	X
WRL-SD-2038 (0-0.5)	X		X	X	X	X	X	
2010 Soil Sample Locations Excluded from the Supplemental BERA								
SS_G-01-04 (0-1)	Sample located in an area of fill that is elevated above the 100-year floodplain							
SS_G-10 (0-1)	Sample located in an area of fill that is elevated above the 100-year floodplain							
SS_G-12 (0-1)	Sample located in an area of fill that is elevated above the 100-year floodplain							
SS_G-13 (0-1)	Sample located in an area of fill that is elevated above the 100-year floodplain							

[a]Sample contained <30% solids; the sample was extracted twice, first using the wet, low-solids content sediment material and again using freeze-dried material from the same sample location. Sample data for the wet and freeze-dried material extracts did not compare well, and data for freeze-dried sample was used in the BERA.

[b]Sample contained <30% solids; the sample was extracted twice, first using the wet, low-solids content sediment material and again using freeze-dried material from the same sample location. Sample data for the wet and freeze-dried material extracts compared well, and data for the freeze-dried sample is reported.

TABLE 2a
SELECTION OF CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN (COPECs) FOR OXBOW STUDY AREA SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Standarized CAS#	Chemical Category/Name	Minimum Detected	Maximum Detected	Maximum Detected Qualifier	Units	Location of Maximum Detected	Number of Samples Detected	Number of Samples Measured	Selected Soil Benchmark[a]	Number Exceeding Benchmark	Retain as COPEC?	Rationale[b]	Arithmetic Mean	Standard Deviation of the Arithmetic Mean	Median	Geometric Mean	Standard Deviation of the Geometric Mean
	Dioxins/Furans																
35822469	1,2,3,4,6,7,8-HpCDD	6.4	1739.31	J	PG/G_DRY	LPX-FP-4007	51	51	not available	-	No	A	189.20	281.64	91.20	91.18	3.58
67562394	1,2,3,4,6,7,8-HpCDF	2.6	843.93	J	PG/G_DRY	LPX-FP-4007	51	51	not available	-	No	A	74.87	128.58	32.90	34.49	3.48
55673897	1,2,3,4,7,8,9-HpCDF	0.244	38.93	J	PG/G_DRY	LPX-FP-4007	39	51	not available	-	No	A	4.34	6.46	2.12	2.06	3.60
39227286	1,2,3,4,7,8-HxCDD	0.375	27.12	J	PG/G_DRY	LPX-FP-4007	33	51	not available	-	No	A	3.33	4.66	1.70	1.66	3.37
70648269	1,2,3,4,7,8-HxCDF	0.546	259	EB	PG/G_DRY	RES-10-042-01	39	51	not available	-	No	A	12.51	36.26	4.40	4.64	3.47
57653857	1,2,3,6,7,8-HxCDD	0.542	74.39	J	PG/G_DRY	LPX-FP-4007	42	51	not available	-	No	A	8.71	12.56	4.52	4.08	3.71
57117449	1,2,3,6,7,8-HxCDF	0.514	88.2		PG/G_DRY	RES-10-042-01	46	51	not available	-	No	A	7.52	13.33	3.28	3.44	3.46
19408743	1,2,3,7,8,9-HxCDD	0.417	72.2	J	PG/G_DRY	LPX-FP-4007	40	51	not available	-	No	A	7.70	11.96	3.49	3.65	3.51
72918219	1,2,3,7,8,9-HxCDF	0.0642	8.6		PG/G_DRY	SS_G-31	21	51	not available	-	No	A	1.15	1.56	0.42	0.52	3.65
40321764	1,2,3,7,8-PeCDD	0.322	17.4		PG/G_DRY	RES-10-042-01	34	51	not available	-	No	A	3.15	3.82	1.40	1.50	3.84
57117416	1,2,3,7,8-PeCDF	0.285	227	EMPC	PG/G_DRY	LPX-SD-4406	39	51	not available	-	No	A	10.19	33.74	1.95	2.24	4.41
38178993	1,2,4,5,7,8-hexachloro(9H)xanthene	0.69	3654.2	J$	PG/G_DRY	WRL-SD-2038	12	24	1.71E+09	0	No	A	201.35	742.95	58.01	31.42	15.71
60851345	2,3,4,6,7,8-HxCDF	0.608	134		PG/G_DRY	RES-10-042-01	49	51	not available	-	No	A	9.33	19.08	4.11	4.40	3.21
57117314	2,3,4,7,8-PeCDF	0.478	160		PG/G_DRY	RES-10-042-01	44	51	not available	-	No	A	8.32	22.56	3.34	3.19	3.55
1746016	2,3,7,8-TCDD	0.5	14600	J	PG/G_DRY	SS_G-01-03	54	56	0.89	50	Yes	B	1292.25	2712.55	197.00	99.20	22.88
51207319	2,3,7,8-TCDF	0.922	448	J	PG/G_DRY	RES-10-042-01	43	51	not available	-	No	A	15.01	62.17	4.74	4.34	3.61
3268879	OCDD	39.6	11180.23	J	PG/G_DRY	LPX-FP-4007	51	51	not available	-	No	A	1357.32	1884.67	739.00	670.70	3.63
39001020	OCDF	3.9	1992.34	J	PG/G_DRY	LPX-FP-4007	51	51	not available	-	No	A	133.97	294.72	48.60	51.67	3.82
GTI500081	PCDD/Fs	82.9	6950		PG/G_DRY	RES-10-044-01	22	22	not available	-	No	A	1754.81	2084.33	912.00	906.26	3.41
37871004	Total HpCDD	14.1	3305.9	J	PG/G_DRY	LPX-FP-4007	51	51	not available	-	No	A	365.65	535.48	201.00	180.88	3.50
38998753	Total HpCDF	4.1	1975.68	J	PG/G_DRY	LPX-FP-4007	51	51	not available	-	No	A	159.85	296.89	68.60	67.86	3.79
34465468	Total HxCDD	4.3	396.97	J	PG/G_DRY	LPX-FP-4007	49	51	not available	-	No	A	82.84	95.56	47.20	43.26	3.41
55684941	Total HxCDF	7.66	912	J	PG/G_DRY	RES-10-042-01	48	51	not available	-	No	A	126.16	168.91	64.00	58.97	3.79
36088229	Total PeCDD	0.91	223	J	PG/G_DRY	RES-10-042-01	51	51	not available	-	No	A	32.32	43.48	20.00	15.89	3.64
30402154	Total PeCDF	7.2	1640	J	PG/G_DRY	RES-10-042-01	49	51	not available	-	No	A	135.84	240.63	81.10	59.74	3.76
41903575	Total TCDD	0.76	14900		PG/G_DRY	SS_G-01-03	49	51	not available	-	No	A	1312.46	2883.05	163.00	129.05	14.43
55722275	Total TCDF	2.9	2440	J	PG/G_DRY	RES-10-042-01	50	51	not available	-	No	A	126.78	341.02	48.65	50.18	3.61
TEQB	Bird TEQ	1.0936	14644.02		PG/G_DRY	SS_G-01-03	54	54	0.89	54	Yes	B	1365.91	2756.00	319.34	191.39	11.61
TEQM	Mammal TEQ	0.99793	14633.13		PG/G_DRY	SS_G-01-03	54	54	0.89	54	Yes	B	1349.83	2757.64	283.59	165.89	13.18
	Pesticides																
319846	alpha-BHC	0.12	0.27	J	UG/KG_DRY	SS_G-23	6	37	2.5	0	No	C	0.63	0.98	0.15	0.23	4.24
319857	beta-BHC	ND	ND		UG/KG_DRY	-	0	37	1.00	0	No	E			0.23		3.58
319868	delta-BHC	0.29	0.29	J	UG/KG_DRY	SS_G-29-01	1	37	100	0	No	C	0.61	0.99	0.10	0.18	5.05
58899	Lindane	0.18	2.3		UG/KG_DRY	SS_G-01-01	4	37	0.05	4	Yes	B	0.89	1.01	0.57	0.42	4.11
50293	4,4'-DDT	1.2	1300		UG/KG_DRY	RES-12-556-01	30	37	2.5	27	Yes	B	51.18	211.81	7.80	9.48	4.60
72548	4,4'-DDD	0.48	26.58		UG/KG_DRY	LPX-SD-4407	18	37	2.5	12	Yes	B	3.67	5.38	2.10	1.26	5.62
72559	4,4'-DDE	1	1000		UG/KG_DRY	RES-12-556-01	31	37	2.5	23	Yes	B	36.38	163.19	5.30	6.26	3.90
8001352	Toxaphene	ND	ND		UG/KG_DRY	-	0	37	100.0	0	No	E			65.00		3.06
309002	Aldrin	0.97	3.4	P	UG/KG_DRY	RES-11-012-01	2	37	2.5	1	Yes	B	0.76	1.04	0.43	0.34	3.81
60571	Dieldrin	0.52	17		UG/KG_DRY	SS_G-01-03	8	37	0.5	8	Yes	B	2.62	3.29	1.95	1.25	4.19
72208	Endrin	0.21	1.6	J	UG/KG_DRY	SS_G-01-02	8	37	1.0	3	Yes	B	1.36	1.90	0.68	0.54	4.69
7421934	Endrin aldehyde	0.23	2.3		UG/KG_DRY	SS_G-29-01	10	37	53.99	0	No	C	1.55	1.88	0.68	0.72	4.10
53494705	Endrin ketone	0.28	16		UG/KG_DRY	RES-11-012-01	9	37	100	0	No	C	1.74	3.06	0.57	0.56	5.25
5103719	alpha-Chlordane	0.12	30		UG/KG_DRY	SS_G-23	28	37	100	0	No	C	4.51	6.51	1.70	1.59	5.48
5103742	gamma-Chlordane	0.15	45		UG/KG_DRY	SS_G-23	28	37	100	0	No	C	6.08	8.64	3.40	2.49	4.72
57749	Technical Chlordane	5.8	540		UG/KG_DRY	SS_G-23	17	27	100	4	Yes	B	70.43	129.73	27.00	22.58	4.90
76448	Heptachlor	6.2	6.2		UG/KG_DRY	SS_G-23	1	37	38.85	0	No	C	0.82	1.33	0.29	0.28	4.54
72435	Methoxychlor	0.76	0.76		UG/KG_DRY	SS_G-30	1	37	100	0	No	C	5.44	10.17	0.60	0.89	7.35
1024573	Heptachlor epoxide	0.085	26		UG/KG_DRY	RES-11-012-01	7	37	42.72	0	No	C	1.59	4.38	0.39	0.39	5.00
959988	Endosulfan I	2.5	2.8		UG/KG_DRY	SS_G-01-03	2	37	100	0	No	C	1.09	1.05	0.90	0.55	4.34
33213659	Endosulfan II	0.34	7.5		UG/KG_DRY	SS_G-29-01	4	37	100	0	No	C	1.96	2.09	1.55	1.02	3.87
1031078	Endosulfan sulfate	0.28	2.3		UG/KG_DRY	SS_G-31	8	37	100	0	No	C	1.76	3.22	0.40	0.51	5.43
	PCBs																
11096825	Aroclor 1260	29	280		UG/KG_DRY	SS_G-31	6	37	27.82	6	Yes	B	31.44	54.62	9.00	9.29	5.36
11097691	Aroclor 1254	7.7	637.83		UG/KG_DRY	LPX-SD-4407	24	37	91.70	15	Yes	B	122.94	152.41	58.00	46.89	5.81

TABLE 2a
SELECTION OF CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN (COPECs) FOR OXBOW STUDY AREA SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Standarized CAS#	Chemical Category/Name	Minimum Detected	Maximum Detected	Maximum Detected Qualifier	Units	Location of Maximum Detected	Number of Samples Detected	Number of Samples Measured	Selected Soil Benchmark[a]	Number Exceeding Benchmark	Retain as COPEC?	Rationale[b]	Arithmetic Mean	Standard Deviation of the Arithmetic Mean	Median	Geometric Mean	Standard Deviation of the Geometric Mean
11100144	Aroclor 1268	22.49	54		UG/KG_DRY	SS_G-29-01	6	27	27.82	3	Yes	B	8.95	14.06	1.10	3.06	4.14
11104282	Aroclor-1221	ND	ND		UG/KG_DRY	-	0	37	116.59	0	No	E			1.35		5.94
11141165	Aroclor-1232	ND	ND		UG/KG_DRY	-	0	37	100.79	0	No	E			1.35		4.48
12672296	Aroclor-1248	ND	ND		UG/KG_DRY	-	0	37	102.99	0	No	E			1.35		4.48
12674112	Aroclor-1016	ND	ND		UG/KG_DRY	-	0	37	112.50	0	No	E			1.35		4.48
12767792	Total Aroclors	7.7	637.83		UG/KG_DRY	LPX-SD-4407	24	37	1.37E+05	0	No	C	169.93	170.18	110.00	85.18	4.33
	Metals																
7429905	Aluminum	3520	14791	J	UG/G_DRY	LPX-FP-4004	12	12	3.33	12	Yes	B	8977.67	3918.12	9505.00	8087.69	1.65
7440360	Antimony	0.131	38.2	J	UG/G_DRY	RES-10-042-01	27	37	0.27	21	Yes	B	1.87	6.21	0.57	0.53	4.03
7440382	Arsenic	1.2	55.6		UG/G_DRY	RES-10-042-01	36	37	43	1	Yes	B	7.79	8.96	5.30	5.69	2.17
7440393	Barium	14.8	288		UG/G_DRY	LPX-SD-4407	37	37	330	0	No	C	80.18	70.01	65.50	59.40	2.17
7440417	Beryllium	0.23	3.46		UG/G_DRY	LPX-SD-4407	32	37	21	0	No	C	0.81	0.66	0.72	0.59	2.32
7440439	Cadmium	0.04	5		UG/G_DRY	RES-10-042-01	31	37	0.36	17	Yes	B	0.78	1.10	0.31	0.32	4.08
7440702	Calcium	1060	23900		UG/G_DRY	RES-10-042-01	9	10	not available	-	No	D	4731.00	6978.80	2220.00	2627.14	2.83
7440473	Chromium	4.9	92.6		UG/G_DRY	SS_G-29-01	36	37	0.40	36	Yes	B	28.04	19.48	20.70	22.42	2.00
7440484	Cobalt	0.94	21.7		UG/G_DRY	RES-10-042-01	37	37	120	0	No	C	5.41	3.75	4.80	4.41	1.95
7440508	Copper	6.2	2350		UG/G_DRY	RES-10-042-01	37	37	28	27	Yes	B	109.54	381.09	35.30	38.68	2.89
7439896	Iron	7790	29300		UG/G_DRY	RES-10-042-01	12	12	200	12	Yes	B	16485.42	6236.77	16900.00	15443.01	1.46
7439921	Lead	15.9	2460		UG/G_DRY	RES-11-012-01	37	37	20.08	36	Yes	B	228.46	396.44	139.00	134.36	2.62
7439954	Magnesium	955	2890	J	UG/G_DRY	RES-10-042-01	10	10	not available	-	No	D	1848.50	661.13	1785.00	1737.75	1.46
7439965	Manganese	65.7	2440		UG/G_DRY	SS_G-03	37	37	450	19	Yes	B	614.02	516.45	488.00	440.18	2.34
7439976	Mercury	0.09	1.1	J	UG/G_DRY	RES-10-044-01	8	12	0.10	6	Yes	B	0.27	0.37	0.12	0.15	2.68
22967926	Mercury (methyl)	0.000294	0.000767	J	UG/G_DRY	LPX-FP-4004	2	2	0.03	0	No	C	0.00053	0.00033	0.00053	0.00047	1.97
7439987	Molybdenum	0.53	19.1		UG/G_DRY	SS_G-01-01	27	27	0.32	27	Yes	B	4.34	4.43	2.42	2.93	2.43
7440020	Nickel	2.57	148	J	UG/G_DRY	SS_G-04	37	37	130	1	Yes	B	17.64	24.22	9.90	12.01	2.21
7440097	Potassium	316	2530		UG/G_DRY	RES-10-042-01	10	10	not available	-	No	D	876.70	639.63	689.50	739.70	1.78
7782492	Selenium	0.1	4.5		UG/G_DRY	SS_G-31	25	37	0.63	18	Yes	B	0.89	0.82	0.70	0.64	2.37
7440224	Silver	0.2	5.7	J	UG/G_DRY	RES-11-012-01	17	37	4.2	2	Yes	B	0.75	1.34	0.30	0.33	3.14
7440235	Sodium	48.2	2010		UG/G_DRY	RES-10-042-01	6	10	not available	-	No	D	290.94	607.66	98.00	108.08	3.52
7440280	Thallium	0.279	0.8	J	UG/G_DRY	SS_G-32	6	37	0.24	6	Yes	B	0.39	0.27	0.25	0.33	1.77
7440622	Vanadium	4.6	62.7		UG/G_DRY	LPX-SD-4407	37	37	7.8	35	Yes	B	26.71	12.08	24.00	23.92	1.66
7440666	Zinc	16	808		UG/G_DRY	RES-10-042-01	37	37	46	31	Yes	B	156.10	171.19	90.30	101.91	2.49
	PAHs																
120127	Anthracene	4.2	1000		UG/KG_DRY	SS_G-29-02	34	36	100	15	Yes	B	271.24	451.64	89.50	97.21	4.68
129000	Pyrene	37	6800		UG/KG_DRY	SS_G-29-02	35	36	100	31	Yes	B	1610.95	1852.42	765.00	776.63	3.98
191242	Benzo(g,h,i)perylene	17	2600	J	UG/KG_DRY	RES-12-556-01	33	36	1252	6	Yes	B	678.91	770.20	345.00	342.60	3.70
193395	Indeno(1,2,3-cd)pyrene	17	2800		UG/KG_DRY	SS_G-29-01	34	36	2.09	34	Yes	B	701.96	781.88	375.00	356.64	3.74
205992	Benzo(b)fluoranthene	29	5000		UG/KG_DRY	SS_G-29-01	35	36	1.46	35	Yes	B	1122.79	1219.94	575.00	577.18	3.75
206440	Fluoranthene	37	7700		UG/KG_DRY	RES-12-556-01	35	36	100	31	Yes	B	1709.46	1977.14	811.26	827.56	4.01
207089	Benzo(k)fluoranthene	11	4000	J	UG/KG_DRY	RES-12-556-01	35	36	1.46	35	Yes	B	706.19	927.80	330.00	284.39	4.69
208968	Acenaphthylene	4.4	720		UG/KG_DRY	SS_G-23	28	36	4.73E+04	0	No	C	441.77	648.14	145.00	137.02	5.60
218019	Chrysene	24	3900	J	UG/KG_DRY	RES-12-556-01	35	36	2.09	35	Yes	B	1020.24	1084.12	535.00	521.80	3.85
50328	Benzo(a)pyrene	23	3900		UG/KG_DRY	SS_G-29-01	35	36	20.87	35	Yes	B	894.14	989.73	425.00	457.85	3.67
53703	Dibenzo(a,h)anthracene	3.8	930	J	UG/KG_DRY	RES-12-556-01	29	36	4.07	28	Yes	B	408.97	600.47	110.00	123.70	5.78
56553	Benzo(a)anthracene	16	3100		UG/KG_DRY	SS_G-29-02	35	36	8.24	35	Yes	B	761.10	847.85	385.00	361.42	4.14
83329	Acenaphthene	1.8	240	J	UG/KG_DRY	RES-12-560-02	21	36	20000	0	No	C	340.88	662.34	27.00	38.50	10.52
85018	Phenanthrene	18	5000		UG/KG_DRY	SS_G-29-02	35	36	100	29	Yes	B	922.74	1209.61	350.76	389.32	4.41
86737	Fluorene	1.1	350		UG/KG_DRY	SS_G-29-02	27	36	30000	0	No	C	348.28	659.84	40.00	50.60	8.67
91203	Naphthalene	2.6	180	J	UG/KG_DRY	RES-10-042-01	15	36	100	1	Yes	B	355.20	674.99	24.00	39.88	9.36
132649	Dibenzofuran	1.5	140		UG/KG_DRY	SS_G-29-02	19	36	4.29E+04	0	No	C	357.22	675.11	17.50	33.33	11.77
91576	2-Methylnaphthalene	3.1	35.66		UG/KG_DRY	LPX-FP-4007	8	36	4.68E+04	0	No	C	357.22	676.52	18.25	31.54	11.11
BAPEQ	BAPEQ	150	5000		UG/KG_DRY	RES-12-556-01	9	10	2.34E+05	0	No	C	1502.00	1481.98	990.00	959.46	2.85
HMW	High Molecular Weight PAHs	214.8	36330		UG/KG_DRY	RES-12-556-01	35	36	1000	30	Yes	B	9614.73	10161.58	4885.00	4878.54	3.90
LMW	Low Molecular Weight PAHs	30.65	14530		UG/KG_DRY	RES-12-556-01	35	36	1000	15	Yes	B	3037.33	4207.12	902.00	981.51	5.67
PAH	Total PAH	245.45	50860		UG/KG_DRY	RES-12-556-01	35	36	1000	30	Yes	B	12652.06	13176.45	6240.00	6181.33	4.14
	Other Organics																
100516	Benzyl Alcohol	2.6	58	J	UG/KG_DRY	SS_G-04	6	24	710.71	0	No	C	13.60	13.60	10.00	8.86	2.69
100527	Benzaldehyde	8.7	200	J	UG/KG_DRY	RES-10-042-01	5	35	4619.93	0	No	C	321.27	607.12	38.50	61.88	6.47

TABLE 2a
SELECTION OF CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN (COPECs) FOR OXBOW STUDY AREA SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Standarized CAS#	Chemical Category/Name	Minimum Detected	Maximum Detected	Maximum Detected Qualifier	Units	Location of Maximum Detected	Number of Samples Detected	Number of Samples Measured	Selected Soil Benchmark[a]	Number Exceeding Benchmark	Retain as COPEC?	Rationale[b]	Arithmetic Mean	Standard Deviation of the Arithmetic Mean	Median	Geometric Mean	Standard Deviation of the Geometric Mean
105602	Caprolactam	ND	ND		UG/KG_DRY	-	0	9	86295.88		No	E			1050.00		2.25
78591	Isophorone	ND	ND		UG/KG_DRY	-	0	34	54899.18		No	E			5.00		18.90
92524	1,1'-Biphenyl	2.4	120	J	UG/KG_DRY	RES-10-042-01	4	35	60000	0	No	C	295.95	617.85	9.50	19.76	11.87
105679	2,4-Dimethylphenol	ND	ND		UG/KG_DRY	-	0	34	3868		No	E			27.50		9.32
106445	4-Methylphenol	ND	ND		UG/KG_DRY	-	0	36	500		No	E			8.75		15.70
108952	Phenol	4.9	33	J	UG/KG_DRY	SS_G-04	3	36	30000	0	No	C	369.84	672.62	15.00	32.67	12.49
95487	2-Methylphenol	ND	ND		UG/KG_DRY	-	0	34	500.00		No	E			7.50		15.93
100027	4-Nitrophenol	ND	ND		UG/KG_DRY	-	0	36	7000.00		No	E			105.00		8.40
101553	4-Bromophenyl-phenylether	ND	ND		UG/KG_DRY	-	0	34	38097.60		No	E			8.00		15.50
106467	1,4-Dichlorobenzene	ND	ND		UG/KG_DRY	-	0	25	20000.00		No	E			13.00		5.21
118741	Hexachlorobenzene	ND	ND		UG/KG_DRY	-	0	34	533.46		No	E			6.00		17.50
120821	1,2,4-Trichlorobenzene	ND	ND		UG/KG_DRY	-	0	25	20000.00		No	E			12.00		5.28
120832	2,4-Dichlorophenol	ND	ND		UG/KG_DRY	-	0	34	3.00		No	E			5.00		18.90
121142	2,4-Dinitrotoluene	ND	ND		UG/KG_DRY	-	0	34	103.56		No	E			7.50		15.93
51285	2,4-Dinitrophenol	ND	ND		UG/KG_DRY	-	0	31	6260.24		No	E			170.00		9.81
534521	4,6-Dinitro-o-cresol	ND	ND		UG/KG_DRY	-	0	34	27.92		No	E			7.00		24.31
541731	1,3-Dichlorobenzene	ND	ND		UG/KG_DRY	-	0	25	10.00		No	E			13.50		5.17
59507	4-Chloro-3-methylphenol	ND	ND		UG/KG_DRY	-	0	34	334.74		No	E			7.00		16.39
606202	2,6-Dinitrotoluene	ND	ND		UG/KG_DRY	-	0	34	301.68		No	E			10.00		14.09
87865	Pentachlorophenol	ND	ND		UG/KG_DRY	-	0	36	2073.42		No	E			117.50		8.02
88062	2,4,6-Trichlorophenol	5.2	5.2	J	UG/KG_DRY	SS_G-02	1	34	5124.55	0	No	C	372.72	693.76	7.00	20.87	15.56
88755	2-Nitrophenol	ND	ND		UG/KG_DRY	-	0	36	862.86		No	E			8.75		15.70
95501	1,2-Dichlorobenzene	ND	ND		UG/KG_DRY	-	0	25	10.00		No	E			13.00		5.21
95578	2-Chlorophenol	ND	ND		UG/KG_DRY	-	0	34	10.00		No	E			10.00		14.09
95954	2,4,5-Trichlorophenol	1.6	25	J	UG/KG_DRY	SS_G-01	4	36	5126.37	0	No	C	960.24	1718.66	16.00	39.27	22.15
98953	Nitrobenzene	19	19	J	UG/KG_DRY	SS_G-01	1	34	13443.69	0	No	C	375.82	692.12	12.75	28.09	13.35
117817	Bis(2-ethylhexyl)phthalate	10	2900		UG/KG_DRY	RES-11-012-01	31	36	6842.46	0	No	C	510.44	671.41	225.00	202.12	4.80
117840	Di-n-octylphthalate	97	97	J	UG/KG_DRY	LPX-FP-4007	1	36	5790.73	0	No	C	362.68	674.99	10.00	25.13	14.55
131113	Dimethylphthalate	25	160		UG/KG_DRY	SS_G-01-03	17	34	5790.73	0	No	C	400.14	679.91	60.00	49.64	15.36
84662	Diethylphthalate	ND	ND		UG/KG_DRY	-	0	34	5790.73		No	E			6.50		16.64
84742	Di-n-Butylphthalate	9.1	93	JEB	UG/KG_DRY	RES-11-012-01	3	36	5790.73	0	No	C	377.04	666.27	47.25	69.00	7.39
85687	Butylbenzylphthalate	4.2	620	J	UG/KG_DRY	RES-11-012-01	23	36	5790.73	0	No	C	411.94	658.06	86.00	100.74	6.33
65850	Benzoic acid	130	800		UG/KG_DRY	SS_G-06	4	8	8.63E+04	0	No	C	418.50	336.06	335.00	291.07	2.73
86748	Carbazole	3.4	600	J	UG/KG_DRY	RES-12-556-01	30	36	6.07E+04	0	No	C	355.65	588.01	82.00	96.35	5.99
	Ancillary																
	pH	3.56	6.44		Standard Units	SS_G-29	24	24	not applicable		not applicable		5.22	0.74	5.34	5.17	1.16
	Total Organic Carbon	0.895	36.14		Percent	LPX-SD-4407	28	28	not applicable		not applicable		8.09	7.75	5.01	5.52	2.50

Notes:
For summary statistics, non-detects were assumed to be 1/2 the reporting limit.
PCB congeners are not presented because they were only measured at two locations and PCBs are being evaluated as Aroclors.
Maximum detected concentration used for screening.
Shaded entried are contaminants identified as COPECs
a. Floodplain soil screening values presented in Table D-3 in Centredale Site Baseline Ecological Risk Assessment (MACTEC, 2004) and EPA Ecological Soil Screening Levels; lower of soil invertebrate and wildlife benchmarks selected.
Table values originally presented in ug/g and adjusted as necessary.
b. Rationale for deleting or retaining analyte as a COPEC:
A - Individual dioxin and furan congeners and homologue groups were not specifically identified as COPECs because a TEQ approach was employed in the evaluation.
B - Retained because maximum concentration exceeds screening benchmark value.
C - Not retained because maximum concentration is below the screening benchmark value.
D - Not retained because parameter is an essential element.

TABLE 2b
SELECTION OF CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN (COPECs) FOR OXBOW STUDY AREA SEDIMENTS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Standarized CAS#	Chemical Category/Name	Minimum Detected	Maximum Detected	Units	Location of Maximum Detected	Number of Samples Detected	Number of Samples Measured	Selected Sediment Benchmark[a]	Number Exceeding Benchmark	Retain as COPEC?	Rationale[b]	Arithmetic Mean	Standard Deviation of the Arithmetic Mean	Median	Geometric Mean	Deviation of the Geometric Mean	Lyman Mill Pond Arithmetic Mean Concentration	Lyman Mill Pond Geomentric Mean Concentration	Lyman Mill Pond Maximum Concentration	Allendale Pond Arithmetic Mean Concentration	Allendale Pond Geometric Mean Concentration	Allendale Pond Maximum Concentration	Proposed Sediment Cleanup Goals
	Dioxins/Furans																						
35822469	1,2,3,4,6,7,8-HpCDD	19.2	1230	PG/G	SD_G-01	15	15	not available	-	No	A	290.69	388.53	135.00	132.91	3.75	427.58		3214.62		171.07	5600	
67562394	1,2,3,4,6,7,8-HpCDF	6.99	468	PG/G	SD_G-01	15	15	not available	-	No	A	139.01	152.61	81.80	68.42	3.91		88.52	2375.97		85.86	2913.63	
55673897	1,2,3,4,7,8,9-HpCDF	0.407	23.1	PG/G	SD_G-01	14	15	not available	-	No	A	6.80	7.25	4.47	3.58	3.74		4.24	176.08		5.67	101.13	
39227286	1,2,3,4,7,8-HxCDD	0.5	23.4	PG/G	SD_G-01	15	15	not available	-	No	A	5.79	7.23	2.65	2.98	3.30		3.51	56.33		4.02	123	
70648269	1,2,3,4,7,8-HxCDF	0.601	38.3	PG/G	SD_G-01	15	15	not available	-	No	A	11.21	10.58	9.33	6.62	3.30		15.43	263.66		11.53	284.03	
57653857	1,2,3,6,7,8-HxCDD	1.28	60.4	PG/G	SD_G-01	14	15	not available	-	No	A	15.14	18.88	7.62	6.97	4.12		14.59	130.28		13.89	845	
57117449	1,2,3,6,7,8-HxCDF	0.697	47.7	PG/G	SD_G-01	15	15	not available	-	No	A	12.54	13.23	8.89	6.88	3.51		10.30	336.49		14.13	243.76	
19408743	1,2,3,7,8,9-HxCDD	0.712	46.7	PG/G	SD_G-01	14	15	not available	-	No	A	10.45	13.86	4.79	4.73	3.99		10.95	146.66		11.97	409	
72918219	1,2,3,7,8,9-HxCDF	0.223	3.19	PG/G	SD_G-01	11	15	not available	-	No	A	1.03	0.89	0.88	0.67	2.86			18.09			99.2	
40321764	1,2,3,7,8-PeCDD	0.705	39.5	PG/G	SD_G-01	13	15	not available	-	No	A	6.01	9.91	2.27	2.46	4.32		3.96	164.13		3.87	253	
57117416	1,2,3,7,8-PeCDF	0.634	31.8	PG/G	LPX-SD-4401	12	15	not available	-	No	A	6.22	8.05	3.80	2.96	4.42		3.60	100.5		3.80	133	
60851345	2,3,4,6,7,8-HxCDF	0.663	48.2	PG/G	SD_G-01	15	15	not available	-	No	A	12.52	13.21	8.47	7.12	3.34		7.73	87.44		5.64	93	
57117314	2,3,4,7,8-PeCDF	0.759	26.8	PG/G	SD_G-09	15	15	not available	-	No	A	10.80	9.27	8.95	6.57	3.19		5.50	76.63		6.11	135	
1746016	2,3,7,8-TCDD	75	14600	PG/G	SD_G-01	15	15	2.58	15	Yes	B	3312.07	3962.65	1640.00	1586.37	4.07		433.13	49420.66		878.66	110000	14.7
51207319	2,3,7,8-TCDF	0.418	61.1	PG/G	SD_G-01	15	15	not available	-	No	A	10.61	15.18	5.04	5.32	3.51		10.12	217.36		11.10	338	
3268879	OCDD	142	9800	PG/G	SD_G-02	15	15	not available	-	No	A	2332.53	3187.69	1030.00	997.17	4.01	2697.24		18863.79		1001.32	38000	
39001020	OCDF	11	678	PG/G	SD_G-01	15	15	not available	-	No	A	181.01	217.47	79.90	91.20	3.57		141.75	3281.59		114.80	3606.83	
37871004	Total HpCDD	35.7	2240	PG/G	SD_G-01	15	15	not available	-	No	A	557.42	727.65	298.00	258.64	3.75	1108.93		5586.8		275.32	9750	
38998753	Total HpCDF	14.4	979	PG/G	SD_G-01	15	15	not available	-	No	A	277.93	316.57	146.00	133.79	3.94		156.09	3855.87		138.94	3750	
34465468	Total HxCDD	5.81	489	PG/G	SD_G-01	14	15	not available	-	No	A	115.19	145.05	51.40	51.91	4.35	207.57		1173.41		92.90	5950	
55684941	Total HxCDF	10.5	891	PG/G	SD_G-01	15	15	not available	-	No	A	222.93	251.38	135.00	112.82	3.82		133.09	3998.86		119.19	2210	
36088229	Total PeCDD	0.643	288	PG/G	SD_G-01	14	15	not available	-	No	A	52.13	74.76	23.50	20.27	5.17		25.22	1066.8		24.03	2040	
30402154	Total PeCDF	9.44	1510	PG/G	SD_G-01	15	15	not available	-	No	A	267.98	377.48	147.00	124.21	4.02		132.71	6038.88		105.69	3180	
41903575	Total TCDD	79.4	15100	PG/G	SD_G-01	15	15	not available	-	No	A	3483.69	4162.77	1700.00	1666.96	4.06		518.88	506070.84		477.94	96000	
55722275	Total TCDF	7.56	1600	PG/G	SD_G-01	15	15	not available	-	No	A	232.18	395.38	99.30	99.54	3.90		103.82	4023.18		96.47	6810	
39638329	Bis-(2-chloroisopropyl)ether	ND	ND	UG/KG	-	0	12	1105215.47	0	No	E	0.15	0.13	32.50	0.11	3.01							
FISH_TEQ	Fish TEQ	76.089995	14689.4068	PG/G	SD_G-01	15	15	2.58	15	Yes	B	3333.20	3983.03	1650.63	1600.28	4.06							
BIRD_TEQ_D	Bird TEQ	76.709825	14754.3248	PG/G	SD_G-01	15	15	2.58	15	Yes	B	3347.32	3996.80	1659.71	1609.84	4.05							290
MAM2005_TEQ_D	Mammal TEQ	76.05768	14700.5324	PG/G	SD_G-01	15	15	2.58	15	Yes	B	3334.48	3985.73	1649.57	1600.26	4.06							
	Pesticides																						
319846	alpha-BHC	0.29	0.52	UG/KG	SD_G-03	2	13	6.00	0	No	C	0.15	0.13	0.10	0.11	1.97							
319857	beta-BHC	1.1	1.1	UG/KG	SD_G-01	1	13	5.00	0	No	C	0.26	0.33	0.09	0.15	2.51							
319868	delta-BHC	0.18	0.18	UG/KG	SD_G-02	1	13	3.00	0	No	C	0.20	0.29	0.07	0.10	2.99							
58899	gamma-BHC	0.68	2.2	UG/KG	SD_G-07	5	13	1.57	2	Yes	B	1.20	0.75	1.10	0.88	2.83			7				
72435	Methoxychlor	ND	ND	UG/KG	-	0	13	19.00	0	No	E	-	-	0.80	-	2.75			39				
50293	4,4'-DDT	1.2	160	UG/KG	SD_G-01	11	13	1.00	11	Yes	B	25.55	42.02	12.00	9.01	6.54			39				
72548	4,4'-DDD	0.29	11	UG/KG	SD_G-01	11	13	2.00	9	Yes	B	5.03	3.89	3.30	3.17	3.32			50.19				8.4
72559	4,4'-DDE	0.5	10	UG/KG	SD_G-17	9	13	2.14	6	Yes	B	4.82	3.99	3.75	3.28	2.71			46.16				6
8001352	Toxaphene	ND	ND	UG/KG	-	0	13	1.26	0	No	E	-	-	80.00	-	2.99							
1024573	Heptachlor epoxide	ND	ND	UG/KG	-	0	13	2.47	0	No	E	-	-	0.35	-	2.87			6				
309002	Aldrin	1.64	1.64	UG/KG	LPX-SD-4402	1	13	2.00	0	No	C	0.64	0.52	0.60	0.39	3.25			0.58				
5103719	alpha-Chlordane	0.5	20	UG/KG	SD_G-03	12	13	0.50	11	Yes	B	6.27	5.61	3.80	3.42	4.53		5.76	140.75				
5103742	gamma-Chlordane	0.9	97	UG/KG	SD_G-01	13	13	0.50	13	Yes	B	18.91	25.65	9.10	9.82	3.44		4.69	69.88				
57749	Technical Chlordane	5.8	390	UG/KG	SD_G-01	11	13	0.50	11	Yes	B	79.99	103.02	48.00	44.85	3.14		398.76	2212.73				400
60571	Dieldrin	9.2	63.38	UG/KG	LPX-SD-4402	4	13	0.02	4	Yes	B	16.15	19.60	9.20	6.74	4.84			17				2.6
72208	Endrin	0.2	0.23	UG/KG	SD_G-10	2	13	0.02	2	Yes	B	0.86	1.29	0.31	0.41	3.55			9.5				
7421934	Endrin aldehyde	0.42	9.51	UG/KG	LPX-SD-4402	8	13	0.02	8	Yes	B	2.28	3.28	0.85	0.90	4.61							
76448	Heptachlor	ND	ND	UG/KG	-	0	13	1.10	0	No	E	-	-	0.15	-	2.86			0.81				
53494705	Endrin ketone	0.27	3.6	UG/KG	SD_G-01	8	13	0.02	8	Yes	B	1.02	0.95	0.94	0.63	3.22							
959988	Endosulfan I	0.17	16	UG/KG	SD_G-01	6	13	5.50	3	Yes	B	3.32	4.64	0.80	1.30	4.63							
33213659	Endosulfan II	0.26	15	UG/KG	SD_G-01	8	13	5.50	4	Yes	B	3.91	4.66	1.35	1.71	4.56			290				
1031078	Endosulfan sulfate	0.19	0.51	UG/KG	SD_G-01	5	13	5.50	0	No	C	2.25	5.51	0.38	0.34	6.06			10.55				
	PCB Aroclors																						
11097691	Aroclor-1254	14	3583.3	UG/KG	LPX-SD-4402	13	13	54.78	11	Yes	B	571.79	1007.75	150.00	200.86	4.46		130.45	2600		265.39	28000	150
11100144	Aroclor-1268	2.3	160	UG/KG	SD_G-01	12	13	5.00	11	Yes	B	41.15	42.04	29.00	24.03	3.34			313.79		66.50	156.42	140
11096825	Aroclor-1260	ND	ND	UG/KG	-	0	13	5.00	0	No	E	-	-	1.75	-	2.41			320				
11104282	Aroclor-1221	ND	ND	UG/KG	-	0	13	5.00	0	No	E	-	-	1.75	-	2.41							
11141165	Aroclor-1232	ND	ND	UG/KG	-	0	13	5.00	0	No	E	-	-	1.75	-	2.41							
12672296	Aroclor-1248	ND	ND	UG/KG	-	0	13	30.00	0	No	E	-	-	1.75	-	2.41			94				
12674112	Aroclor-1016	ND	ND	UG/KG	-	0	13	7.00	0	No	E	-	-	1.75	-	2.41							
12767792	Total Aroclors	16.3	3583.3	UG/KG	LPX-SD-4402	13	13	22.70	12	Yes	B	612.32	1014.63	179.00	235.12	4.27							

TABLE 2b
SELECTION OF CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN (COPECs) FOR OXBOW STUDY AREA SEDIMENTS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Standarized CAS#	Chemical Category/Name	Minimum Detected	Maximum Detected	Units	Location of Maximum Detected	Number of Samples Detected	Number of Samples Measured	Selected Sediment Benchmark[a]	Number Exceeding Benchmark	Retain as COPEC?	Rationale[b]	Arithmetic Mean	Standard Deviation of the Arithmetic Mean	Median	Geometric Mean	Deviation of the Geometric Mean	Lyman Mill Pond Arithmetic Mean Concentration	Lyman Mill Pond Geomentric Mean Concentration	Lyman Mill Pond Maximum Concentration	Allendale Pond Arithmetic Mean Concentration	Allendale Pond Geometric Mean Concentration	Allendale Pond Maximum Concentration	Proposed Sediment Cleanup Goals
37324235	Aroclor-1262	ND	ND	UG/KG	-	0	12	5.00	0	No	E	-	-	1.50	-	2.30							
53469219	Aroclor-1242	ND	ND	UG/KG	-	0	13	5.00	0	No	E	-	-	1.75	-	2.41							
	Metals																						
7440360	Antimony	0.213	3.75	UG/G	SD_G-09	12	14	0.60	9	Yes	B	1.15	0.99	1.00	0.83	4.39			8.2			13.7	
7440382	Arsenic	2.9	9.3	UG/G	SD_G-01	12	14	0.96	12	Yes	B	4.08	2.55	3.50	3.25	2.19	3.95		14.8		3.03	18	3.9
7440393	Barium	15.2	224	UG/G	LPX-SD-4401	14	14	53.65	6	Yes	B	85.92	69.13	48.90	62.07	2.37		92.17	380	109.72		326	134
7440417	Beryllium	0.34	7.9	UG/G	LPX-SD-4402	14	14	0.19	14	Yes	B	1.87	2.05	0.94	1.22	2.51		1.07	4.36		0.85	4.6	
7440439	Cadmium	0.12	3.29	UG/G	SD_G-01	14	14	0.59	8	Yes	B	1.23	1.08	0.85	0.81	2.76	1.25		7			5.5	
7440473	Chromium	7.3	193	UG/G	SD_G-01	14	14	0.46	14	Yes	B	67.99	55.89	55.30	47.71	2.55	91.43		259		55.63	536	
7440484	Cobalt	1.42	21.2	UG/G	LPX-SD-4402	14	14	1.74	12	Yes	B	6.57	5.46	4.29	4.93	2.20		5.71	26.6		4.91	16.5	
7440508	Copper	3.8	218	UG/G	SD_G-01	14	14	0.02	14	Yes	B	58.59	60.74	36.90	35.38	3.03	86.87		319		56.40	419	
7439921	Lead	18	467	UG/G	SD_G-01	14	14	1.46	14	Yes	B	136.77	129.21	97.00	87.38	2.83	205.84		613		122.34	1090	
7439965	Manganese	99.4	1160	UG/G	SD_G-01	14	14	460.00	4	Yes	B	380.10	344.77	221.00	268.18	2.33		378.73	1970		256.94	2050	
7439987	Molybdenum	1.59	17.3	UG/G	LPX-SD-4402	14	14	2.83	8	Yes	B	5.37	4.79	3.16	3.91	2.23	6.45		17.5	13.12		29.6	
7440020	Nickel	3.01	92.1	UG/G	SD_G-01	14	14	16.00	6	Yes	B	21.99	23.32	13.35	14.55	2.55		19.24	113		14.05	94.6	
7782492	Selenium	0.5	2	UG/G	SD_G-02	11	14	0.52	9	Yes	B	0.99	0.64	0.75	0.77	2.23			4.5			4.7	1.1
7440224	Silver	0.116	2.84	UG/G	SD_G-01	13	14	0.50	7	Yes	B	0.77	0.80	0.48	0.50	2.66			14.6		0.50	16	
7440280	Thallium	0.631	0.791	UG/G	LPX-SD-4401	2	14	3.21	0	No	C	0.55	0.24	0.50	0.51	1.54			4.9			2.4	
7440622	Vanadium	7.2	59.8	UG/G	LPX-SD-4401	14	14	9.62	12	Yes	B	26.50	17.26	22.15	21.51	1.99		27.24	91.7		24.70	111	37.6
7440666	Zinc	27.9	899	UG/G	SD_G-01	14	14	0.37	14	Yes	B	229.65	232.01	143.50	157.91	2.45		255.53	2060	299.34		2088	221
	PAHs																						
111444	Bis(2-chloroethyl)ether	ND	ND	UG/KG	-	0	12	4414.96	0	No	E	-	-	24.00	-	3.02							
111911	Bis(2-chloroethoxy)methane	ND	ND	UG/KG	-	0	12	4516.03	0	No	E	-	-	19.00	-	3.01							
67721	Hexachloroethane	ND	ND	UG/KG	-	0	12	1000.00	0	No	E	-	-	39.00	-	3.00							
7005723	4-Chlorophenyl-phenylether	ND	ND	UG/KG	-	0	12	273128.58	0	No	E	-	-	17.50	-	3.00							
77474	Hexachlorocyclopentadiene	ND	ND	UG/KG	-	0	12	3678.30	0	No	E	-	-	365.00	-	2.99							
87683	Hexachlorobutadiene	ND	ND	UG/KG	-	0	12	4251.97	0	No	E	-	-	31.50	-	2.98							
100516	Benzyl Alcohol	ND	ND	UG/KG	-	0	12	1.10	0	No	E	-	-	26.50	-	3.00							
100527	Benzaldehyde	ND	ND	UG/KG	-	0	12	461.99	0	No	E	-	-	100.00	-	3.03			459.4				
78591	Isophorone	ND	ND	UG/KG	-	0	12	5489.92	0	No	E	-	-	12.50	-	3.02							
92524	1,1'-Biphenyl	ND	ND	UG/KG	-	0	12	1100.00	0	No	E	-	-	24.00	-	3.02			94.6				
105679	2,4-Dimethylphenol	ND	ND	UG/KG	-	0	12	386.83	0	No	E	-	-	70.00	-	3.01							
98953	Nitrobenzene	ND	ND	UG/KG	-	0	12	1779.07	0	No	E	-	-	27.50	-	3.03							
120127	Anthracene	20	970	UG/KG	SD_G-03	12	12	27.00	11	Yes	B	442.50	284.23	430.00	317.87	2.91			1124.2			3500	
129000	Pyrene	200	6300	UG/KG	SD_G-01	12	12	195.00	12	Yes	B	3691.67	1932.71	3700.00	2826.44	2.66		1313.93	14005.85		1322.36	17223.08	
191242	Benzo(g,h,i)perylene	89	3300	UG/KG	SD_G-01	12	12	63.40	12	Yes	B	1590.75	1017.22	1300.00	1153.31	2.78		334.05	5594.06		90.74	7473.29	
193395	Indeno(1,2,3-cd)pyrene	92	3200	UG/KG	SD_G-01	12	12	0.52	12	Yes	B	1693.50	999.26	1600.00	1249.24	2.77		562.65	6063.25		496.97	8172.14	
205992	Benzo(b)fluoranthene	170	5000	UG/KG	SD_G-01, SD_G-09	12	12	0.37	12	Yes	B	2990.83	1693.04	2750.00	2246.68	2.69		868.24	8635.11		838.18	11383.07	
206440	Fluoranthene	200	6700	UG/KG	SD_G-03, SD_G-10	12	12	64.23	12	Yes	B	3941.67	2133.48	3950.00	2997.00	2.70		1538.58	18646.58		1367.56	22283.2	
207089	Benzo(k)fluoranthene	60	1900	UG/KG	SD_G-01	12	12	0.37	12	Yes	B	1042.50	589.38	965.00	784.89	2.68		645.13	8122.28		900.66	10518.57	
208968	Acenaphthylene	13	800	UG/KG	SD_G-01	12	12	44.00	11	Yes	B	334.67	226.11	365.00	229.13	3.13			428.56			970	
218019	Chrysene	120	4400	UG/KG	SD_G-01	12	12	0.53	12	Yes	B	2516.67	1385.30	2450.00	1881.80	2.78		882.64	9697.45		987.22	11721.71	
50328	Benzo(a)pyrene	130	4400	UG/KG	SD_G-10	12	12	5.27	12	Yes	B	2520.00	1397.41	2400.00	1904.36	2.70		671.37	7040.3		715.10	9617.88	1400
53703	Dibenzo(a,h)anthracene	20	660	UG/KG	SD_G-01	12	12	1.01	12	Yes	B	370.00	220.29	345.00	270.66	2.80			1237.92			2600	975
56553	Benzo(a)anthracene	98	3000	UG/KG	SD_G-03	12	12	2.10	12	Yes	B	1694.00	894.00	1800.00	1301.74	2.62		688.84	5526.5		627.17	8400	
83329	Acenaphthene	22	320	UG/KG	SD_G-03	10	12	16.00	10	Yes	B	111.79	87.49	93.00	74.24	3.26			327.21			1200	
85018	Phenanthrene	79	3400	UG/KG	SD_G-03	12	12	204.00	11	Yes	B	1633.25	883.97	1750.00	1235.99	2.75		799.32	8378.61		689.88	14000	
86737	Fluorene	6.6	450	UG/KG	SD_G-03	12	12	19.00	11	Yes	B	163.38	119.47	150.00	113.41	3.02			670.84			1600	
91203	Naphthalene	14	130	UG/KG	SD_G-03	5	12	32.75	3	Yes	B	59.83	47.44	52.50	42.15	2.61			387.94			290	
132649	Dibenzofuran	23	140	UG/KG	SD_G-03	10	12	420.00	0	No	C	64.58	39.37	58.50	47.82	2.79			274.32			920	
91576	2-Methylnaphthalene	30	77	UG/KG	SD_G-03	3	12	70.00	1	Yes	B	49.42	43.70	35.50	31.66	2.99			393.05			190	
91587	2-Chloronaphthalene	ND	ND	UG/KG	-	0	12	10916.92	0	No	C	64.58	39.37	20.00	47.82	3.00							
HMW	High Molecular Weight PAHs	1179	38260	UG/KG	SD_G-01	12	12	60.00	12	Yes	B	22051.58	12042.66	21110.00	16689.61	2.69			40000		4296.24	100000	
LMW	Low Molecular Weight PAHs	133.6	5767	UG/KG	SD_G-03	12	12	77.40	12	Yes	B	2794.84	1594.65	2891.00	2078.42	2.80			3900		585.82	20000	
PAH	Total PAH	1312.6	43070	UG/KG	SD_G-01	12	12	2280.00	11	Yes	B	24846.43	13481.71	24295.50	18812.41	2.70		3960.46	95489.22		5869.90	121765.74	
	Other Organics																						
106445	4-Methylphenol	36	270	UG/KG	SD_G-17	3	12	110.67	2	Yes	B	62.25	79.21	30.25	29.20	3.96			2600			830	
108952	Phenol	ND	ND	UG/KG	-	0	12	48.00	0	No	E	-	-	25.00	-	3.02			96				
95487	2-Methylphenol	ND	ND	UG/KG	-	0	12	12.00	0	No	E	-	-	19.00	-	3.01							
100027	4-Nitrophenol	ND	ND	UG/KG	-	0	12	113.21	0	No	E	-	-	225.00	-	3.02							
101553	4-Bromophenyl-phenylether	ND	ND	UG/KG	-	0	12	1200.00	0	No	E	-	-	20.00	-	3.00							
106467	1,4-Dichlorobenzene	ND	ND	UG/KG	-	0	12	340.00	0	No	E	-	-	36.50	-	2.99							

TABLE 2b
SELECTION OF CONTAMINANTS OF POTENTIAL ECOLOGICAL CONCERN (COPECs) FOR OXBOW STUDY AREA SEDIMENTS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Standarized CAS#	Chemical Category/Name	Minimum Detected	Maximum Detected	Units	Location of Maximum Detected	Number of Samples Detected	Number of Samples Measured	Selected Sediment Benchmark[a]	Number Exceeding Benchmark	Retain as COPEC?	Rationale[b]	Arithmetic Mean	Standard Deviation of the Arithmetic Mean	Median	Geometric Mean	Deviation of the Geometric Mean	Lyman Mill Pond Arithmetic Mean Concentration	Lyman Mill Pond Geomentric Mean Concentration	Lyman Mill Pond Maximum Concentration	Allendale Pond Arithmetic Mean Concentration	Allendale Pond Geometric Mean Concentration	Allendale Pond Maximum Concentration	Proposed Sediment Cleanup Goals
118741	Hexachlorobenzene	ND	ND	UG/KG	-	0	12	20.00	0	No	E	-	-	15.00	-	3.03							
120821	1,2,4-Trichlorobenzene	ND	ND	UG/KG	-	0	12	9600.00	0	No	E	-	-	32.50	-	3.01							
120832	2,4-Dichlorophenol	ND	ND	UG/KG	-	0	12	3720.09	0	No	E	-	-	12.50	-	3.02							
121142	2,4-Dinitrotoluene	ND	ND	UG/KG	-	0	12	203.40	0	No	E	-	-	19.00	-	3.01							
51285	2,4-Dinitrophenol	ND	ND	UG/KG	-	0	11	2.72	0	No	E	-	-	215.00	-	3.03							
534521	4,6-Dinitro-o-cresol	ND	ND	UG/KG	-	0	12	2.79	0	No	E	-	-	17.50	-	3.00							
541731	1,3-Dichlorobenzene	ND	ND	UG/KG	-	0	12	1700.00	0	No	E	-	-	37.50	-	3.02							
59507	4-Chloro-3-methylphenol	ND	ND	UG/KG	-	0	12	33.47	0	No	E	-	-	17.50	-	3.00							
606202	2,6-Dinitrotoluene	ND	ND	UG/KG	-	0	12	30.17	0	No	E	-	-	25.00	-	3.02							
87865	Pentachlorophenol	ND	ND	UG/KG	-	0	12	376.98	0	No	E	-	-	250.00	-	3.02							
88062	2,4,6-Trichlorophenol	ND	ND	UG/KG	-	0	12	1357.38	0	No	E	-	-	17.50	-	3.00							
88755	2-Nitrophenol	ND	ND	UG/KG	-	0	12	86.29	0	No	E	-	-	19.00	-	3.01							
95501	1,2-Dichlorobenzene	ND	ND	UG/KG	-	0	12	330.00	0	No	E	-	-	36.50	-	2.99							
95578	2-Chlorophenol	ND	ND	UG/KG	-	0	12	569.12	0	No	E	-	-	25.00	-	3.02							
95954	2,4,5-Trichlorophenol	20	220	UG/KG	SD_G-01	3	12	2042.93	0	No	C	44.06	61.46	22.25	23.84	3.06						80	
117817	Bis(2-ethylhexyl)phthalate	46	7100	UG/KG	SD_G-01	12	12	6841.12	1	Yes	B	1385.50	1966.86	480.00	652.30	3.80		211.57	7900			12000	
117840	Di-n-octylphthalate	ND	ND	UG/KG		0	12	690.33	0	No	E	-	-	21.50	-	3.01			400				
131113	Dimethylphthalate	83	150	UG/KG	SD_G-02	9	12	1.12	9	Yes	B	85.08	45.24	91.00	59.88	3.31			180				
84662	Diethylphthalate	ND	ND	UG/KG	-	0	12	600.00	0	No	E	-	-	16.50	-	3.01							
84742	Di-n-Butylphthalate	ND	ND	UG/KG	-	0	12	42.00	0	No	E	-	-	100.00	-	3.01			290				
85687	Butylbenzylphthalate	130	300	UG/KG	SD_G-02	3	12	1512.82	0	No	C	103.79	100.38	67.50	54.61	3.81			1200			1100	
100016	4-Nitroaniline	ND	ND	UG/KG	-	0	12	7.68	0	No	E	-	-	22.50	-	3.02							
106478	4-Chloroaniline	23	120	UG/KG	SD_G-03	2	12	0.02	2	Yes	B	44.67	44.75	24.00	25.77	3.24							
88744	2-Nitroaniline	ND	ND	UG/KG	-	0	12	15.16	0	No	E	-	-	40.00	-	3.01							
99092	3-Nitroaniline	ND	ND	UG/KG	-	0	12	7.56	0	No	E	-	-	31.50	-	2.98							
91941	3,3'-Dichlorobenzidine	ND	ND	UG/KG	-	0	12	2963.46	0	No	E	-	-	46.50	-	2.99							
621647	N-Nitroso-di-n-propylamine	ND	ND	UG/KG	-	0	12	126.50	0	No	E	-	-	30.00	-	3.02							
86306	N-Nitroso-diphenylamine	ND	ND	UG/KG	-	0	12	100.00	0	No	E	-	-	20.00	-	3.00							
86748	Carbazole	12	420	UG/KG	SD_G-03	12	12	360.00	1	Yes	B	212.83	124.58	215.00	158.99	2.70			810			1800	
	Ancillary																						
	pH						12					6.03	0.44	6.15	6.01	1.08							
Notes:	Total Organic Carbon						13					7.96	5.45	8.04	5.75	2.58							

Notes:
For summary statistics, non-detects were assumed to be 1/2 the reporting limit.
Maximum detected concentration used for screening.
Shaded entried are contaminants identified as COPECs
a. Sediment screening values presented in Table D-2 in Centredale Site Baseline Ecological Risk Assessment (MACTEC, 2004) and EPA Ecological Soil Screening Levels; lower of soil invertebrate and wildlife benchmarks selected.
Table values originally presented in mg/kg and adjusted as necessary.
b. Rationale for deleting or retaining analyte as a COPEC:
A - Individual dioxin and furan congeners and homologue groups were not specifically identified as COPECs because a TEQ approach was employed in the evaluation.
B - Retained because maximum concentration exceeds screening benchmark value.
C - Not retained because maximum concentration is below the screening benchmark value.
D - Not retained because parameter is an essential element.

TABLE 3
ESTIMATED EARTHWORM TISSUE CONCENTRATIONS DERIVED USING SITE-SPECIFIC BSAFs

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

CAS Number	Chemical	Floodplain Soil			Earthworm BSAFs[a]	Estimated Earthworm Tissue[b]		
		Maximum	Average	Units		Maximum	Average	Units
	Metals							
7429-90-5	Aluminum	1.5E+04	9.0E+03	UG/G_DRYWT	0.250	1.2E+03	7.4E+02	UG/G_WETWT
7440-36-0	Antimony	3.8E+01	1.9E+00	UG/G_DRYWT	0.699	8.8E+00	4.3E-01	UG/G_WETWT
7440-38-2	Arsenic	5.6E+01	7.8E+00	UG/G_DRYWT	0.112	2.0E+00	2.9E-01	UG/G_WETWT
7440-43-9	Cadmium	5.0E+00	7.8E-01	UG/G_DRYWT	4.016	6.6E+00	1.0E+00	UG/G_WETWT
7440-47-3	Chromium	9.3E+01	2.8E+01	UG/G_DRYWT	0.083	2.5E+00	7.7E-01	UG/G_WETWT
7440-50-8	Copper	2.4E+03	1.1E+02	UG/G_DRYWT	0.098	7.6E+01	3.5E+00	UG/G_WETWT
7439-92-1	Lead	2.5E+03	2.3E+02	UG/G_DRYWT	0.145	1.2E+02	1.1E+01	UG/G_WETWT
7439-96-5	Manganese	2.4E+03	6.1E+02	UG/G_DRYWT	0.201	1.6E+02	4.1E+01	UG/G_WETWT
7439-97-6	Mercury	1.1E+00	2.7E-01	UG/G_DRYWT	0.190	6.9E-02	1.7E-02	UG/G_WETWT
7439-98-7	Molybdenum	1.9E+01	4.3E+00	UG/G_DRYWT	0.082	5.1E-01	1.2E-01	UG/G_WETWT
7440-02-0	Nickel	1.5E+02	1.8E+01	UG/G_DRYWT	1.700	8.3E+01	9.9E+00	UG/G_WETWT
7782-49-2	Selenium	4.5E+00	8.9E-01	UG/G_DRYWT	1.730	2.6E+00	5.0E-01	UG/G_WETWT
7440-22-4	Silver	5.7E+00	7.5E-01	UG/G_DRYWT	0.110	2.1E-01	2.7E-02	UG/G_WETWT
7440-28-0	Thallium	8.0E-01	3.9E-01	UG/G_DRYWT	0.176	4.6E-02	2.3E-02	UG/G_WETWT
7440-62-2	Vanadium	6.3E+01	2.7E+01	UG/G_DRYWT	0.080	1.7E+00	7.1E-01	UG/G_WETWT
7440-66-6	Zinc	8.1E+02	1.6E+02	UG/G_DRYWT	0.618	1.6E+02	3.2E+01	UG/G_WETWT
	Pesticides/Herbicides							
72-54-8	4,4'-DDD	2.7E-02	3.7E-03	UG/G_DRYWT	0.466	4.1E-03	5.6E-04	UG/G_WETWT
72-55-9	4,4'-DDE	1.0E+00	3.6E-02	UG/G_DRYWT	0.545	1.8E-01	6.5E-03	UG/G_WETWT
50-29-3	4,4'-DDT	1.3E+00	5.1E-02	UG/G_DRYWT	0.210	9.0E-02	3.5E-03	UG/G_WETWT
309-00-2	Aldrin	3.4E-03	7.6E-04	UG/G_DRYWT	-	-	-	UG/G_WETWT
60-57-1	Dieldrin	1.7E-02	2.6E-03	UG/G_DRYWT	0.583	3.3E-03	5.0E-04	UG/G_WETWT
57-74-9	Technical chlordane	5.4E-01	7.0E-02	UG/G_DRYWT	0.390	6.9E-02	9.0E-03	UG/G_WETWT
58-89-9	Lindane	2.3E-03	8.9E-04	UG/G_DRYWT	1.331	1.0E-03	3.9E-04	UG/G_WETWT
72-20-8	Endrin	1.6E-03	1.4E-03	UG/G_DRYWT	-	-	-	UG/G_WETWT
	PCB as Aroclors							
11097-69-1	Aroclor 1254	6.4E-01	1.2E-01	UG/G_DRYWT	0.354	7.4E-02	1.4E-02	UG/G_WETWT
1109-68-25	Aroclor 1260	2.8E-01	3.1E-02	UG/G_DRYWT	-	-	-	UG/G_WETWT
11100-14-4	Aroclor 1268	5.4E-02	9.0E-03	UG/G_DRYWT	0.428	7.6E-03	1.3E-03	UG/G_WETWT
	Dioxin/Furans[c]							
1746-01-6	2,3,7,8-TCDD	1.5E-02	1.3E-03	UG/G_DRYWT	0.252	1.2E-03	1.1E-04	UG/G_WETWT
35822-46-9	**1,2,3,4,6,7,8-HpCDD**	1.7E-03	1.9E-04	UG/G_DRYWT	0.218	1.2E-04	1.4E-05	UG/G_WETWT
67562-39-4	**1,2,3,4,6,7,8-HpCDF**	8.4E-04	7.5E-05	UG/G_DRYWT	0.213	5.9E-05	5.2E-06	UG/G_WETWT
55673-89-7	**1,2,3,4,7,8,9-HpCDF**	3.9E-05	4.3E-06	UG/G_DRYWT	0.251	3.2E-06	3.6E-07	UG/G_WETWT
39227-28-6	**1,2,3,4,7,8-HxCDD**	2.7E-05	3.3E-06	UG/G_DRYWT	0.696	6.2E-06	7.6E-07	UG/G_WETWT
70648-26-9	**1,2,3,4,7,8-HxCDF**	2.6E-04	1.3E-05	UG/G_DRYWT	0.172	1.5E-05	7.1E-07	UG/G_WETWT
57653-85-7	**1,2,3,6,7,8-HxCDD**	7.4E-05	8.7E-06	UG/G_DRYWT	-	-	-	UG/G_WETWT
57117-44-9	**1,2,3,6,7,8-HxCDF**	8.8E-05	7.5E-06	UG/G_DRYWT	0.415	1.2E-05	1.0E-06	UG/G_WETWT
19408-74-3	**1,2,3,7,8,9-HxCDD**	7.2E-05	7.7E-06	UG/G_DRYWT	0.199	4.7E-06	5.1E-07	UG/G_WETWT
72918-21-9	**1,2,3,7,8,9-HxCDF**	8.6E-06	1.2E-06	UG/G_DRYWT	4.569	1.3E-05	1.7E-06	UG/G_WETWT
40321-76-4	**1,2,3,7,8-PeCDD**	1.7E-05	3.2E-06	UG/G_DRYWT	1.027	5.9E-06	1.1E-06	UG/G_WETWT
57117-41-6	**1,2,3,7,8-PeCDF**	2.3E-04	1.0E-05	UG/G_DRYWT	1.083	8.1E-05	3.6E-06	UG/G_WETWT
60851-34-5	**2,3,4,6,7,8-HxCDF**	1.3E-04	9.3E-06	UG/G_DRYWT	0.500	2.2E-05	1.5E-06	UG/G_WETWT
57117-31-4	**2,3,4,7,8-PeCDF**	1.6E-04	8.3E-06	UG/G_DRYWT	0.299	1.6E-05	8.2E-07	UG/G_WETWT
1746-01-6	**2,3,7,8-TCDD**	1.5E-02	1.3E-03	UG/G_DRYWT	0.252	1.2E-03	1.1E-04	UG/G_WETWT
51207-31-9	**2,3,7,8-TCDF**	4.5E-04	1.5E-05	UG/G_DRYWT	0.125	1.8E-05	6.1E-07	UG/G_WETWT
3268-87-9	**OCDD**	1.1E-02	1.4E-03	UG/G_DRYWT	0.219	8.1E-04	9.8E-05	UG/G_WETWT
39001-02-0	**OCDF**	2.0E-03	1.3E-04	UG/G_DRYWT	0.234	1.5E-04	1.0E-05	UG/G_WETWT
TEQB	Bird TEQ	1.5E-02	1.4E-03	UG/G_DRYWT	0.339	1.6E-03	1.5E-04	UG/G_WETWT
TEQM	Mammal TEQ	1.5E-02	1.3E-03	UG/G_DRYWT	0.353	1.7E-03	1.6E-04	UG/G_WETWT

TABLE 3
ESTIMATED EARTHWORM TISSUE CONCENTRATIONS DERIVED USING SITE-SPECIFIC BSAFs

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Notes:

a. Mean Biota Soil Accumulation Factors (BSAFs) presented in Table J-8 of the BERA (MACTEC, 2004). Units are g_{OC}(drywt)/g_{lipid}(wetwt).

b. Earthworm tissue concentrations were estimated by multiplying the soil concentration (either maximum or arithmetic average) by the BSAF and the estimated earthworm lipid percentage and dividing by estimated soil TOC.

2.66%	Average earthworm lipid percentage of Lyman Mill earthworm samples collected to support the BERA (Table 20; MACTEC, 2004).
8.09%	Average TOC in LPX-SD-4402 and field duplicate (RI samples collected by Battelle in 2004); conservative estimate of soil TOC, lowest TOC was measured at this location and average of 3 Oxbow sampling locations was 0.02163 g OC/g.

c. **Bold** font indicates chemicals that were not selected as COPECs because a toxic equivalency approach was employed in the BERA; however, earthworm tissue concentrations were estimated for individual dioxin and furan congeners in order to estimate wildlife tissue concentrations.

A dash (-) means not available.

TABLE 4
SOIL MACROINVERTEBRATE HAZARD QUOTIENTS FOR COPECs IN OXBOW AREA FLOODPLAIN SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Chemical	Detection Frequency	Units	Exposure Point		TRV[b]	Hazard Quotients	
			MAX[a]	AVG[a]		MAX[c]	AVG[d]
Pesticides							
4,4'-DDD	18/37	UG/G	2.7E-02	3.7E-03	0.0025	**1.1E+01**	**1.5E+00**
4,4'-DDE	31/37	UG/G	1.0E+00	3.6E-02	0.0025	**4.0E+02**	**1.5E+01**
4,4'-DDT	30/37	UG/G	1.3E+00	5.1E-02	0.0025	**5.2E+02**	**2.0E+01**
Aldrin	2/37	UG/G	3.4E-03	7.6E-04	0.0025	**1.4E+00**	3.1E-01
Dieldrin	8/37	UG/G	1.7E-02	2.6E-03	0.00050	**3.4E+01**	**5.2E+00**
Technical chlordane	17/27	UG/G	5.4E-01	7.0E-02	0.10	**5.4E+00**	7.0E-01
Lindane	4/37	UG/G	2.3E-03	8.9E-04	0.000050	**4.6E+01**	**1.8E+01**
Endrin	8/37	UG/G	1.6E-03	1.4E-03	0.0010	**1.6E+00**	**1.4E+00**
					Total Pesticides	**1.0E+03**	**6.2E+01**
PCBs							
Aroclor 1254	24/37	UG/G	6.4E-01	1.2E-01	17	3.9E-02	7.4E-03
Aroclor 1260	6/37	UG/G	2.8E-01	3.1E-02	9.5	2.9E-02	3.3E-03
Aroclor 1268	6/27	UG/G	5.4E-02	9.0E-03	861	6.3E-05	1.0E-05
					Total PCBs	6.8E-02	1.1E-02
PAHs							
High Molecular Weight PAHs	35/36	UG/G	3.6E+01	9.6E+00	1.0	**3.6E+01**	**9.6E+00**
Low Molecular Weight PAHs	35/36	UG/G	1.5E+01	3.0E+00	1.0	**1.5E+01**	**3.0E+00**
					Total PAHs	**5.1E+01**	**1.3E+01**
Inorganics/Metals							
Aluminum	12/12	UG/G	1.5E+04	9.0E+03	600	**2.5E+01**	**1.5E+01**
Antimony	27/37	UG/G	3.8E+01	1.9E+00	78	4.9E-01	2.4E-02
Arsenic	36/37	UG/G	5.6E+01	7.8E+00	60	9.3E-01	1.3E-01
Cadmium	31/37	UG/G	5.0E+00	7.8E-01	140	3.6E-02	5.6E-03
Chromium	36/37	UG/G	9.3E+01	2.8E+01	0.40	**2.3E+02**	**7.0E+01**
Copper	37/37	UG/G	2.4E+03	1.1E+02	80	**2.9E+01**	**1.4E+00**
Lead	12/12	UG/G	2.5E+03	2.3E+02	500	**4.9E+00**	4.6E-01
Manganese	37/37	UG/G	2.4E+03	6.1E+02	450	**5.4E+00**	**1.4E+00**
Mercury	8/12	UG/G	1.1E+00	2.7E-01	0.1	**1.1E+01**	**2.7E+00**
Molybdenum	27/27	UG/G	1.9E+01	4.3E+00	200	9.6E-02	2.2E-02
Nickel	37/37	UG/G	1.5E+02	1.8E+01	280	5.3E-01	6.3E-02
Selenium	25/37	UG/G	4.5E+00	8.9E-01	4.1	**1.1E+00**	2.2E-01
Silver	17/37	UG/G	5.7E+00	7.5E-01	50	1.1E-01	1.5E-02
Thallium	6/10	UG/G	8.0E-01	3.9E-01	1.0	8.0E-01	3.9E-01
Vanadium	37/37	UG/G	6.3E+01	2.7E+01	20	**3.1E+00**	**1.3E+00**
Zinc	37/37	UG/G	8.1E+02	1.6E+02	120	**6.7E+00**	**1.3E+00**
					Total Inorganics/Metals	**3.2E+02**	**9.4E+01**
2,3,7,8-TCDD	54/56	UG/G	1.5E-02	1.3E-03	0.0048	**3.0E+00**	2.7E-01
					Total TCDD TEQ	**3.0E+00**	2.7E-01
					Total	**1.4E+03**	**1.7E+02**

Notes:

a. MAX and AVG EPCs defined as the maximum detected and arithmetic mean COPEC concentrations presented in Table 2.

b. Soil Toxicity Reference Values (TRVs) based on lowest available invertebrate screening benchmark values as summarized in the BERA (MACTEC, 2004; Table D-3).

c. MAX Hazard Quotient is the ratio of the maximum concentration to the TRV.

d. AVG Hazard Quotient is the ratio of the average concentration to the TRV.

Shaded cells indicate a hazard quotient greater than 1.

TABLE 5
CBR-BASED HAZARD QUOTIENTS FOR COPECs IN OXBOW EARTHWORM TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

							Hazard Quotient[c]			
Chemical	Detection Frequency	Units	Exposure Point Concentration		CBR[b]		Maximum		Average	
			MAX[a]	AVG[a]	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Pesticides										
4,4'-DDD	18/37	UG/G	4.1E-03	5.6E-04	0.008	0.6	5.1E-01	6.8E-03	7.0E-02	9.4E-04
4,4'-DDE	31/37	UG/G	1.8E-01	6.5E-03	0.042	0.29	4.3E+00	6.2E-01	1.6E-01	2.2E-02
4,4'-DDT	30/37	UG/G	9.0E-02	3.5E-03	0.13	0.15	6.9E-01	6.0E-01	2.7E-02	2.4E-02
Aldrin	2/37	UG/G	-	-	0.132	0.8	-	-	-	-
Dieldrin	8/37	UG/G	3.3E-03	5.0E-04	0.01	0.08	3.3E-01	4.1E-02	5.0E-02	6.3E-03
Technical chlordane	17/27	UG/G	6.9E-02	9.0E-03	-	0.02	-	3.5E+00	-	4.5E-01
Lindane	4/37	UG/G	1.0E-03	3.9E-04	-	-	-	-	-	-
Endrin	8/37	UG/G	-	-	0.02	0.01	-	-	-	-
						Total Pesticides	5.8E+00	4.7E+00	3.0E-01	5.0E-01
PCBs										
Aroclor 1254	24/37	UG/G	7.4E-02	1.4E-02	-	8.1	-	9.2E-03	-	1.8E-03
Aroclor 1260	6/37	UG/G	-	-	0.036	0.36	-	-	-	-
Aroclor 1268	6/27	UG/G	7.6E-03	1.3E-03		0.45	-	1.7E-02	-	2.8E-03
						Total PCBs	0.0E+00	2.6E-02	0.0E+00	4.6E-03
Inorganics/Metals										
Aluminum	12/12	UG/G	1.2E+03	7.4E+02	1	8	1.2E+03	1.5E+02	7.4E+02	9.2E+01
Antimony	27/37	UG/G	8.8E+00	4.3E-01	5.0	9	1.8E+00	9.8E-01	8.6E-02	4.8E-02
Arsenic	36/37	UG/G	2.0E+00	2.9E-01	1.0	4.2	2.0E+00	4.9E-01	2.9E-01	6.8E-02
Cadmium	31/37	UG/G	6.6E+00	1.0E+00	1.1	0.93	6.0E+00	7.1E+00	9.3E-01	1.1E+00
Chromium	36/37	UG/G	2.5E+00	7.7E-01	-	-	-	-	-	-
Copper	37/37	UG/G	7.6E+01	3.5E+00	3.4	4.4	2.2E+01	1.7E+01	1.0E+00	8.1E-01
Lead	12/12	UG/G	1.2E+02	1.1E+01	2.3	5.8	5.1E+01	2.0E+01	4.7E+00	1.9E+00
Manganese	37/37	UG/G	1.6E+02	4.1E+01	18.4	-	8.7E+00	-	2.2E+00	-
Mercury	8/12	UG/G	6.9E-02	1.7E-02	1.53	1.64	4.5E-02	4.2E-02	1.1E-02	1.0E-02
Molybdenum	27/27	UG/G	5.1E-01	1.2E-01	-	-	-	-	-	-
Nickel	37/37	UG/G	8.3E+01	9.9E+00	0.59	0.59	1.4E+02	1.4E+02	1.7E+01	1.7E+01
Selenium	25/37	UG/G	2.6E+00	5.0E-01	-	0.2	-	1.3E+01	-	2.5E+00
Silver	17/37	UG/G	2.1E-01	2.7E-02	5.4	1650	3.8E-02	1.2E-04	5.1E-03	1.6E-05
Thallium	6/10	UG/G	4.6E-02	2.3E-02	2.7	-	1.7E-02	-	8.5E-03	-
Vanadium	37/37	UG/G	1.7E+00	7.1E-01	1	0.41	2.1E+00	4.0E+00	8.8E-01	1.7E+00
Zinc	37/37	UG/G	1.6E+02	3.2E+01	13	20	1.3E+01	8.4E+00	2.5E+00	1.6E+00
						Total Inorganics/Metals	1.5E+03	3.6E+02	7.7E+02	1.2E+02
Dioxins										
2,3,7,8-TCDD	54/56	UG/G	1.2E-03	1.1E-04	13	20	9.5E-05	6.2E-05	8.4E-06	5.5E-06
						Total TCDD TEQ	9.5E-05	6.2E-05	8.4E-06	5.5E-06
						Total	1.5E+03	3.7E+02	7.7E+02	1.2E+02

Notes:

a. Background values are presented in the RI; See Section 3 of the risk assessment text for discussion of background values.
b. Critical Body Residues (CBRs) obtained from summary of tissue effects data presented in the BERA (MACTEC, 2004; Tables G-1 and G-3).
c. Hazard Quotient is the ratio of the Average and Maximum concentration to the NOAEL or LOAEL CBR.
Shaded cells indicate a hazard quotient greater than 1.
A dash (-) means not available.

TABLE 6
INCREMENTAL RISK SUMMARY FOR MACROINVERTEBRATES IN OXBOW STUDY AREA FLOODPLAIN SOIL

Centredale Manor Restoration Project Superfund Site -Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]		
	Oxbow[a]		Greystone[b]				
Chemical	MAX	AVG	MAX	AVG	MAX	AVG	%
HI	**1.4E+03**	**1.7E+02**	**1.1E+03**	**8.5E+02**	**1.0E+03**	**6.1E+01**	
4,4'-DDT	5.2E+02	2.0E+01	7.3E+00	3.4E+00	5.1E+02	1.7E+01	49%
4,4'-DDE	4.0E+02	1.5E+01	8.2E+00	5.3E+00	3.9E+02	9.2E+00	38%
Lindane	4.6E+01	1.8E+01			4.6E+01	1.8E+01	4%
Aluminum	2.5E+01	1.5E+01			2.5E+01	1.5E+01	2%
Copper	2.9E+01	1.4E+00	6.5E+00	4.1E+00	2.3E+01		2%
Dieldrin	3.4E+01	5.2E+00	1.9E+01	1.3E+01	1.5E+01		1%
Total PAHs	5.1E+01	1.3E+01	4.6E+01	4.1E+01	5.1E+00		0%
4,4'-DDD	1.1E+01	1.5E+00	6.1E+00	3.3E+00	4.6E+00		0%
Lead	4.9E+00	4.6E-01	1.2E+00	9.0E-01	3.7E+00		0%
2,3,7,8-TCDD	3.0E+00	2.7E-01	1.2E-02	3.6E-03	3.0E+00	2.6E-01	0%
Mercury	1.1E+01	2.7E+00	8.1E+00	5.8E+00	2.9E+00		0%
Zinc	6.7E+00	1.3E+00	5.0E+00	2.9E+00	1.8E+00		0%
Endrin	1.6E+00	1.4E+00			1.6E+00	1.4E+00	0%
Aldrin	1.4E+00	3.1E-01			1.4E+00	3.1E-01	0%
Selenium	1.1E+00	2.2E-01	1.4E-02	1.0E-02	1.1E+00	2.1E-01	0%

Notes:

a. Risk estimates as calculated and presented in Table 4.

b. Risk estimates as calculated and presented in Table 71 in the BERA (MACTEC, 2004). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with maximum concentration-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceed the corresponding reference risk estimates.

Incremental risks for individual analytes derived by subtracting the upgradient/reference HQs from the exposure area HQ.

TABLE 7
INCREMENTAL RISK SUMMARY FOR ESTIMATED OXBOW STUDY AREA EARTHWORM TISSUE CBRs

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]		
	Oxbow[a]		Greystone[b]				
Chemical	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	%
HI for Average Body Burdens	**7.7E+02**	**1.2E+02**	**2.7E+03**	**4.9E+02**	**8.4E+00**	**8.3E+00**	
Aluminum	7.4E+02	9.2E+01	2.7E+03	3.4E+02			
Cadmium	9.3E-01	1.1E+00	2.7E+00	3.2E+01			
Copper	1.0E+00	8.1E-01	4.1E+00	3.2E+00			
Lead	4.7E+00	1.9E+00	1.2E+01	4.9E+00			
Manganese	2.2E+00		1.2E+01				
Nickel	1.7E+01	1.7E+01	8.5E+00	8.5E+00	8.3E+00	8.3E+00	98%
Zinc	2.5E+00	1.6E+00	6.7E+00	4.4E+00			

Notes:

a. Risk estimates as calculated and presented in Table 5.

b. Risk estimates as calculated and presented Table 74 in the BERA (MACTEC, 2004). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with average concentration-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceeds the corresponding reference risk estimate.

Incremental risks for individual analytes derived by subtracting the upgradient/reference HQs from the exposure area HQ.

TABLE 8. EXPOSURE ASSUMPTIONS FOR THE AMERICAN WOODCOCK.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Parameter	Symbol	Value	Units	Reference
Soil concentration	C_{soil}	COPEC-specific	ug/g_{dw}	Table 1
Percentage of earthworms in diet	$P_{earthworms}$	100	%	Assumption
Earthworm concentration[a]	$C_{earthworm}$	COPEC-specific	ug/g_{ww}	Table 2
Ingestion Rate[b]	IR_{food}	0.082	kg/day	USEPA, 1993
Incidental Soil Ingestion Rate[c]	IR_{soil}	0.012	kg/day	Assumption
Site Foraging Factor[d]	SFF	100	%	Gregg, 1984
Body Weight	BW	0.20	kg	USEPA, 1993

Notes:

a. Earthworm tissue concentrations estimated using site-specific BSAFs as discussed in 3.1.1.
b. Calculated using regression equation for non-passerines: IR_{food} (g/day) = 0.301 * BW 0.751 (g) and converted to kg/day.
c. Assume 15% of daily food ingestion rate.
d. Assumed 100% for initial calculations using maximum exposure estimates; also 100% for evaluation of average conditions based on average home range (5 hectares) of females with broods in Wisconsin woods (Gregg, 1984) relative to estimated available habitat in Oxbow Area (11.12 hectares).

TABLE 9. EXPOSURE ASSUMPTIONS FOR THE SHORT-TAILED SHREW.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Parameter	Symbol	Value	Units	Reference
Soil concentration	C_{soil}	COPEC-specific	ug/g_{dw}	Table 1
Percentage of plants in diet	P_{plants}	15	%	USEPA, 1993; Whittaker and Feraro, 1963
Plant concentration	C_{plant}	COPEC-specific	ug/g_{ww}	Tables C.2-1, D.2-1
Percentage of earthworms in diet	$P_{earthworms}$	85	%	USEPA, 1993; Whittaker and Feraro, 1963
Earthworm concentration[a]	$C_{earthworm}$	COPEC-specific	ug/g_{ww}	Table 2
Ingestion Rate[b]	IR_{food}	0.013	kg/day	USEPA, 1993
Incidental Soil Ingestion Rate[c]	IR_{soil}	0.00064	kg/day	Assumption
Site Foraging Factor[d]	SFF	100	%	Buckner, 1966
Body Weight	BW	0.017	kg	Guilday, 1957

Notes:

a. Earthworm tissue concentrations estimated using site-specific BSAFs as discussed in 3.1.1.

b. Calculated using regression equation for mammals: IR_{food} (g/day) = 0.235 * BW 0.822 (g) and converted to kg/day.

c. Assume 5% of daily food ingestion rate.

d. Assumed 100% for initial calculations using maximum exposure estimates; also 100% for evaluation of average conditions based on average home ranges (0.390 hectares) in southern Manitoba/tamarack bog habitat relative to estimated available habitat in Oxbow Area (11.12 hectares).

TABLE 10
CBR-BASED HAZARD QUOTIENTS FOR ESTIMATED VERMIVOROUS AVIAN EGG TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Chemical	Estimated Earthworm Tissue Concentration[a]		Units	Avian BMF[b] (lipid basis)	TEF	Estimated Egg Tissue Concentration[c]		CBR[d]		Hazard Quotients[e] Maximum		Hazard Quotients[e] Average	
	MAX	AVG				MAX	AVG	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Pesticides/PCBs													
4,4'-DDE	1.8E-01	6.5E-03	UG/G	13.3	na	6.9E+00	2.5E-01	-	0.10	-	**6.9E+01**	-	**2.5E+00**
Dieldrin	3.3E-03	5.0E-04	UG/G	2.82	na	2.7E-02	4.1E-03	-	0.059	-	4.5E-01	-	6.9E-02
Total Pesticides/PCBs										-	**7.0E+01**	-	**2.6E+00**
Dioxins/Furans[f]													
2,3,7,8-TCDD	1.2E-03	1.1E-04	UG/G	6.99	1	2.4E-02	2.2E-03						
1,2,3,7,8-PeCDD	5.9E-06	1.1E-06	UG/G	3.35	1	5.7E-05	1.0E-05						
2,3,4,7,8-PeCDF	1.6E-05	8.2E-07	UG/G	1.57	1	7.2E-05	3.7E-06						
1,2,3,6,7,8-HxCDD	-	-	UG/G	5.98	0.01	-	-						
1,2,3,4,6,7,8-HpCDD	1.2E-04	1.4E-05	UG/G	-	0.001	-	-						
OCDD	8.1E-04	9.8E-05	UG/G	-	0.0001	-	-						
1,2,3,4,7,8-HxCDF	1.5E-05	7.1E-07	UG/G	-	0.1	-	-						
1,2,3,6,7,8-HxCDF	1.2E-05	1.0E-06	UG/G	-	0.1	-	-						
2,3,7,8-TCDF	1.8E-05	6.1E-07	UG/G	-	1	-	-						
1,2,3,4,7,8-HxCDD	6.2E-06	7.6E-07	UG/G	-	0.05	-	-						
1,2,3,7,8,9-HxCDD	4.7E-06	5.1E-07	UG/G	-	0.1	-	-						
2,3,4,6,7,8-HxCDF	2.2E-05	1.5E-06	UG/G	-	0.1	-	-						
1,2,3,4,6,7,8-HpCDF	5.9E-05	5.2E-06	UG/G	-	0.01	-	-						
1,2,3,4,7,8,9-HpCDF	3.2E-06	3.6E-07	UG/G	-	0.01	-	-						
OCDF	1.5E-04	1.0E-05	UG/G	-	0.0001	-	-						
TCDD Toxic Equivalency (Birds)						2.5E-02	2.2E-03	7.0E-05	1.2E-03	**3.5E+02**	**2.1E+01**	**3.1E+01**	**1.8E+00**
Total										**3.5E+02**	**9.0E+01**	**3.1E+01**	**4.4E+00**

TABLE 10
CBR-BASED HAZARD QUOTIENTS FOR ESTIMATED VERMIVOROUS AVIAN EGG TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Notes:

a. EPCs for earthworm tissue (Table 3); only analytes with BMFs presented.

b. Biomagnification Factors (BMFs - expressed in units of g (lipid % fish)/g (lipid % gull egg) presented in the BERA (MACTEC, 2004; Table J-12).

c. Egg concentration for avian insectivore receptor (mg/kg wet weight) estimated by multiplying the earthworm tissue concentration by the BMF and the ratio of the egg to earthworm percent lipid. The following lipid contents were assumed:

2.7	Average earthworm lipid percent in Lyman Mill Pond.
7.7	Average gull egg lipid percentage (Braune and Norstrom, 1989)

d. Critical Body Residues (CBRs) are obtained from summary of tissue effects data presented in the BERA (MACTEC, 2004; Table G-1); TCDD CBRs presented in Table 130 (MACTEC, 2004).

e. Hazard Quotient is the ratio of the estimated tissue concentration to the NOAEL or LOAEL CBR.

f. Individual congeners were not identified as COPECs but were included in the calculation of dioxin TEQs.

A dash (-) means not available or not applicable.

TABLE 11
CBR-BASED HAZARD QUOTIENTS FOR ESTIMATED VERMIVOROUS MAMMALIAN TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Chemical	Estimated Earthworm Tissue Concentration[a]		Units	Mammal BMF[b] (lipid basis)	TEF	Estimated Tissue Concentration[c]		CBR[d]		Hazard Quotients[e] Maximum		Hazard Quotients[e] Average	
	MAX	AVG				MAX	AVG	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Pesticides/PCBs													
4,4'-DDD	4.1E-03	5.6E-04	UG/G	-	na	-	-	8.0E-03	0.6	-	-	-	-
Aroclor, Total	7.7E-02	2.0E-02	UG/G	14	na	1.8E+00	4.8E-01	-	-	-	-	-	-
									Pesticides/PCBs	-	-	-	-
Dioxins/Furans[f]													
2,3,7,8-TCDD	1.2E-03	1.1E-04	UG/G	11	1	2.3E-02	2.0E-03						
1,2,3,4,6,7,8-HpCDD	1.2E-04	1.4E-05	UG/G	36	0.01	7.5E-05	8.1E-06						
1,2,3,6,7,8-HxCDD	-	-	UG/G	30	0.1	-	-						
1,2,3,4,7,8-HxCDF	1.5E-05	7.1E-07	UG/G	57	0.1	1.4E-04	6.7E-06						
2,3,4,7,8-PeCDF	1.6E-05	8.2E-07	UG/G	54	0.5	7.1E-04	3.7E-05						
1,2,3,4,7,8-HxCDD	6.2E-06	7.6E-07	UG/G	9.3	0.1	9.6E-06	1.2E-06						
2,3,7,8-TCDF	1.8E-05	6.1E-07	UG/G	0.40	0.1	1.2E-06	4.1E-08						
1,2,3,7,8-PeCDD	5.9E-06	1.1E-06	UG/G	-	1	-	-						
1,2,3,7,8,9-HxCDD	4.7E-06	5.1E-07	UG/G	-	0.1	-	-						
OCDD	8.1E-04	9.8E-05	UG/G	-	0.0001	-	-						
1,2,3,6,7,8-HxCDF	1.2E-05	1.0E-06	UG/G	-	0.1	-	-						
2,3,4,6,7,8-HxCDF	2.2E-05	1.5E-06	UG/G	-	0.1	-	-						
1,2,3,4,6,7,8-HpCDF	5.9E-05	5.2E-06	UG/G	-	0.01	-	-						
1,2,3,4,7,8,9-HpCDF	3.2E-06	3.6E-07	UG/G	-	0.01	-	-						
OCDF	1.5E-04	1.0E-05	UG/G	-	0.0001	-	-						
				TCDD Toxic Equivalency (Mammals)		2.3E-02	2.0E-03	1.5E-04	2.3E-04	**1.6E+02**	**1.0E+02**	**1.4E+01**	**8.9E+00**
									TEQ (D/F)	**1.6E+02**	**1.0E+02**	**1.4E+01**	**8.9E+00**
									TEQ (PCBs)	0.0E+00	0.0E+00	0.0E+00	0.0E+00
									Total TCDD TEQ	**1.6E+02**	**1.0E+02**	**1.4E+01**	**8.9E+00**
									Total	**1.6E+02**	**1.0E+02**	**1.4E+01**	**8.9E+00**

TABLE 11
CBR-BASED HAZARD QUOTIENTS FOR ESTIMATED VERMIVOROUS MAMMALIAN TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Notes:

a. EPCs for earthworm tissue (Table 3); only analytes with BMFs presented.

b. Biomagnification Factors (BMFs - expressed in units of g (lipid % fish)/g (lipid % otter liver tissue) presented in the BERA (MACTEC, 2004; Table J-12).

c. Mammalian tissue concentration (mg/kg wet weight) estimated by multiplying the earthworm tissue concentration by the BMF and the ratio of the otter to earthworm percent lipid. The following lipid contents were assumed:

2.7	Average earthworm lipid percent in Lyman Mill Pond.
4.4	Average lipid percentage in five otter liver samples (Leonards et al., 1997).

d. Critical Body Residues (CBRs) are obtained from summary of tissue effects data presented in the BERA (MACTEC, 2004; Table G-1).

e. Hazard Quotient is the ratio of the estimated tissue concentration to the NOAEL or LOAEL CBR.

f. Individual congeners were not identified as COPECs but were included in the calculation of dioxin TEQs.

A dash (-) means not available or not applicable.

TABLE 12. INCREMENTAL RISK SUMMARY FOR WILDLIFE RECEPTORS - AMERICAN WOODCOCK

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]		
	Oxbow[a]		Greystone[b]				
Analyte	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	%
HI	**4.9E+01**	**5.9E+00**	**4.1E+01**	**6.7E+00**			
TEQ-BIRD	**1.3E+01**	**1.3E+00**	5.1E-01	5.1E-02	**1.2E+01**	**1.2E+00**	35%
4,4'-DDE	**1.2E+01**	**1.2E+00**	5.3E-01	5.3E-02	**1.1E+01**	**1.1E+00**	32%
4,4'-DDT	**1.0E+01**	**1.0E+00**	3.2E-01	3.2E-02	**9.9E+00**	9.9E-01	28%
Lead	**6.5E+00**	6.5E-01	**1.0E+01**	1.0E+00	-	-	
Zinc	**2.0E+00**	2.2E-01	**3.6E+00**	3.9E-01	**2.0E+00**	-	6%
Chromium	**2.0E+00**	4.0E-01	**1.8E+01**	**3.5E+00**	-	-	

Notes:

a. Oxbow risk estimates as calculated and presented in Appendix D.1.

b. Risk estimates as calculated and presented in the BERA (MACTEC, 2004; Appendix L). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with NOAEL-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceeds the corresponding reference risk estimate.

Incremental risks for individual analytes are derived by subtracting the upgradient background HQs from the Oxbow HQ.

TABLE 13. INCREMENTAL RISK SUMMARY FOR WILDLIFE RECEPTORS - SHORT-TAILED SHREW

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]		
	Oxbow[a]		Greystone[b]				
Analyte	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	%
HI	**3.5E+02**	**3.7E+01**	**1.3E+02**	**1.6E+01**	**2.2E+02**	**2.1E+01**	
TEQ-MAMMAL	**1.9E+02**	**1.9E+01**	**4.2E+00**	4.2E-01	**1.9E+02**	**1.9E+01**	84%
Antimony	**6.9E+01**	**6.9E+00**	**6.3E+00**	6.3E-01	**6.3E+01**	**6.3E+00**	28%
Copper	**7.4E+01**	**7.4E+00**	**4.4E+01**	**4.4E+00**	**3.0E+01**	**3.0E+00**	13%

Notes:

a. Oxbow risk estimates as calculated and presented in Appendix D.2.

b. Risk estimates as calculated and presented in the BERA (MACTEC, 2004; Appendix L). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with NOAEL-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceeds the corresponding reference risk estimate.

Incremental risks for individual analytes are derived by subtracting the upgradient/reference HQs from the exposure area HQ.

TABLE 14. EXPOSURE ASSUMPTIONS FOR THE RACCOON

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Parameter	Symbol	Value	Units	Reference
Soil concentration	C_{soil}	COPEC-specific	ug/g_{dw}	Table 1
Percentage of plants in diet	P_{plants}	71	%	Llewellyn and Uhler, 1952 as cited in USEPA, 1993
Plant concentration	C_{plant}	COPEC-specific	ug/g_{ww}	Tables C.3-1, D.3-1
Percentage of earthworms in diet	$P_{earthworms}$	29	%	Llewellyn and Uhler, 1952 as cited in USEPA, 1993
Earthworm concentration[a]	$C_{earthworm}$	COPEC-specific	ug/g_{ww}	Table 2
Ingestion Rate[b]	IR_{food}	1.7	kg/day	USEPA, 1993
Incidental Soil Ingestion Rate[c]	IR_{soil}	0.087	kg/day	Assumption
Site Foraging Factor[d]	SFF	5	%	Stuewer, 1943, as cited in USEPA, 1993
Body Weight	BW	6.2	kg	Sanderson, 1984, as cited in USEPA, 1993

Notes:

a. Earthworm tissue concentrations estimated using site-specific BSAFs as discussed in 3.1.1.

b. Calculated using regression equation for mammals: IR_{food} (g/day) = 0.235 * BW 0.822 (g) and converted to kg/day.

c. Assume 5% of daily food ingestion rate.

d. Assumed 100% for initial calculations using maximum exposure estimates; 10% selected for evaluation of average conditions based on average adult female home range size from May to December in riparian habitat in Michigan (Stuewer, 1943) (108 hectares) relative to estimated available habitat in Oxbow Area (11.12 hectares). Also assumed that raccoons forage in floodplain habitat for 50% of the year and exposure to terrestrial prey limited primarily to late summer and fall (USEPA, 1993). This resulted in an overall SFF of 0.1 * 0.5 or 5%.

TABLE 15. INCREMENTAL RISK SUMMARY FOR WILDLIFE RECEPTORS - RACCOON (FLOODPLAIN)

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

Oxbow Study Area	Risk Summary				Incremental Risk[c]		
	Oxbow[a]		Greystone[b]				
Analyte	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	%
HI	**3.3E+00**	**4.2E-01**	**1.4E+01**	**2.3E+00**			
TEQ-MAMMAL	**2.1E+00**	2.1E-01	5.3E-01	5.3E-02	**1.6E+00**	1.6E-01	100%

Notes:

a. Oxbow risk estimates as calculated and presented in Appendix D.3.

b. Greystone risk estimates presented in the BERA (MACTEC, 2004; Appendix N). HI is based on summing the HQs of all COPECs selected in the BERA.

c. Incremental risks calculated for all analytes with NOAEL-based HQs greater than one which, in combination, contribute at least 95% to the total risk, and which exceeds the corresponding reference risk estimate.

Incremental risks for individual analytes are derived by subtracting the upgradient/reference HQs from the exposure area HQ.

TABLE 16. SUMMARY OF UNCERTAINTIES

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under-estimation (-) of Risk	Rationale
Problem Formulation		
Selection of Receptors of Concern	+	The urbanized and industrialized nature of the landscape in the vicinity of the Oxbow Area may limit habitat suitability for sensitive receptors such as the American woodcock
	-	Plants were not specifically evaluated in the Addendum. Although inorganic analytes were generally consistent with upgradient background concentrations, reported levels in floodplain soils could adversely affect these receptors.
	-	The Oxbow Area was considered to provide primarily floodplain (i.e., terrestrial) habitat for ecological receptors. However, seasonal ponding could result in exposures to aquatic invertebrates and amphibians. These exposures were not evaluated because surface water data are not available.
	+	The availability of soil invertebrates as a forage base for vermivorous wildlife was assumed but not verified. Depositional regions of the Oxbow Area may contain saturated hydric soils for sufficient periods of time to exclude or reduce the numbers of soil invertebrates. In these areas, the bioaccumulation hazard to vermivorous wildlife would be less than assumed.
Identification and Selection of COPECs	-	HCX and coplanar PCBs were not included in the analytical parameters for soil samples collected at the Oxbow Area. Although this may result in exposures (and hazards) being under-estimated, it is unlikely that the risk conclusions drawn would have been significantly affected had these additional data been available. Based on the toxicological assessment conducted in the BERA, HCX and coplanar PCBs are most likely relatively poor aryl hydrocarbon (Ah) receptor agonists compared to TCDD and exposure to the most elevated concentrations detected in Centredale Site media posed minimal ecological risk. TCDD is the risk driver.
	+	It is assumed that measured concentrations of contaminants in soil are 100% bioavailable. This could lead to identification of chemicals as COPECs even if they are not available for exposure and uptake. For example, even at concentrations detected onsite, aluminum is not bioavailable and toxic at soil pH above 5.0.

TABLE 16. SUMMARY OF UNCERTAINTIES.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under-estimation (-) of Risk	Rationale
Exposure Assessment		
Measured Concentrations of Contaminants	+/-	Inaccuracies in analytical measurements due to sample moisture content, instrument calibration exceedences and spatial heterogeneity in the field could result underestimating or overestimating exposure concentrations.
Exposure Parameters	+/-	Uncertainty is inherent in the use of literature-derived exposure parameters because they were not empirically measured at the site. The general use of conservative values likely resulted in wildlife hazards being over-estimated.
Exposure Concentrations	+/-	There is a possibility that ecological receptors may preferentially utilize areas of higher habitat quality (i.e., better food or other resources) or avoid areas where resources are limited. Because of the heterogeneous distribution of contaminant concentrations in the floodplain, it is possible that preferential use or avoidance of some areas could result in higher or lower exposures to contaminants, depending on COPEC concentrations at those locations. Furthermore, measured concentrations of contaminants represent exposures within the 0 - 4, 0 - 6 and 0 - 12 inch soil horizon. There may be differences in concentrations on a finer scale over depth such that layers of higher concentrations occur deeper or closer to the surface. Because most ecological exposures occur closer to the surface, invertebrates or wildlife receptors may be exposed to concentrations that are higher or lower than those measured for the depth intervals sampled. Also, while exposures for burrowing soil invertebrates may be integrated across this soil horizon, exposures for leaf litter invertebrates and wildlife receptors is limited to the upper layers. If there are differences in contamination between finer resolution layers within the 0 – 1-foot soil horizon, this could result in an overestimate of risk if contamination is greater in deeper soil layers or an underestimate of risk if contamination is greater (i.e., more concentrated) in surface soil layers. This also reflects on the accuracy of the site-specific biota-soil accumulation factors (BSAFs), and BSAFs could be higher or lower depending on whether measured soil concentrations used for developing the BSAFs represent actual earthworm exposures. Consequently, these uncertainties are carried through the exposure models in the estimates of exposures through the incidental ingestion of soil and the ingestion of soil invertebrates, for which body burdens of COPECs are estimated using site-specific BSAFs.

TABLE 16. SUMMARY OF UNCERTAINTIES.

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Uncertainty	Potential Over- (+) or Under-estimation (-) of Risk	Rationale
Exposure Assessment		
Exposure Concentrations	+/-	Earthworm tissue concentrations were estimated using BSAFs that were normalized based on the average organic carbon concentration detected in the 2010 Oxbow Area floodplain soils. Floodplain soil carbon content is variable (1 -36%); the average is almost 8 times the minimum value and use of the average TOC would have resulted in estimated earthworm tissue concentrations being reduced by this same factor. Conversely, the average is also more than 4 times less than the maximum concentration, and bioaccumulation under conditions of greater TOC would result in lower body burdens.
Bioaccumulati on Factors	-	The lack of soil/plant uptake factors for TCDD may have resulted in an underestimation of dietary exposures to omnivorous wildlife (raccoon).
	-	The lack of BMFs necessary to estimate wildlife tissue concentrations for certain COPECs may have resulted in an underestimation of risks.
Effects Assessment		
Toxicity Reference Values	+	The use of conservative application factors to derive benchmark doses may have resulted in risks being over-estimated for some COPECs.
	-	Avian toxicological data for antimony and cobalt were not available and, as a result, potential risks for these COPECs could not be quantified.
	+/-	CBRs were not available for all COPECs. In addition, the relatively high percentage of studies reporting unbounded results contributed significant uncertainty to the residue-based analysis. The general methodology employed likely resulted in the selection of conservative measures of effect.
Dioxin, Furan, and PCB Congeners	-	The TEQ approach does not explicitly account for antagonistic or synergistic interactions between congeners and may underestimate risk to wildlife; however, because TCDD was the primary risk driver this uncertainty is likely of little consequence.
Risk Characterization		
Hazard Quotients/ Hazard Indices	+/-	Uncertainty exists regarding the interpretation of the HQ or HI value of one as a definitive indicator of population level impacts to wildlife. The magnitude of this uncertainty is bounded because the likelihood of classification errors in the evaluation of the assessment endpoints based on the results of the risk characterization decreases as hazard ratios become smaller or greater than one.

TABLE 17. SUMMARY OF ECOLOGICAL RISKS WITHIN THE OXBOW AREA AND OTHER EXPOSURE AREAS[a]

Centredale Manor Restoration Project Superfund Site – Oxbow Area
North Providence, Rhode Island

Receptor	Contaminant Group	Hazard Indicies[b]							
		OXB		LPX		APB		GMP	
		NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Soil invertebrates (soil screen)[a]	Pesticides	62		24		51		29	
	PCBs	-		-		-		-	
	Metals	94		150		37		620	
	Dioxin TEQ	-		-		-		-	
	SVOCs (PAHs)	- (13)[c]		57 (12)		78 (13)		210 (41)	
	Total	170		230		170		850	
Soil invertebrates (tissue screen)[a]	Pesticides	-	-	-	2.2	-	4.8	-	2.1
	PCBs	-	-	-	-	-	-	-	-
	Metals	770 (30)[d]	120 (18)[d]	2400	460	4400	700	2700	490
	Dioxin TEQ	-	-	-	-	-	-	-	-
	Total	770(30)[d]	120(18)[d]	2400	460	4400	710	2700	490
Short-tailed shrew (dietary exposure)	Pesticides	-	-	-	-	-	-	-	-
	PCBs	-	-	-	-	-	-	-	-
	Metals	160	16	58	9.8	43	5.9	92	12
	TEQ/TCDD	190	19	38	3.8	140	14	4.2	-
	Total	350	37	110	16	200	22	130	16
Short-tailed shrew (liver residues)[a]	Pesticides	-	-	-	-	-	-	-	-
	Dioxin TEQ	14	8.9	4.2	2.8	19	13	-	-
	Total	14	8.9	7.0	4.6	19	13	2.0	1.3
American woodcock	Pesticides	22	2.2	-	-	-	-	-	-
	PCBs	-	-	-	-	-	-	-	-
	Metals	11	1.5	22	3	9.7	1.4	33	5.2
	TEQ/TCDD	13	1.3	2.5	-	7.1	-	-	-
	Total	49	5.9	31	4.3	22	3.1	41	6.7
Vermivorous birds (egg residues)[a]	Pesticides	-	2.6	-	1.4	-	-	-	-
	Dioxin TEQ	31	1.8	8.6	-	45	2.6	-	-
	Total	31	4.4	10	1.9	45	3	-	-
Raccoon	Pesticides	-	-	-	-	-	-	-	-
	PCBs	-	-	-	-	-	-	1.1	-
	Metals	-	-	-	-	-	-	10	1.5
	TEQ/TCDD	2.1	-	-	-	-	-	-	-
	Total	3.3	-	-	-	-	-	14	2.3

a. Exposure areas include the Oxbow (OXB), Lyman Mill Pond (LPX), Allendale Pond (APB), and Greystone Mill Pond (GMP); the latter represents an upgradient background area not impacted by the Source Area.
b. Hazard indices (HI) based on average COPEC concentrations at the Oxbow Area.
c Only risks from exposure to PAHs were evaluated for the Oxbow Area.
d HI without the HQ for aluminum.
\- Indicates that the HI is below 1.

FIGURES

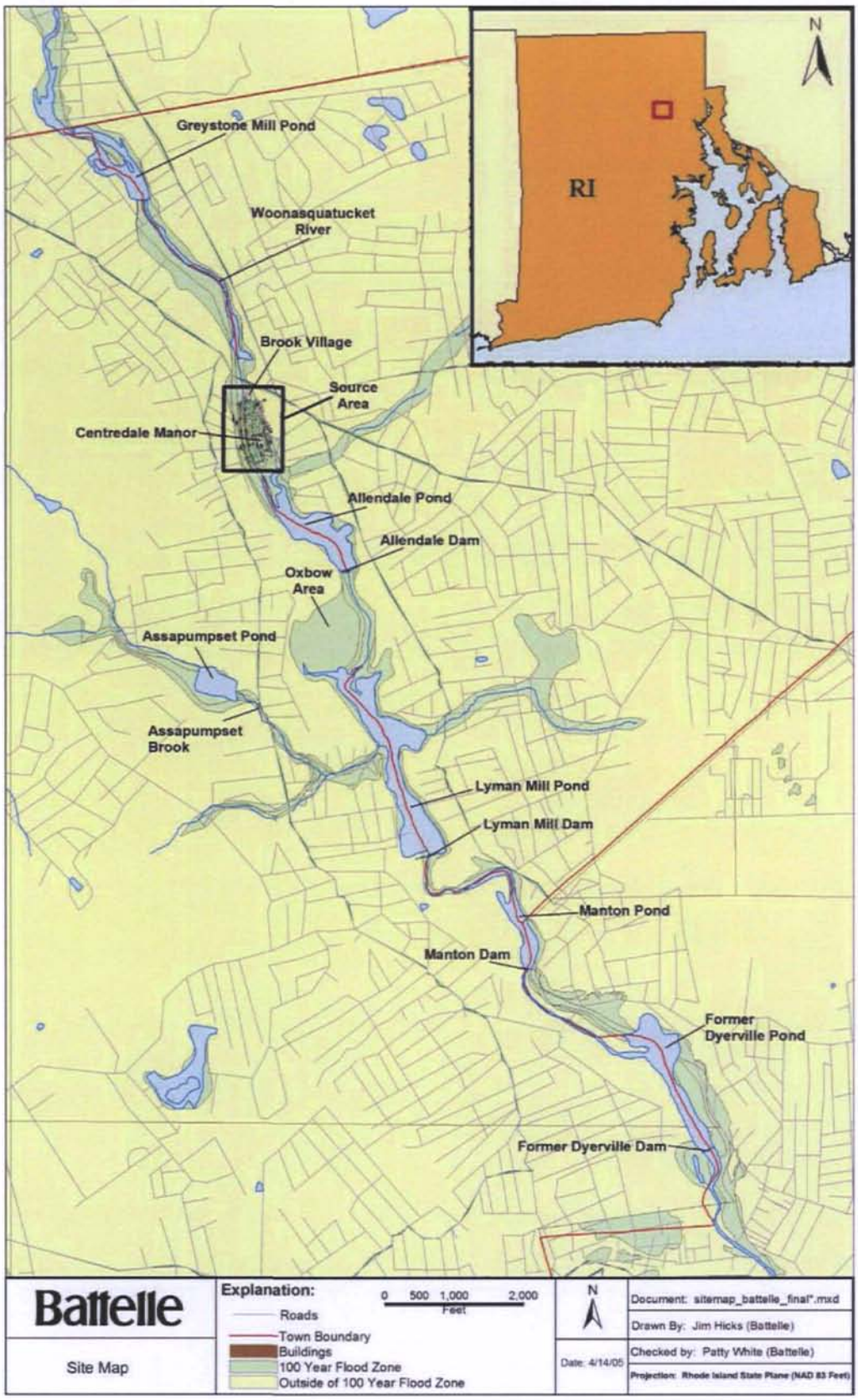


Figure 1. Site Locus Map
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

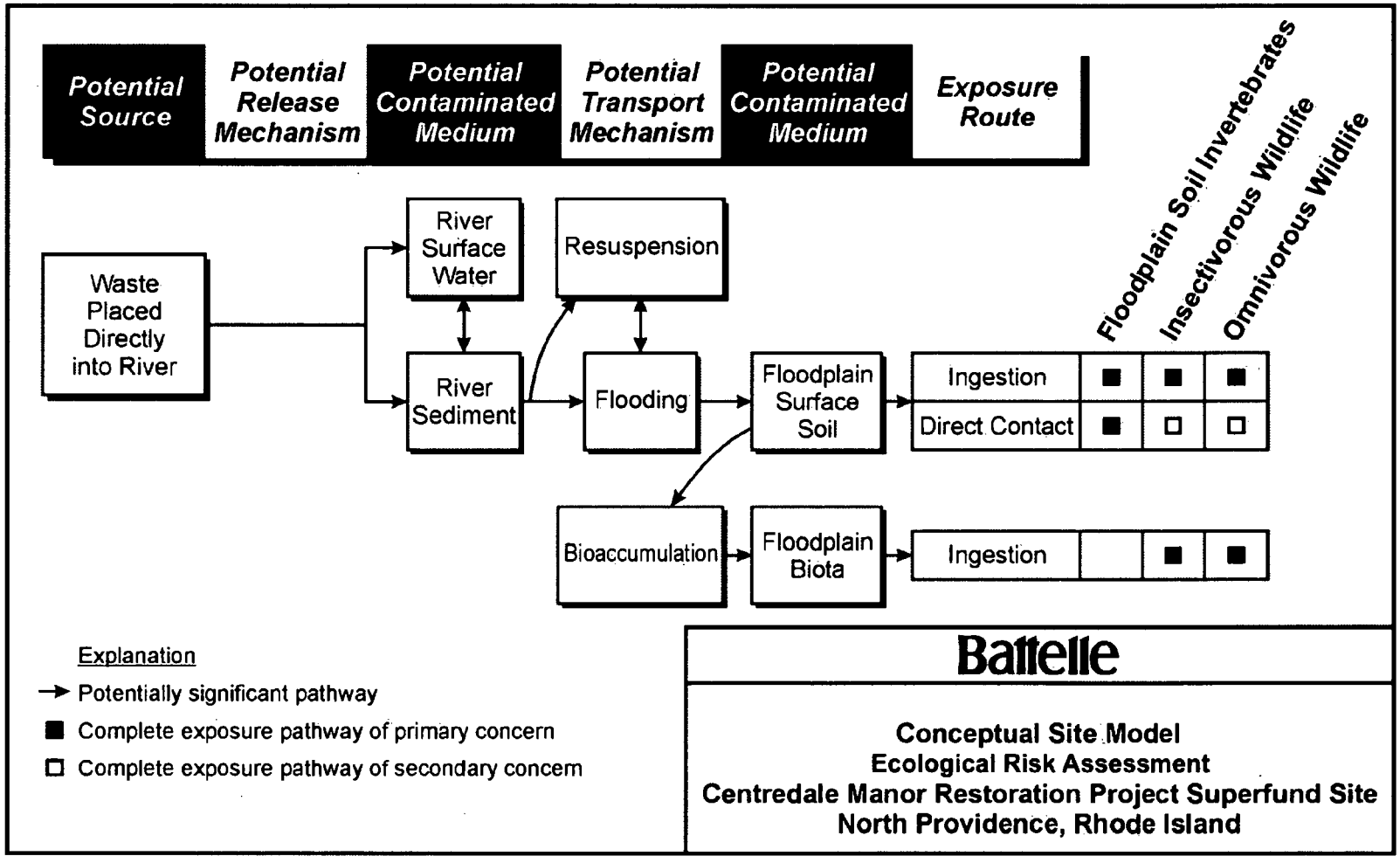


Figure 2. Conceptual Site Model
Centredale Manor Restoration Project Superfund Site
North Providence, Rhode Island

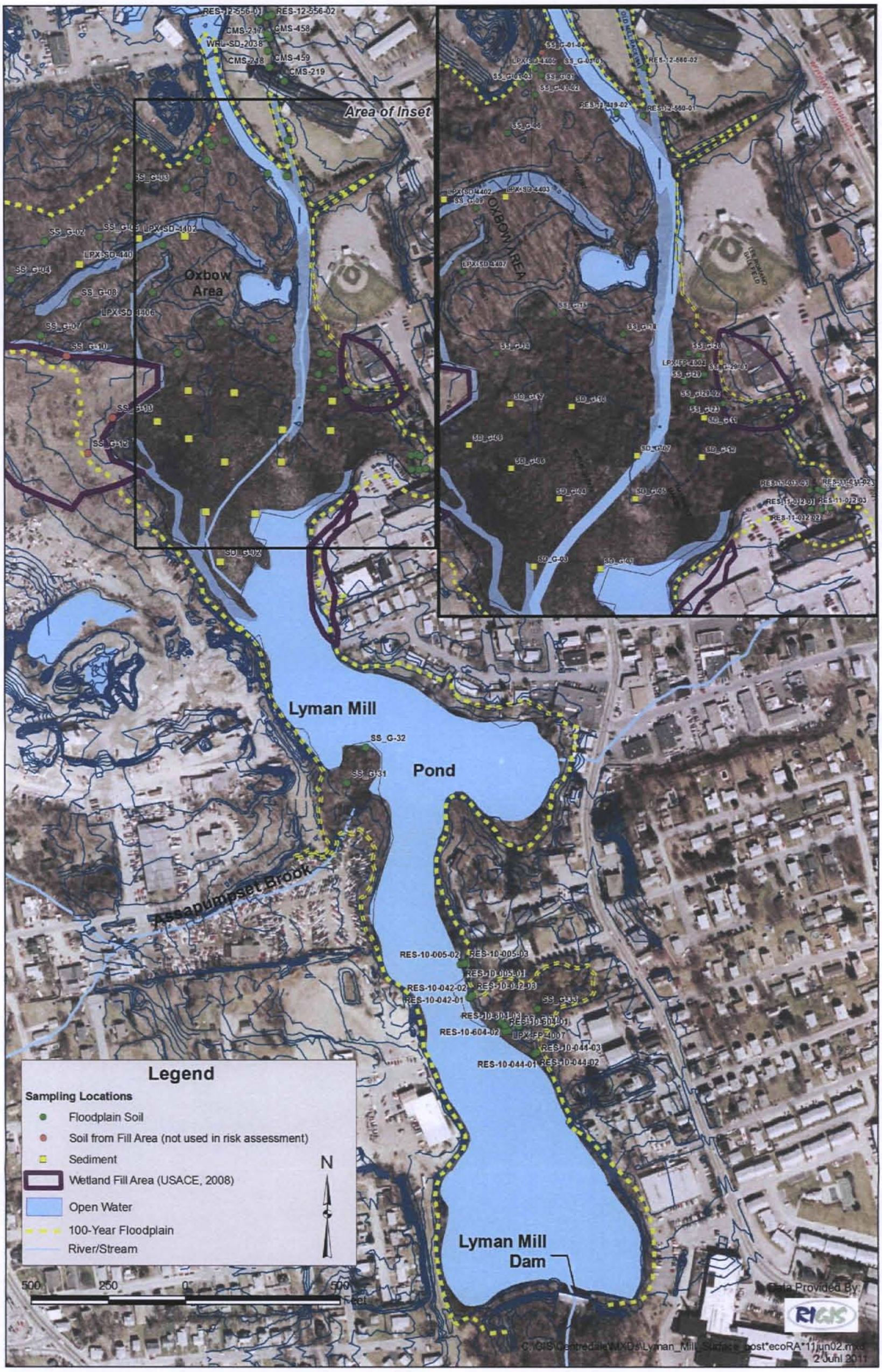
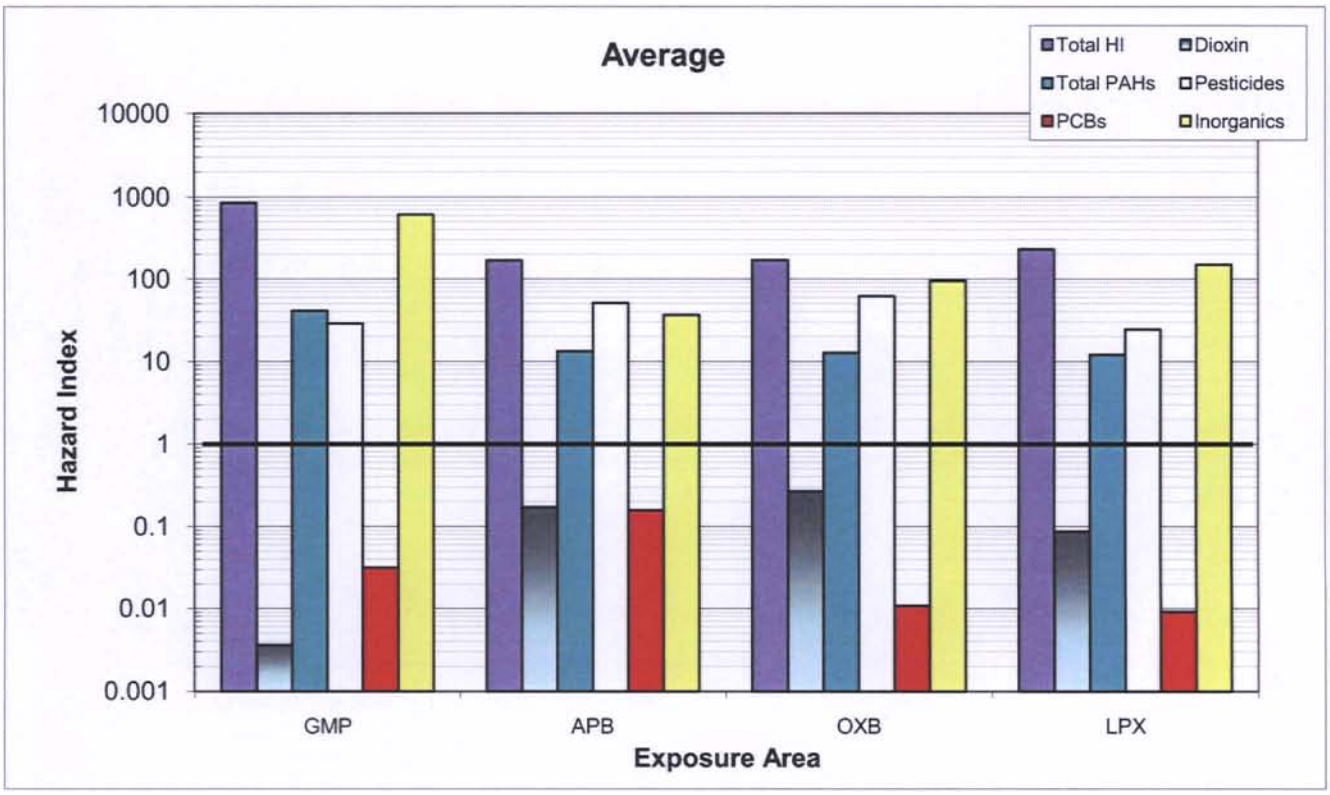


Figure 3. Ecological Risk Assessment Soil and Sediment Sampling Locations
Centredale Manor Restoration Project superfund Site – Oxbow Area
North Providence, Rhode Island

FIGURE 4
SOIL MACROINVERTEBRATE HAZARD INDICES BY CONTAMINANT CATEGORY FOR OXBOW (OXB) AND BERA (GMP, APB and LPX) FLOODPLAIN SOILS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



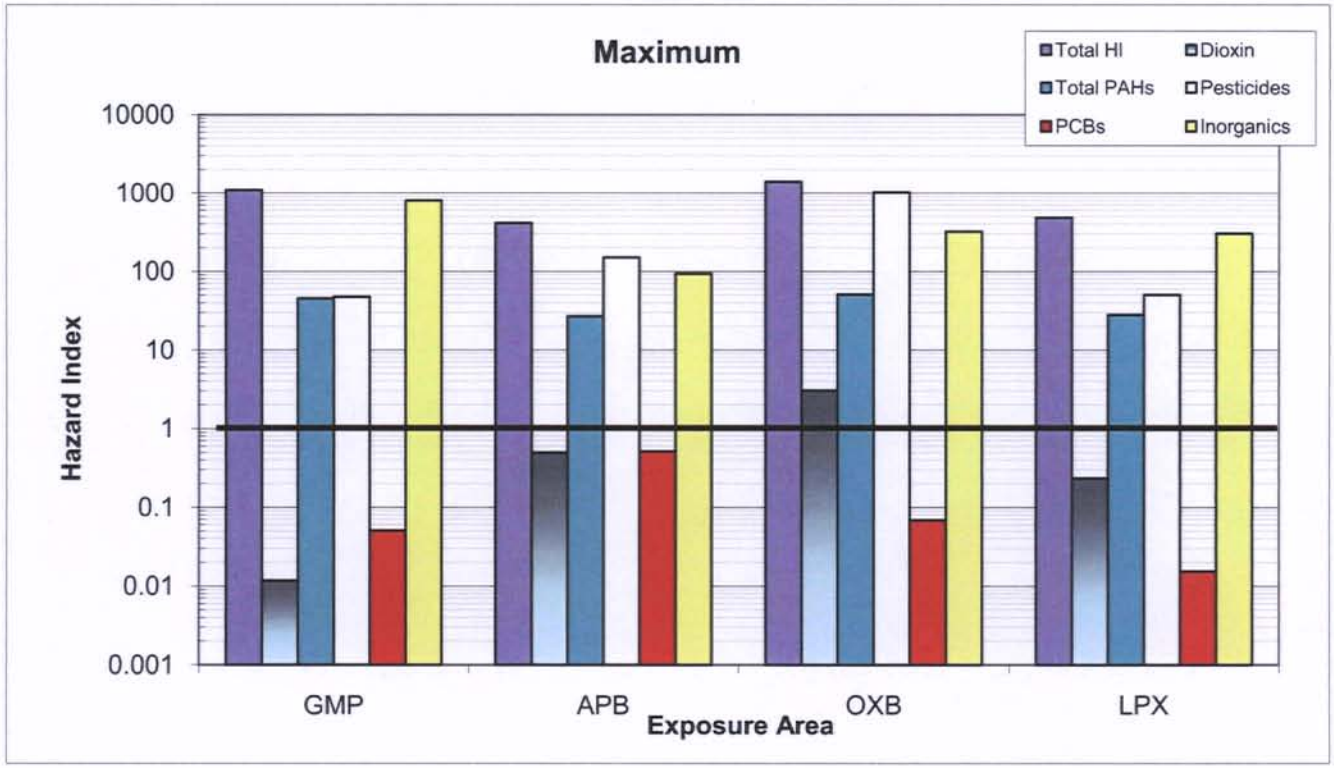
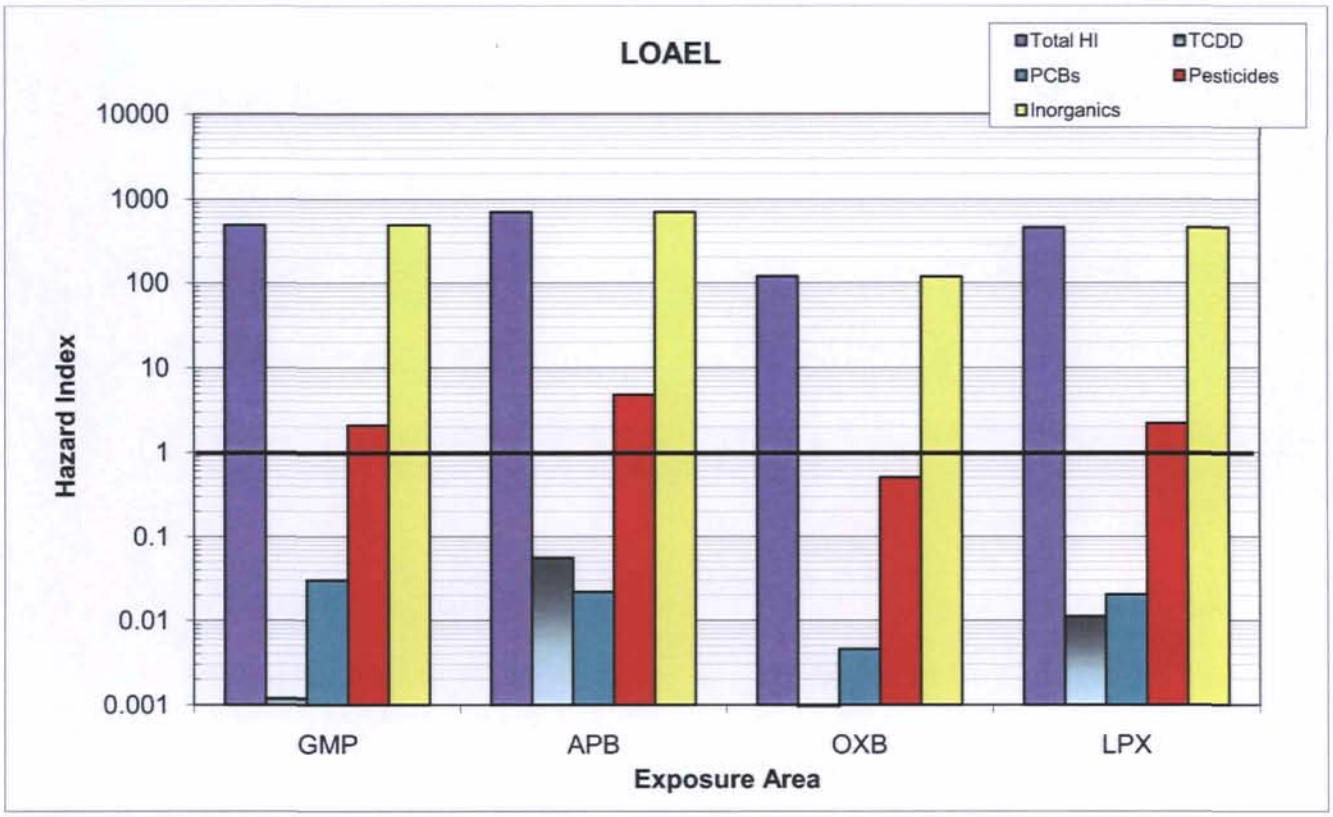


FIGURE 5
CBR HAZARD INDICES BY CONTAMINANT CATEGORY FOR OXBOW (OXB) AND BERA (GMP, APB and LPX) AVERAGE EARTHWORM TISSUE CONCENTRATIONS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



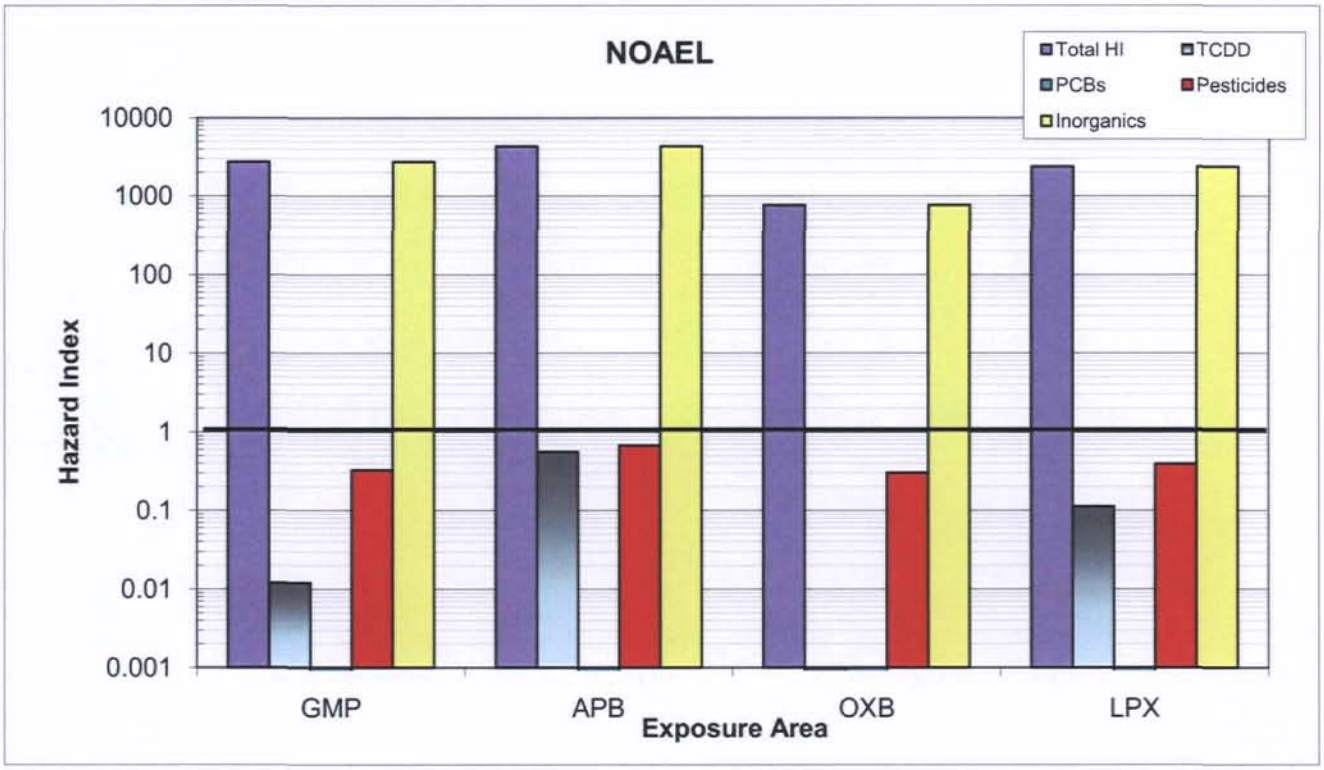
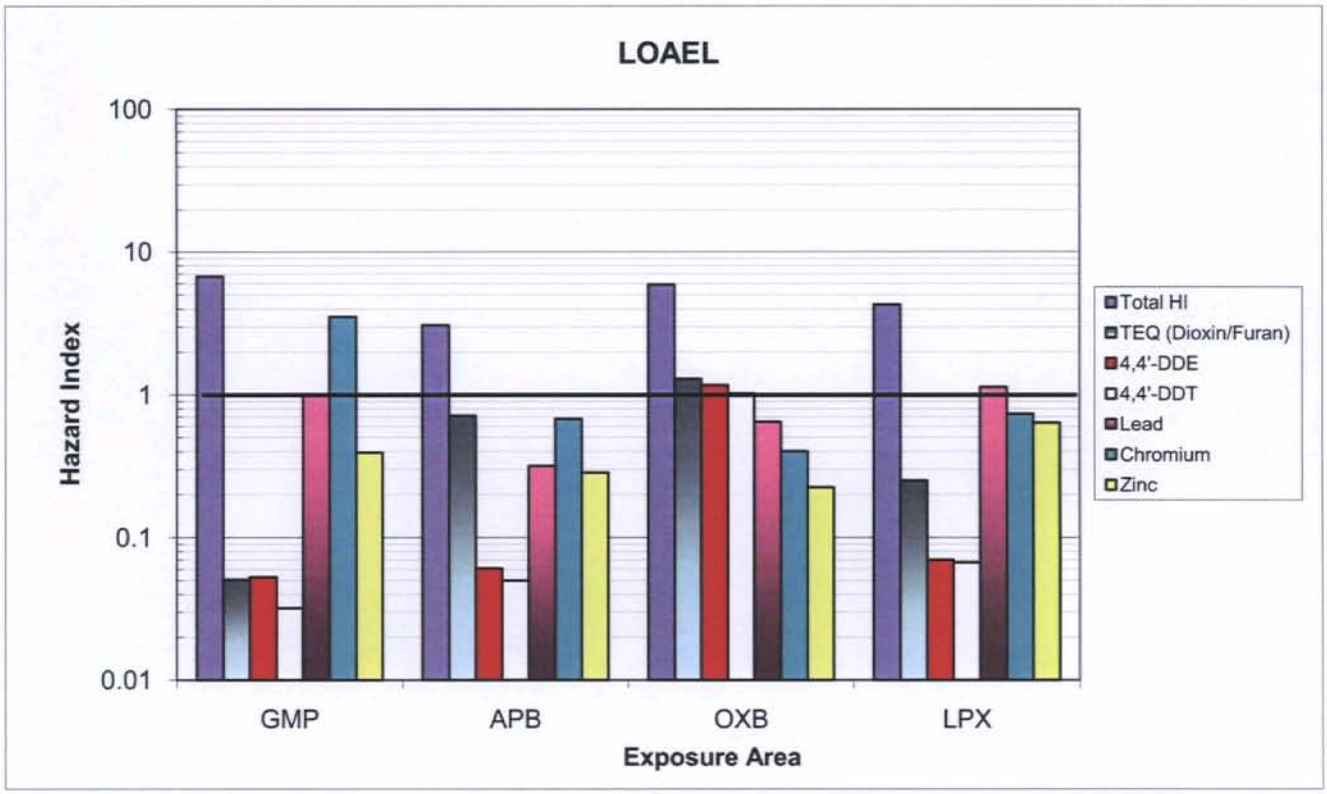


FIGURE 6
SUMMARY OF WILDLIFE EXPOSURE MODELING - AMERICAN WOODCOCK

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



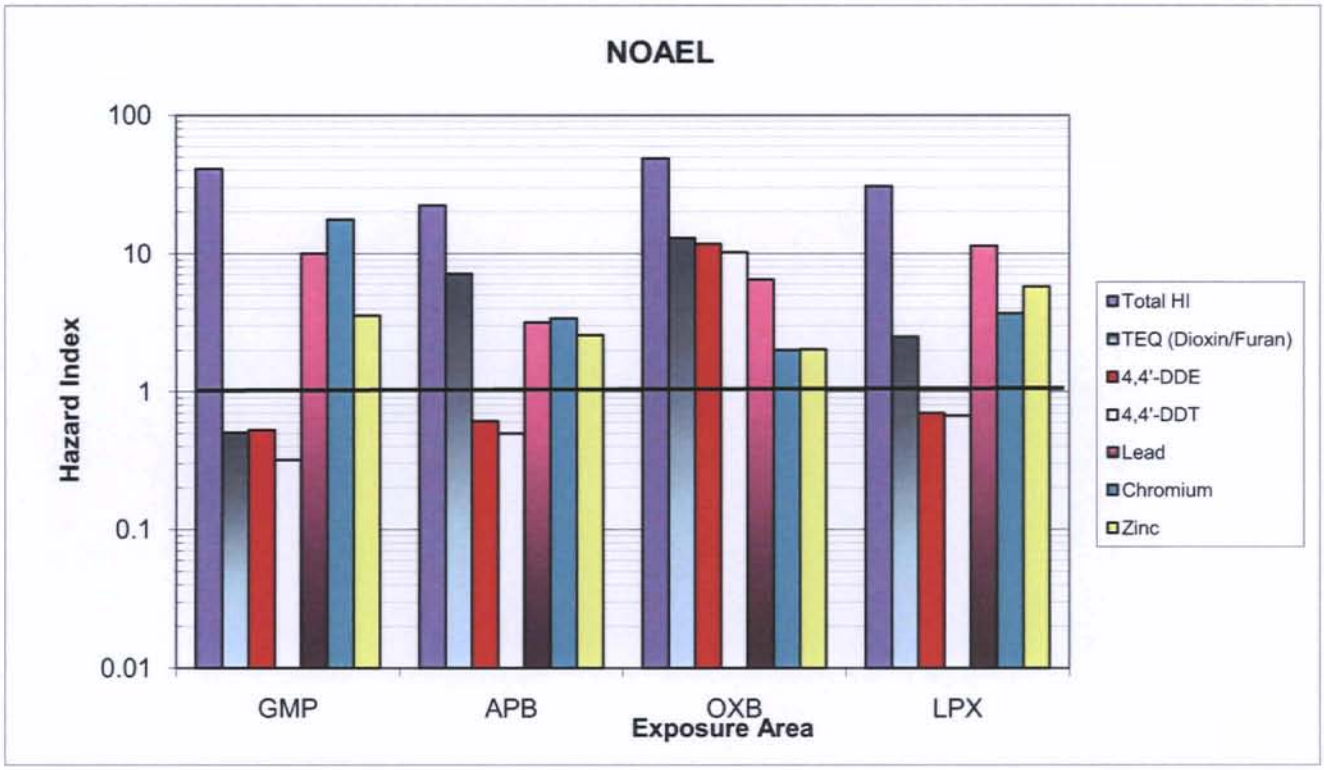
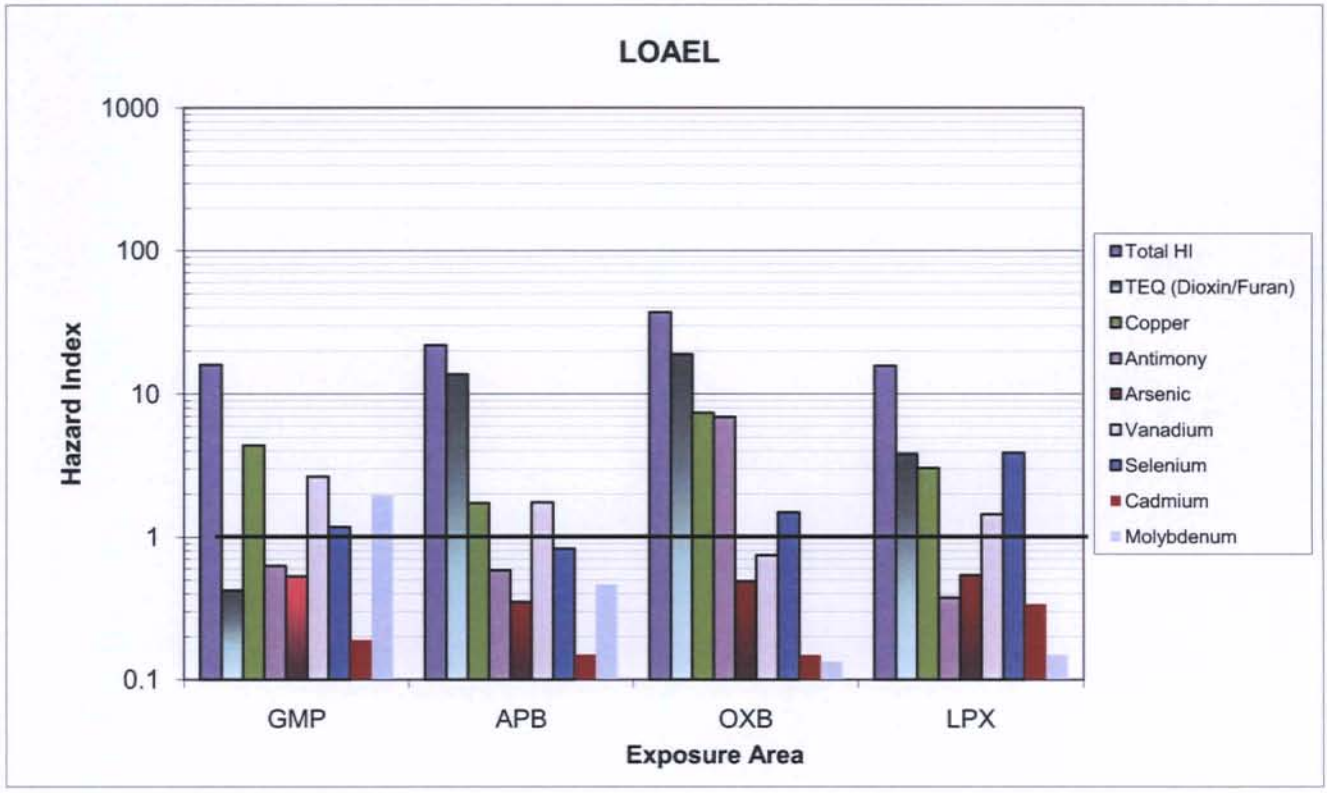


FIGURE 7
SUMMARY OF WILDLIFE EXPOSURE MODELING - SHORT-TAILED SHREW

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



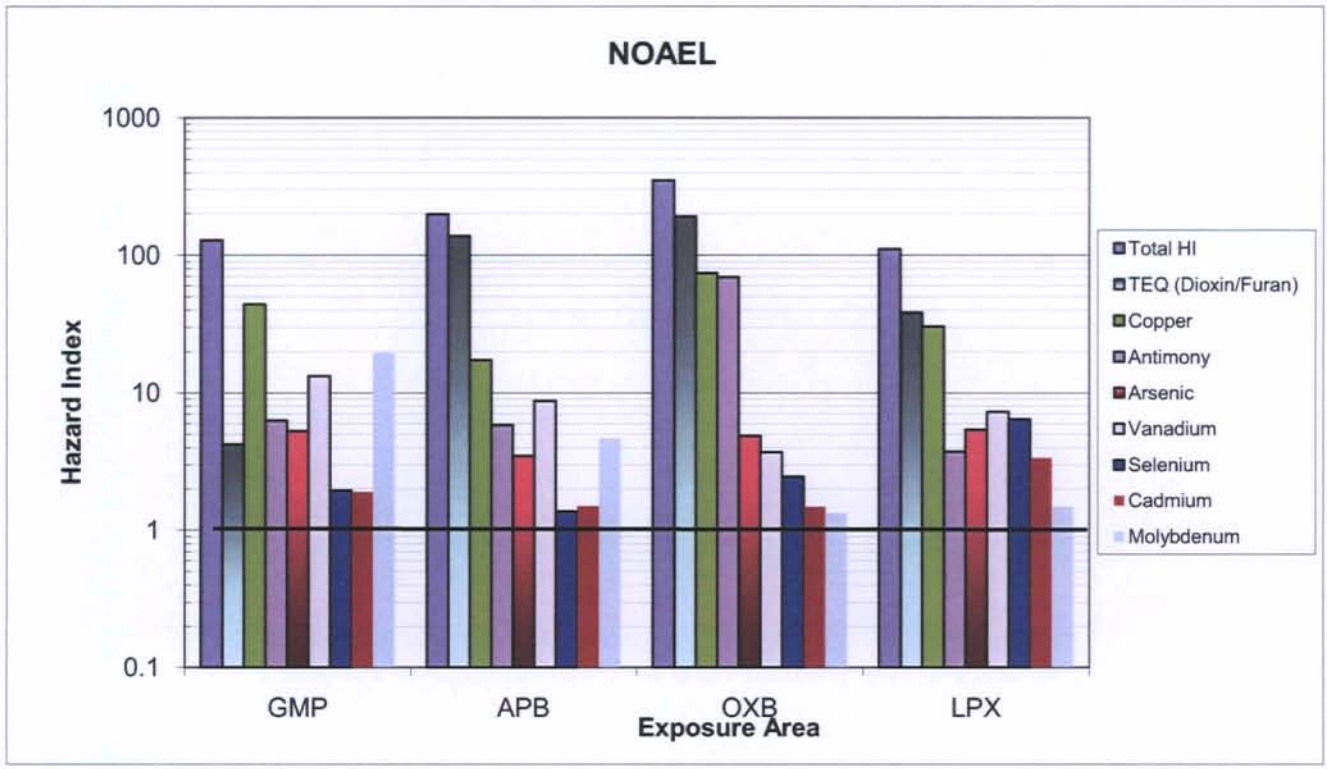
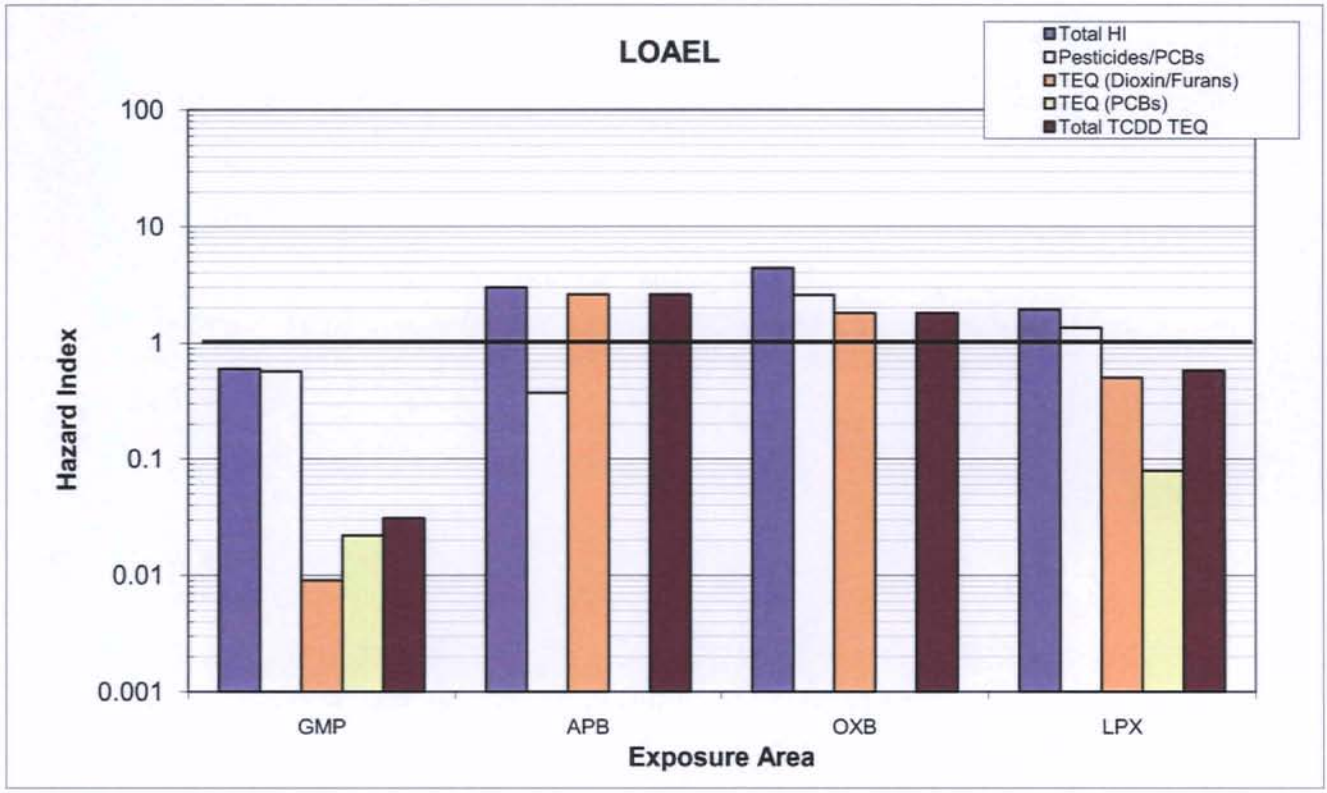
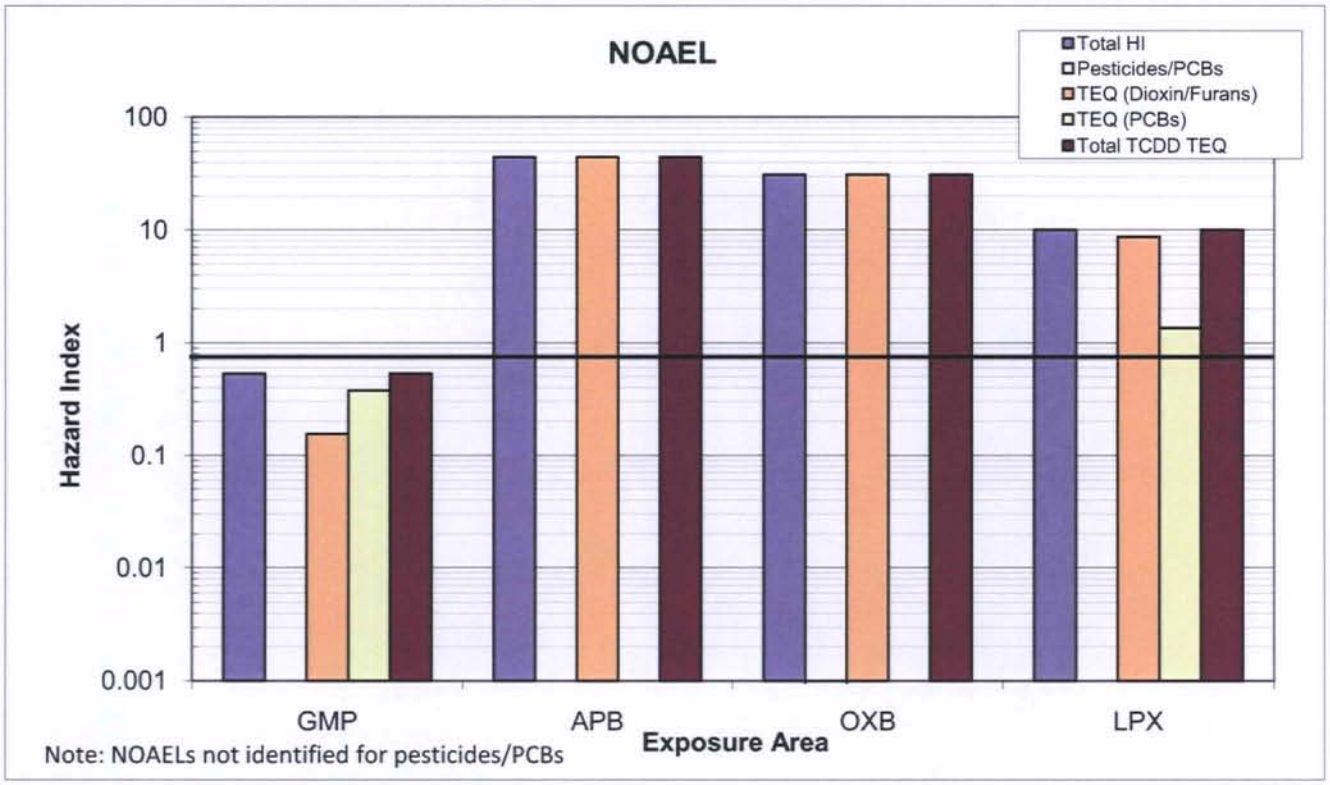


FIGURE 8
CBR HAZARD INDICES -ESTIMATED VERMIVOROUS BIRD EGG TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

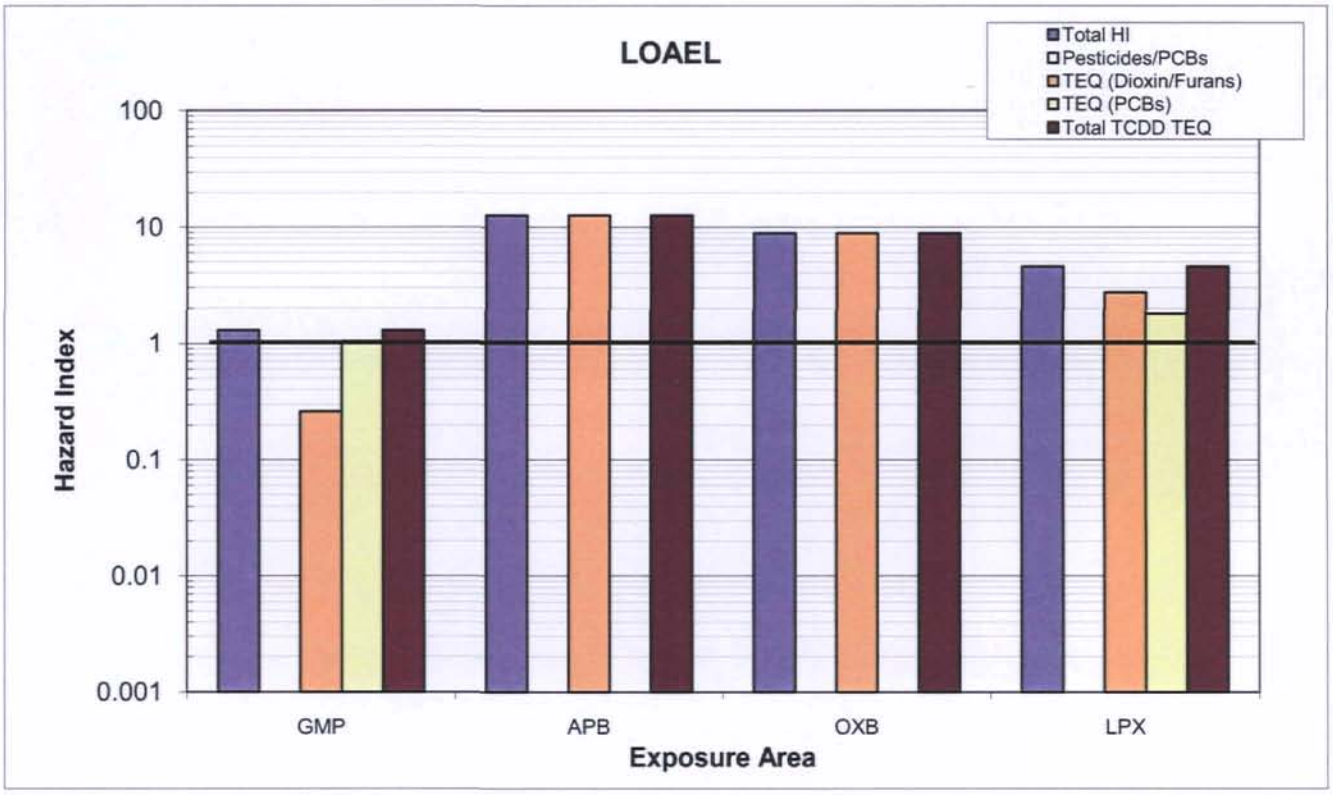




Note: NOAELs not identified for pesticides/PCBs

FIGURE 9
CBR HAZARD INDICES - ESTIMATED VERMIVOROUS MAMMAL LIVER TISSUE

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



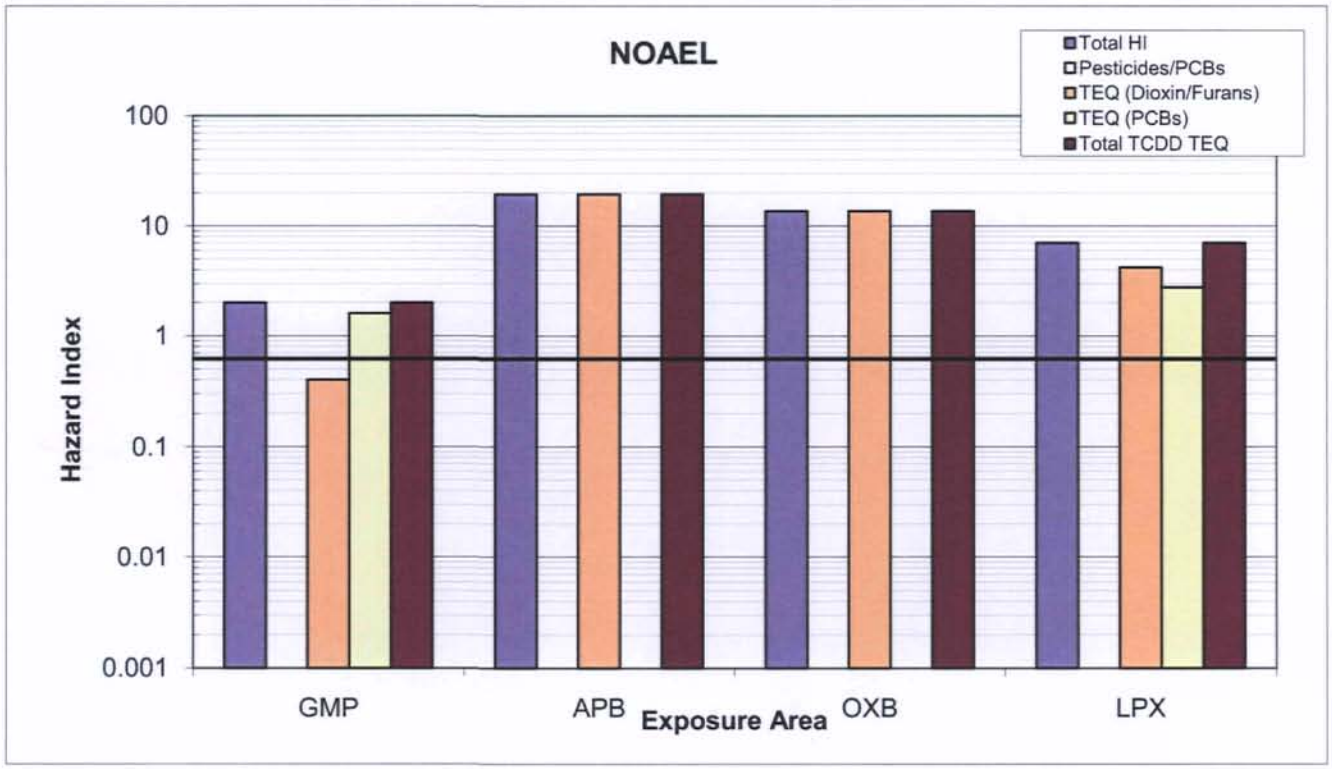
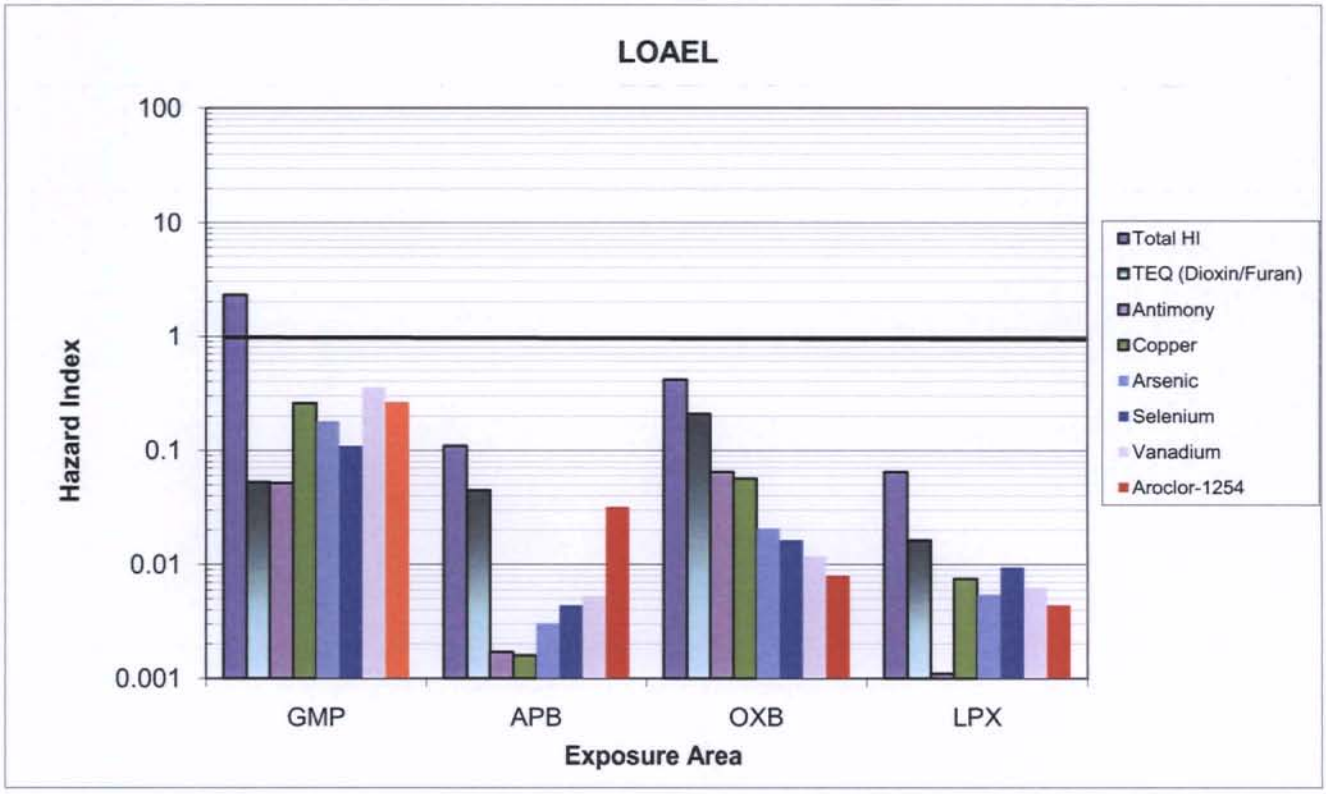
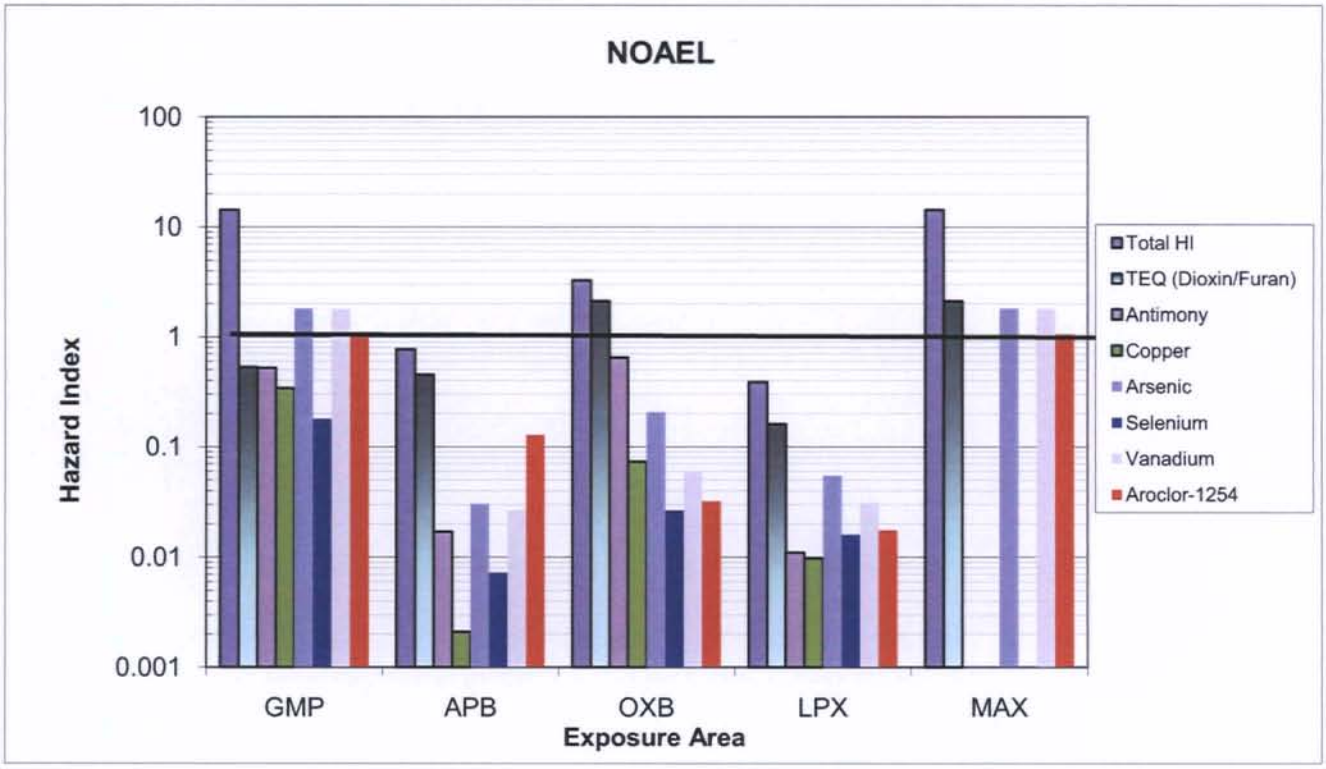


FIGURE 10
SUMMARY OF WILDLIFE EXPOSURE MODELING - RACCOON (Floodplain Exposures)

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island





APPENDICES

APPENDIX A

SITE PHOTOGRAPHS

Figure a. Facing south along utility right-of-way along western edge of Oxbow Area (photo taken early spring 2006).

Figure b. Facing west-south-west near center of Oxbow Area adjacent to former river channel (photo taken early spring 2006).

Figure c. Facing west in a forest opening located approximately 100 feet north of Figure b. Small ponded area in foreground may be one of several vernal pools located within the Oxbow Area (photo taken early spring 2006).

Figure d. Facing west in northwestern portion of Oxbow Area; note yellow-stained leaves along recent wet channel (photo taken early spring 2006).

Figure e. Disturbed borrow and fill topography typical of south central portion of the Oxbow Area across the Woonasquatucket River from the Lee Romano Baseball Field (photo taken early spring 2006).

Figure f. Across Woonasquatucket River from the former Allendale Pond mill building complex. Allendale Dam is approximately 500 feet upstream around bend to the left. Note cut in bank in the center of the photo where floodwaters can flow into the Oxbow Area and the low-lying muddy areas that have been affected by recent high water (photo taken 03/10/11).

Figure g. Topographically elevated oak-hardwood hammock in south-central portion of the Oxbow Area (photo taken early spring 2006).

Figure h. Facing south from southern end of oak hammock area and looking into the scrub-shrub habitat that fringes the upper portion of Lyman Mill Pond (photo taken early spring 2006).

Figure i. Northern end of former Allendale Mill tailrace (photo taken 03/11/11).

Figure j. Low-lying area in eastern portion of the Oxbow Area behind the Boys and Girls Club during a period of high water (photo taken 03/11/11).

Figure k. Possible vernal pond on the east side of a wooded wetland habitat fragment located on the east bank of Lyman Mill Pond (photo taken 03/11/11).

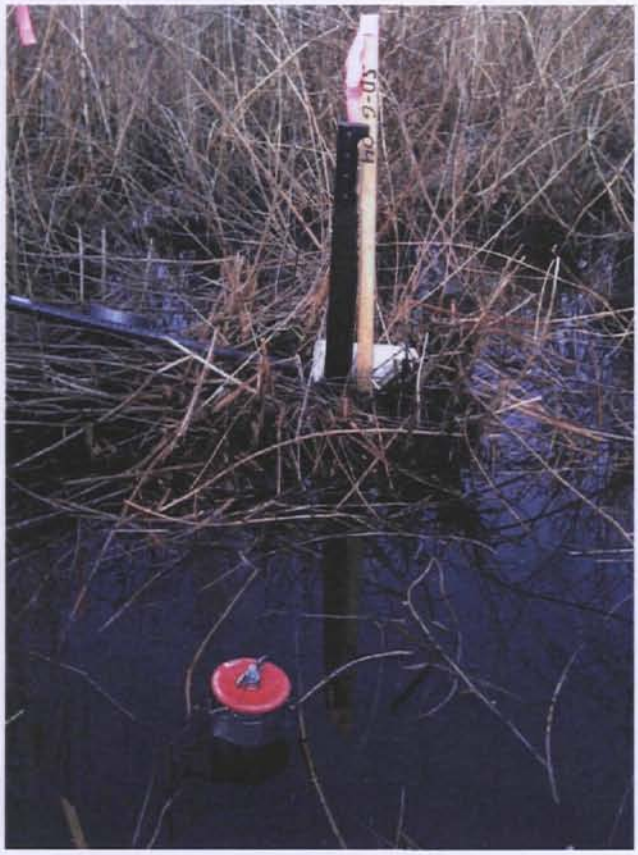


Figure l. Sediment sample location SD_G-04 representative of the Oxbow Area emergent marsh habitat. Red cap is the top of the core (photo taken in fall 2010).

Figure m. Sediment sample location SD_G-09 representative of the Oxbow Area scrub-shrub habitat. Sample was collected in channel (photo taken in fall 2010).

Figure n. Sediment sample location SD_G-10 representative of the Oxbow Area scrub-shrub habitat. (photo taken in fall 2010).

Figure o. Floodplain soil sample location SS_G-06 representative of the Oxbow Area wooded wetland habitat (photo taken in fall 2010).

Figure p. Floodplain soil sample location SS_G-14 representative of the Oxbow Area wooded wetland habitat (photo taken in fall 2010).

Figure q. Floodplain soil sample location SS_G-26 representative of the Oxbow Area wooded wetland habitat (photo taken in fall 2010).

APPENDIX B

SPECIES OF CONCERN – RESPONSES FROM TRUSTEE AGENCIES

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RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
235 Promenade Street, Providence, RI 02908-5767 TDD 401-222-4462

Melissa A. Beauchemin
Battelle
397 Washington Street
Duxbury, MA 02332

June 1, 2006

RE: Centredale Manor Restoration Project, North Providence, RI.

Dear Ms. Beauchemin:

Thank you for contacting the RI Natural Heritage Program for information regarding the presence of rare, threatened, or endangered species, or exemplary natural communities within the vicinity of the above-referenced project as outlined in your letter and map received at this office by fax on May 8, 2006.

Review of the Program database indicates there are no rare, threatened, or endangered species, or exemplary natural communities within the vicinity of this site. As our inventory is ongoing, more information may become available concerning this area in the future. If you have any questions regarding this review, please contact me at 277-2776, extension 4308.

Sincerely,

Richard W. Enser, Coordinator
RI Natural Heritage Program

30% post-consumer fiber

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New England Field Office
70 Commercial Street, Suite 300
Concord, New Hampshire 03301-5087

June 14, 2006

Reference:	Project	Location
	Site assessment	Johnston, RI

Melissa Beauchemin
Battelle
397 Washington St.
Duxbury, MA 02332

Dear Ms. Beauchemin:

This responds to your recent correspondence requesting information on the presence of federally-listed and/or proposed endangered or threatened species in relation to the proposed activity(ies) referenced above.

Based on information currently available to us, no federally-listed or proposed, threatened or endangered species or critical habitat under the jurisdiction of the U.S. Fish and Wildlife Service are known to occur in the project area(s). Preparation of a Biological Assessment or further consultation with us under Section 7 of the Endangered Species Act is not required.

This concludes our review of listed species and critical habitat in the project location(s) and environs referenced above. No further Endangered Species Act coordination of this type is necessary for a period of one year from the date of this letter, unless additional information on listed or proposed species becomes available.

Thank you for your coordination. Please contact us at 603-223-2541 if we can be of further assistance.

Sincerely yours,

Michael J. Amaral

Michael J. Amaral
Endangered Species Specialist
New England Field Office

APPENDIX C

Characterization of Site Contamination

CHARACTERIZATION OF SITE CONTAMINATION

The information presented below characterizes contamination in Oxbow Area floodplain surface soil and surface sediment at the Centredale Manor Restoration Project Superfund Site. Because this work has occurred after the Feasibility Study for the Site, this information is presented here to update the site characterization that was performed previously. Additional analysis during the design phase of the Site investigation could include statistical comparison to determine whether contamination within the Oxbow Area is significantly different from background.

Dioxins/Furans

At most of the sampling locations, 25 dioxin/furan analytical parameters were quantified, including 17 individual dioxin/furan congeners and eight homologue groups. At most locations in the old mill raceway, only 2,3,7,8-TCDD was measured. In addition, toxic equivalencies (TEQs) for fish (sediment only), and for birds and mammals (sediment and floodplain soil) were calculated (Tables 2a and 2b, main report). Figure C-1a presents a summary of the analytical results for the dioxin and furan congener concentrations detected in Oxbow Area floodplain surface soils; Figure C-1b presents a summary of dioxin and furan congener concentrations for surface sediments.

<u>Surface soil</u>. Dioxin congener concentrations in Oxbow Area floodplain soil range from non-detect to 14,600 picograms per gram (pg/g) (Table 2a, main report). For many samples, 2,3,7,8-TCDD is the congener detected with the highest concentration (Figure C-1a), and this compound is elevated above background (average Greystone - ~20 pg/g [see Figure 20 of MACTEC, 2004]). The location with the highest 2,3,7,8-TCDD concentration is SS_G-01-03, which is within 200 ft of the Woonasquatucket River (Figure 3, main report) in an area where floodwaters appear to routinely overflow the river bank. Appendix A presents a photograph (Figure f) showing the bank condition in this area. Concentrations of octachlorodibenzodioxin (OCDD) are also relatively high compared to other congeners, and OCDD was also detected with the highest concentration in many floodplain soil samples. Concentrations of OCDD range from 48.9 to 11,180 pg/g. Concentrations of this congener also appear to be elevated above background concentrations (average Greystone ~5,000 pg/g [see Figure 20 of MACTEC, 2004]). For the most part, concentrations of other congeners are at or below 100 pg/g.

In general, the congener pattern for sample locations in the old mill raceway (RES-12-556), the easternmost point of the Oxbow Area (RES-11 samples), the wooded wetland area on the east bank of Lyman Mill Pond (RES-10, LPX-FP-4007, SS_G-30 and SS_G-33 samples), and the wooded wetland

area on the west bank of Lyman Mill Pond (SS_G-31 and SS_G-32 samples) have a different congener pattern than most sample locations in the Oxbow Area (Figure 3, main report and C-1a). These floodplain soil locations are dominated by OCDD, while the congener pattern for samples collected from within the Oxbow Area are dominated by 2,3,7,8-TCDD.

Samples from LPX-FP-4007, SS_G-01-03, and SS_G-29-01 are distinctive compared to the other samples because the dioxin concentrations at these locations are substantially elevated in comparison with other locations (Figure C-1a). SS_G-01-03 is located immediately downstream from Allendale Dam about 200 ft from the west bank of the Woonasquatucket River; SS_G-29-01 is located in the western portion of Oxbow Area in a low-lying area behind the Boys and Girls Club that floods frequently; and LPX-FP-4007 is located in the wooded wetland area along the east bank of Lyman Mill Pond (Figure 3, main report). LPX-FP-4007 also has the highest concentrations of 7 of the 17 dioxin/furan congeners compared to other soil locations sampled (Table 2a, main report).

Calculated dioxin mammal TEQ concentrations and the relative importance of individual congeners for the floodplain surface samples in the Oxbow Area are plotted in Figure C-2a. The contribution of 2,3,7,8-TCDD to the total dioxin TEQ is greater than 90% for a majority of sample locations. Consistent with the trend observed for dioxin congener concentrations, 2,3,7,8-TCDD contributed far less to the total dioxin TEQ at nearly all of the sample locations in the two smaller wooded wetland areas and in the old mill raceway.

Dioxin TEQ concentrations for Oxbow Area floodplain soil sampling locations are elevated relative to background conditions. The average dioxin mammal TEQ concentration in Greystone Mill Pond floodplain soil samples is approximately 60 pg/g (Figure 9, MACTEC, 2004), whereas the average dioxin mammal TEQ concentration in the Oxbow Area is 1,350 pg/g (range from 1 to 14,633 pg/g; see Table 2a, main report and Figure C-2a). In general, the RI report determined that the dioxin TEQ concentrations in the Oxbow Area floodplain soils are within the range measured in sediment samples from Allendale and Lyman Mill Ponds (see Table 4-9 of Battelle, 2005) and concluded that low-lying areas in the forested wetland have been affected by contamination from the Site.

Surface sediment. Dioxin congener concentrations in Oxbow Area sediments range from non-detect to 14,600 pg/g (see Table 2b, main report). At most locations, 2,3,7,8-TCDD is the congener detected with the highest concentration in sediment (Figure C-1b), and this compound is elevated above background (average Greystone - ~30 pg/g [see Figure 18 of MACTEC, 2004]). The highest 2,3,7,8-TCDD

concentration was detected at SD_G-01, which is located at the southern end of the Oxbow Area on the north bank of Lyman Mill Pond (Figure 3, main report) in what appears to be a highly depositional area. Appendix A presents a photograph (Figure f) showing the bank condition in this area. As with Oxbow Area floodplain soils, concentrations of OCDD at some locations are also relatively high compared to other congeners, and OCDD was detected at the highest concentration for those sediment locations where 2,3,7,8-TCDD was not. Concentrations of OCDD ranged from 142 to 9,800 pg/g. Concentrations of this congener also appear to be consistent with background concentrations (average Greystone ~1,200 pg/g [see Figure 18 of MACTEC, 2004]). For the most part, concentrations of other congeners are at or less than 50 pg/g.

In general, the congener patterns for most sediment sample locations are similar and dominated by 2,3,7,8-TCDD and OCDD (Figure C-1b). Sediment location SD_G-11, located behind the Boys and Girls Club, appears to have a slightly different signature and has a higher relative proportion of 2,3,7,8-TCDD compared with the other sediment sample locations. The highest concentrations of 14 of the 17 dioxin-like congeners were detected at location SD_G-01.

Calculated dioxin mammal TEQ concentrations and the relative importance of individual congeners for Oxbow Area surface sediment samples are plotted in Figure C-2b. The contribution of 2,3,7,8-TCDD to the total dioxin TEQ is greater than 97% for all sediment sample locations. Dioxin TEQ concentrations for Oxbow Area sediments are also elevated relative to background conditions. The average dioxin mammal TEQ concentration in Greystone Mill Pond (background) sediment samples is approximately 135 pg/g (Figure 7, MACTEC, 2004), whereas the average sediment concentration for the Oxbow Area is 3,330 pg/g (range from 76 to 14,700 pg/g; see Table 2b, main report and Figure C-2b).

Polychlorinated Biphenyls

Several Oxbow Area floodplain surface soil and surface sediment samples locations were analyzed for the presence of PCBs as Aroclors.

Surface soil. Only Aroclor 1254, Aroclor 1260, and Aroclor 1268 were detected in floodplain surface soil samples. Total Aroclor concentrations in Oxbow Area floodplain soil range from 7.7 to 638 micrograms per kilogram (μg/kg) (micrograms per kilogram = parts per billion) (Table 2a, main report and Figure C-3a). Aroclor 1254 dominates the total Aroclor composition at most Oxbow locations, although Aroclor 1260 is also a key contributor to the Total Aroclor concentration at RES-10-044 and SS_G-30 in the wooded wetland area on the east bank of Lyman Mill Pond, at SS_G-31 and SS_G-32 in the wooded

wetland area at the mouth of Assapumpset Brook on the west bank of Lyman Mill Pond, and at SS_G-08 and SS_G-09 on the west side of the Oxbow Area (Figure 3, main report). Concentrations of Aroclor 1268 and Aroclor 1254 appear to be consistent with background conditions (Greystone average Aroclor 1268 ~ 90 µg/kg and average Aroclor 1254 ~600 µg/kg [Figure 36 of MACTEC, 2004]). Aroclor 1260 was infrequently detected at the Site, and Aroclor 1254 is the dominant Aroclor detected at the Site source area (Battelle, 2005).

Surface sediment. The only Aroclors detected in Oxbow Area sediment were Aroclor 1254 and Aroclor 1268. Total Aroclor concentrations in Oxbow Area sediments range from 16.3 to 3,583 µg/kg (Table 2b, main report and Figure C-3b). The maximum concentration is at LPX-SD-4402, located in the remnant of the former Woonasquatucket River bed, followed by SD_G-01, on the southeast bank of the Oxbow Area in a depositional area along the north shore of Lyman Mill Pond (Figure 3, main report). Aroclor 1254 dominates the Total Aroclor concentration at all Oxbow Area sediment locations. Sediment concentrations of Aroclor 1254 in the lower Oxbow are consistent with concentrations in Lyman Mill Pond (average ~200 µg/kg [MACTEC, 2004]) and similar to background (Greystone average ~300 µg/kg [MACTEC, 2004]). Concentrations of Aroclor 1268 in the lower Oxbow Area are lower than concentrations in Lyman Mill Pond and background concentrations (average ~125 µg/kg for both Lyman Mill Pond and Greystone Mill Pond [MACTEC, 2004]).

Pesticides/Herbicides

Several Oxbow Area floodplain surface soil and surface sediment samples locations were analyzed for the presence of pesticide compounds.

Surface soil. Pesticide concentrations detected in Oxbow Area floodplain surface soil are generally less than 100 µg/kg (Table 2a, main report and Figure C-4a). Maximum concentrations range from 0.27 µg/kg (alpha-benzene hexachloride [alpha-BHC]) to 1,300 µg/kg (4,4'-DDT). Many maximum concentrations were detected at SS_G-23 and SS_G-29, in a low-lying, flood-prone area in the eastern portion of the Oxbow Area behind the Boys and Girls Club, and at RES-12-556 located in the old mill raceway (Figure C-4a). In general, pesticide concentrations appear to be consistent with Greystone Mill Pond, Allendale Pond, and Lyman Mill Pond floodplain soil results with the exception of RES-12-556 location in the old mill raceway (Figure 3, main report), where concentrations of DDT and its breakdown products are elevated (Figure C-4a compared with Figure 36 of MACTEC, 2004).

Surface sediment. Pesticide concentrations detected in Oxbow Area sediment are also generally less than 100 µg/kg (Table 2b, main report and Figure C-4b). Maximum concentrations range from 0.23 µg/kg (endrin) to 390 µg/kg (chlordane). The highest concentrations of most pesticides were detected at SD_G-01, in a depositional area in the southeastern portion of the Oxbow Area on the north bank of Lyman Mill Pond (Table 2b, main report). Maximum concentrations of other pesticides (including dieldrin) were detected at LPX-SD-4402 located in the remnant of the Woonasquatucket River bed within the Oxbow Area (Figures 3, main report and C-4b). In general, pesticide concentrations appear to be consistent with background sediment concentrations with the exception of DDT and dieldrin, which appear to be elevated compared with Greystone Mill Pond concentrations (Figure C-4b compared with Figure 34 of MACTEC, 2004). Concentrations of pesticides are also elevated compared with Lyman Mill Pond, which has concentrations similar to background. Dieldrin concentrations in Oxbow Area sediments at some locations appear to be greater than concentrations in Allendale Pond as well (Figure C-4b compared with Figure 34 of MACTEC, 2004).

Polycyclic Aromatic Hydrocarbons

Several Oxbow Area floodplain surface soil and surface sediment samples locations were analyzed for the presence of polycyclic aromatic hydrocarbons (PAHs).

Surface soil. PAHs selected as COPECs occur in Oxbow Area floodplain surface soil at concentrations ranging from non-detectable to 7,700 µg/kg, with the maximum Total PAH concentration being 50,860 µg/kg (Table 2a, main report and Figure C-5a). Maximum concentrations of most PAHs were detected at location RES-12-556, in the old mill raceway, and at SS_G-29, in a low-lying, flood-prone area in the eastern portion of the Oxbow Area behind the Boys and Girls Club (Table 2a and Figure 3, main report). The composition of Total PAHs across Oxbow Area floodplain soil locations appears to be similar (Figure C-5a). PAH concentrations in Oxbow Area floodplain surface soil are lower than background concentrations at Greystone Mill Pond (average concentrations in Table 2a compared with Figure 30 of MACTEC, 2004). Not surprisingly, PAH concentrations are consistent with Lyman Mill Pond floodplain soil concentrations and appear to be somewhat lower than concentrations in Allendale Pond floodplain soil.

Surface sediment. PAH concentrations in Oxbow Area sediments range from non-detectable to 6,700 µg/kg (Table 2b, main report). The maximum Total PAH concentration is 43,070 µg/kg (Figure C-5b). Nearly all maximum concentrations of PAHs selected as COPECs were detected at SD_G-01 and SD_G-03 in the southern portion of the Oxbow Area (Table 2b and Figure 3, main report). The composition of

Total PAHs across Oxbow Area sediment locations appears to be similar (Figure C-5b). PAH concentrations in Oxbow surface sediment appear to be similar to background concentrations at Greystone Mill Pond and concentrations in Lyman Mill Pond sediments, and lower than concentrations in Allendale Pond sediments (average concentrations in Table 2a, main report compared with Figure 29 of MACTEC, 2004).

Metals

Most Oxbow Area floodplain surface soil and surface sediment samples locations were analyzed for the presence of inorganic analytes.

Surface soil. Not including the essential elements (calcium, iron, magnesium, potassium, and sodium) and aluminum, which is the most abundance element in the earth's crust and occurs at high concentrations naturally, concentrations of most metals in floodplain surface soil are below 100 milligrams per kilogram (mg/kg) (Table 2a, main report). The exceptions for the toxic metals are manganese, copper, and lead, which have maximum concentrations of 2,440, 2,350, and 2,460 mg/kg, respectively. Figure C-6a presents a summary of concentrations for select metals that were identified as COPECs in the SLERA for the Oxbow (Battelle, 2006). The highest concentrations for most metals were detected at location RES-10-042 in the smaller wooded wetland habitat along the east bank of Lyman Mill Pond (Figure 3, main report). Concentrations of copper, zinc, and antimony are an order of magnitude higher at RES-10-042 compared with other floodplain soil sample locations. Concentrations of select metals in Oxbow Area floodplain surface soil appear to be comparable to concentrations in the Site source area and other Lyman Mill Pond floodplain soil but lower than concentrations in Allendale Pond floodplain soil (Table 2a, main report compared with Appendix C of the RI report [Battelle, 2005]).

Surface sediment. Concentrations of metals in Oxbow Area sediments are generally higher than concentrations in floodplain soil. Maximum sediment concentrations of non-essential elements ranged from 0.791 mg/kg (thallium) to 1,160 mg/kg (manganese). Concentrations of select metals in Oxbow surface sediment are presented in Figure C-6b. As with many other sediment contaminants, maximum concentrations of many metals occur at SD_G-01 located at the southern end of the Oxbow Area along the north bank of Lyman Mill Pond (Figure 3, main report). Sediment concentrations of metal in Oxbow Area sediments appear to be comparable with Allendale and Lyman Mill Pond sediment concentrations (Table 2, main report compared with Appendix C of the RI report [Battelle, 2005]).

FIGURE C-1A.
DIOXIN CONGENERS IN OXBOW AREA FLOODPLAIN SURFACE SOIL

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

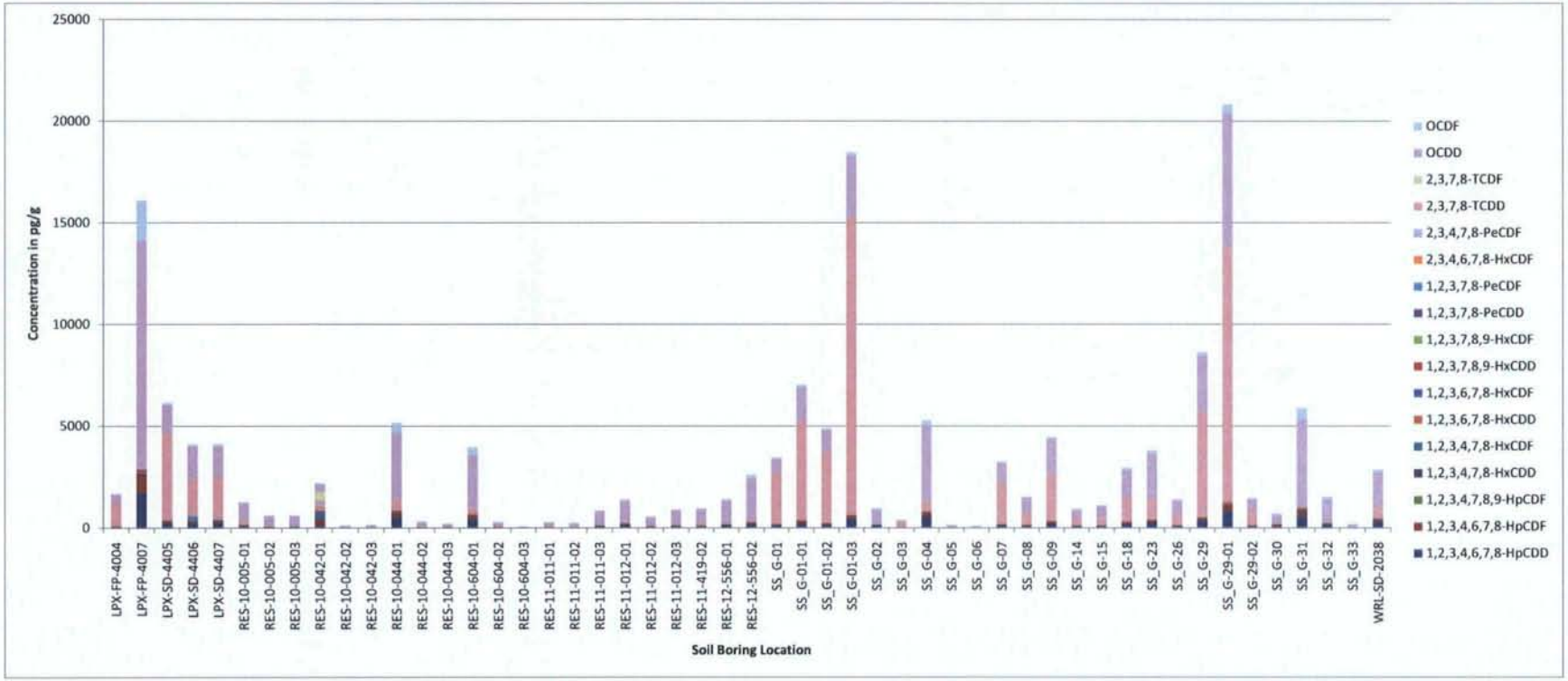
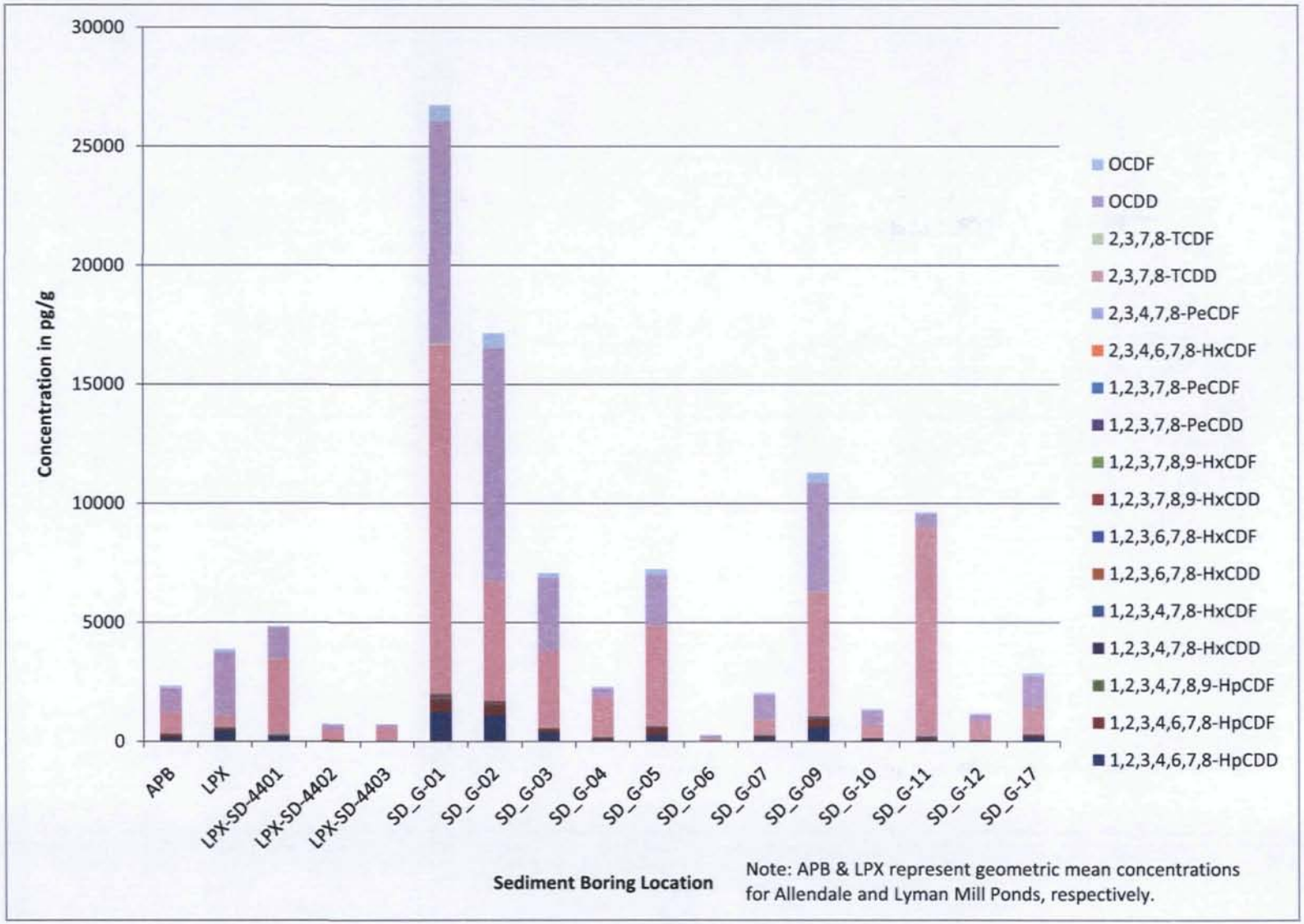


FIGURE C-1B.
DIOXIN CONGENERS IN OXBOW AREA SURFACE SEDIMENT

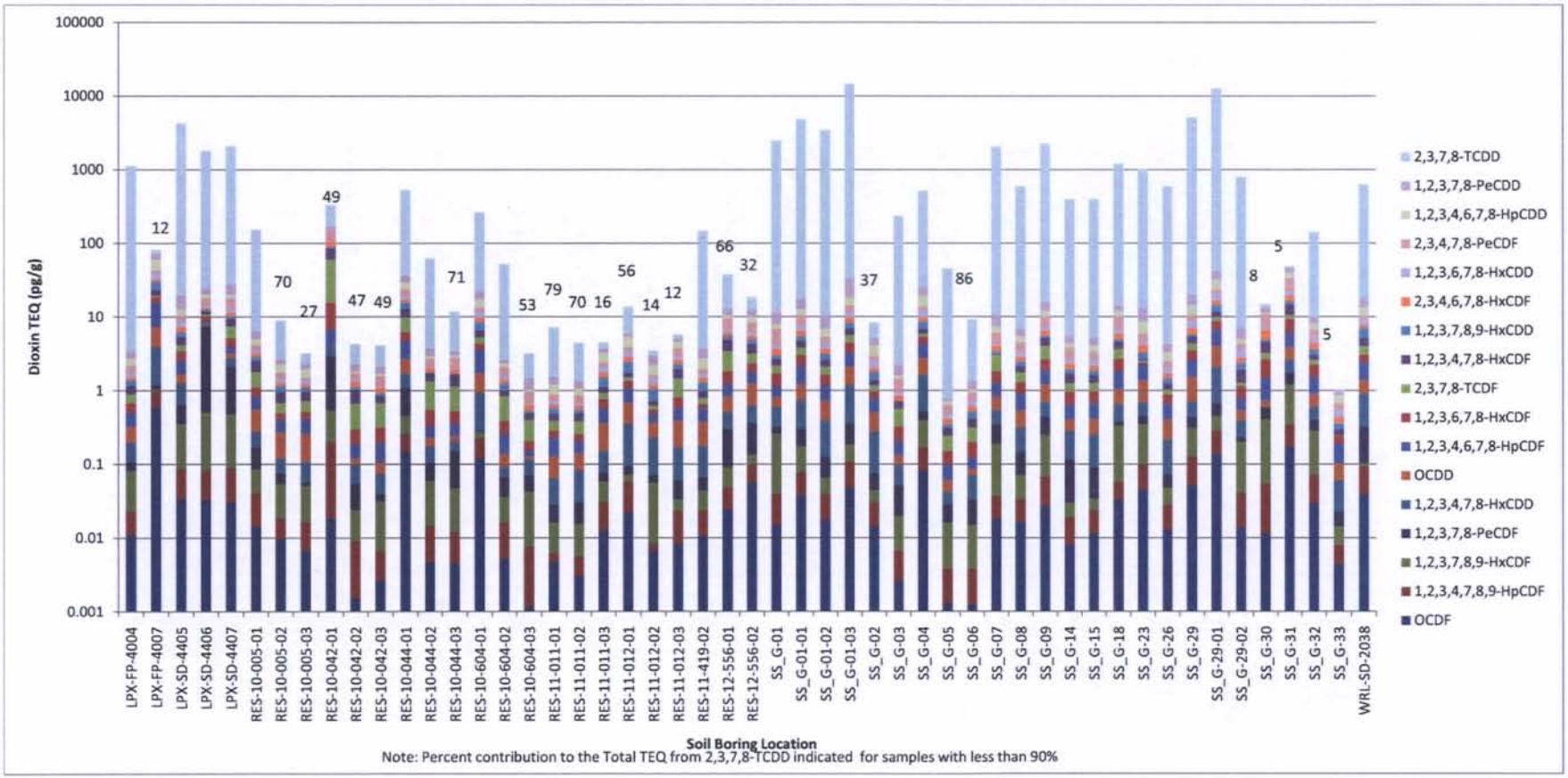
Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



Note: APB & LPX represent geometric mean concentrations for Allendale and Lyman Mill Ponds, respectively.

FIGURE C-2A.
DIOXIN MAMMAL TEQ COMPOSITION IN OXBOW AREA FLOODPLAIN SURFACE SOIL

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



Note: Percent contribution to the Total TEQ from 2,3,7,8-TCDD indicated for samples with less than 90%

FIGURE C-2B.
DIOXIN MAMMAL TEQ COMPOSITION IN OXBOW AREA SURFACE SEDIMENT

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

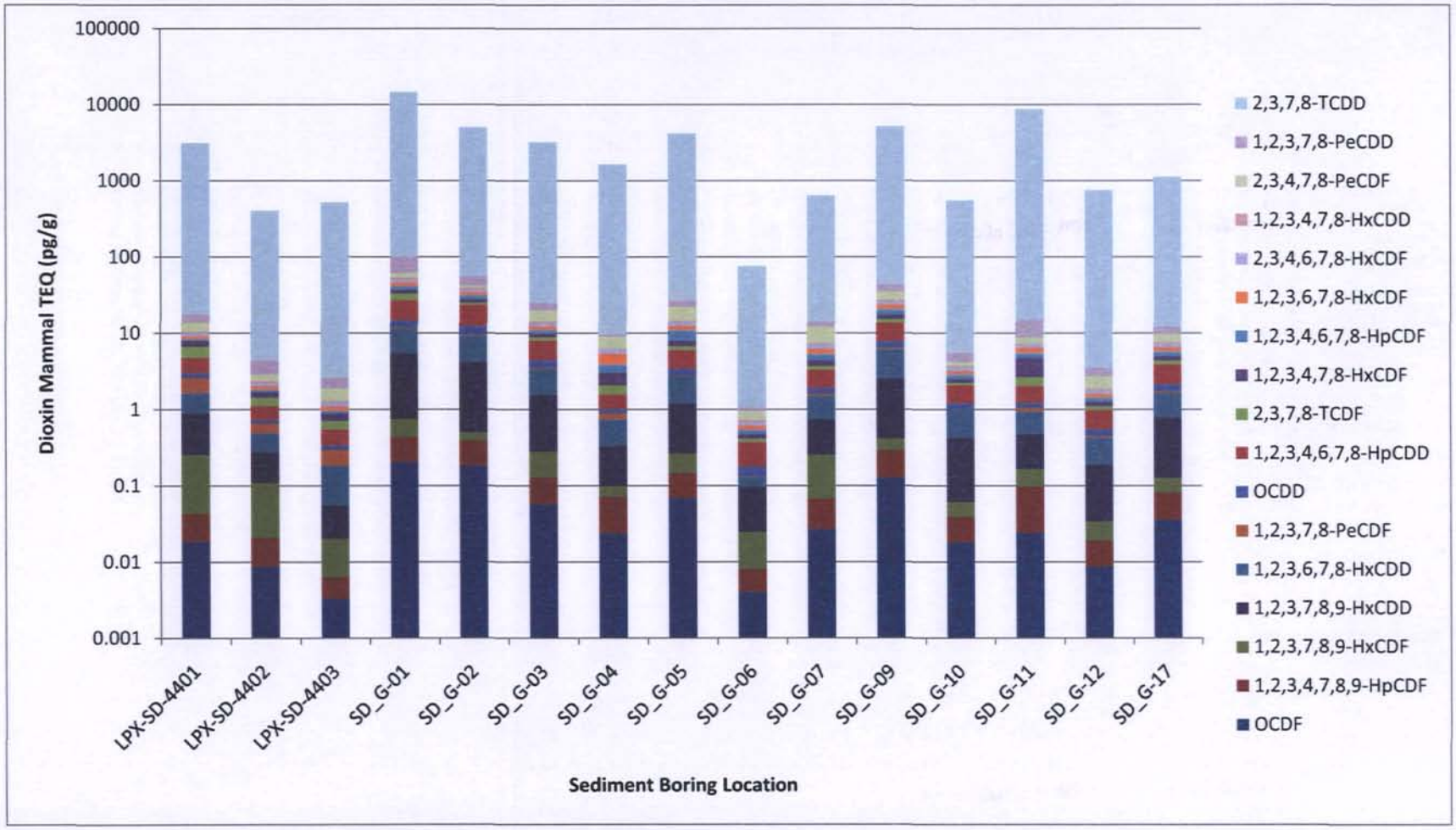


FIGURE C-3A.
TOTAL AROCLORS IN OXBOW AREA FLOODPLAIN SURFACE SOIL

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

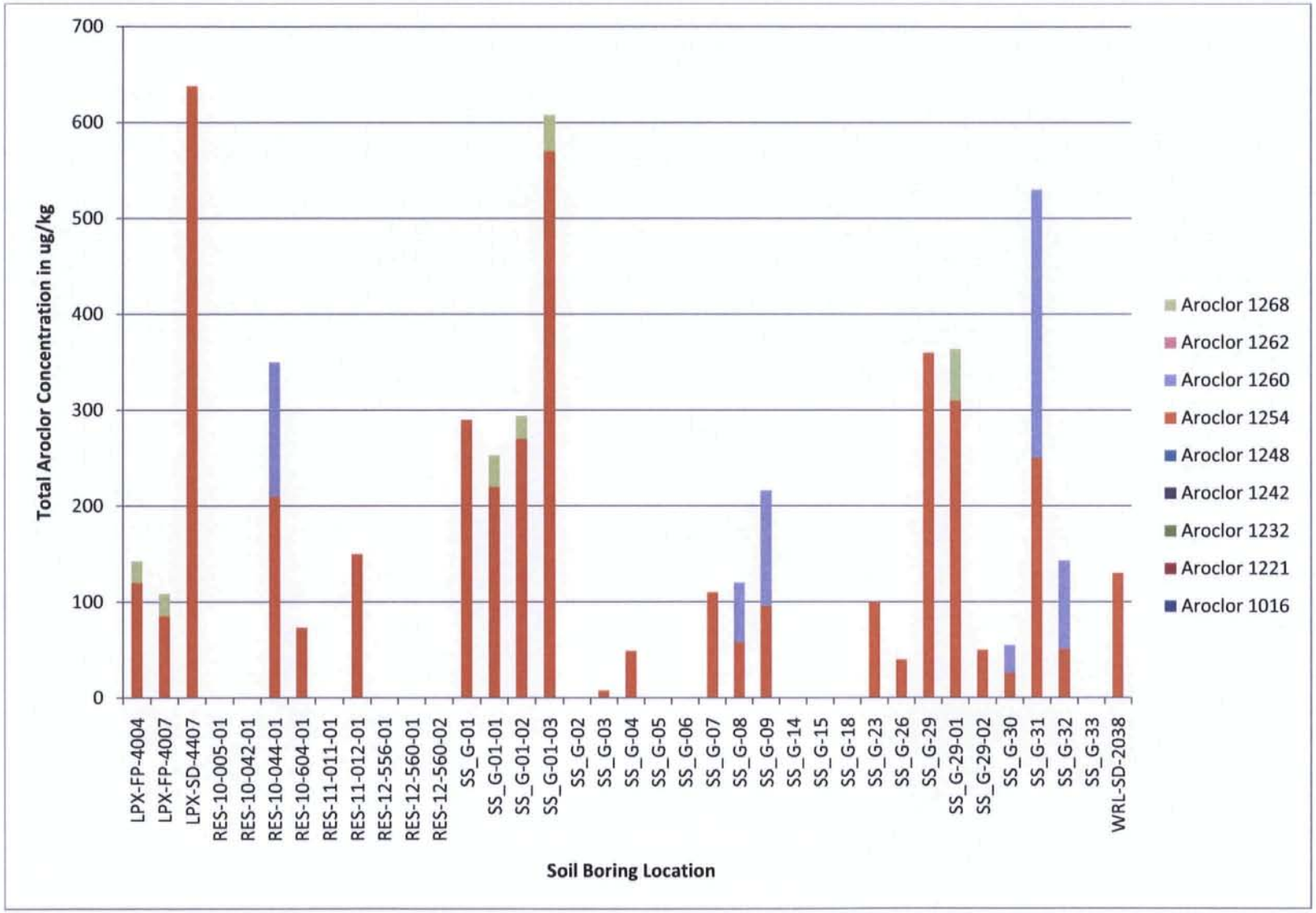


FIGURE C-3B.
TOTAL AROCLORS IN OXBOW AREA SURFACE SEDIMENT

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

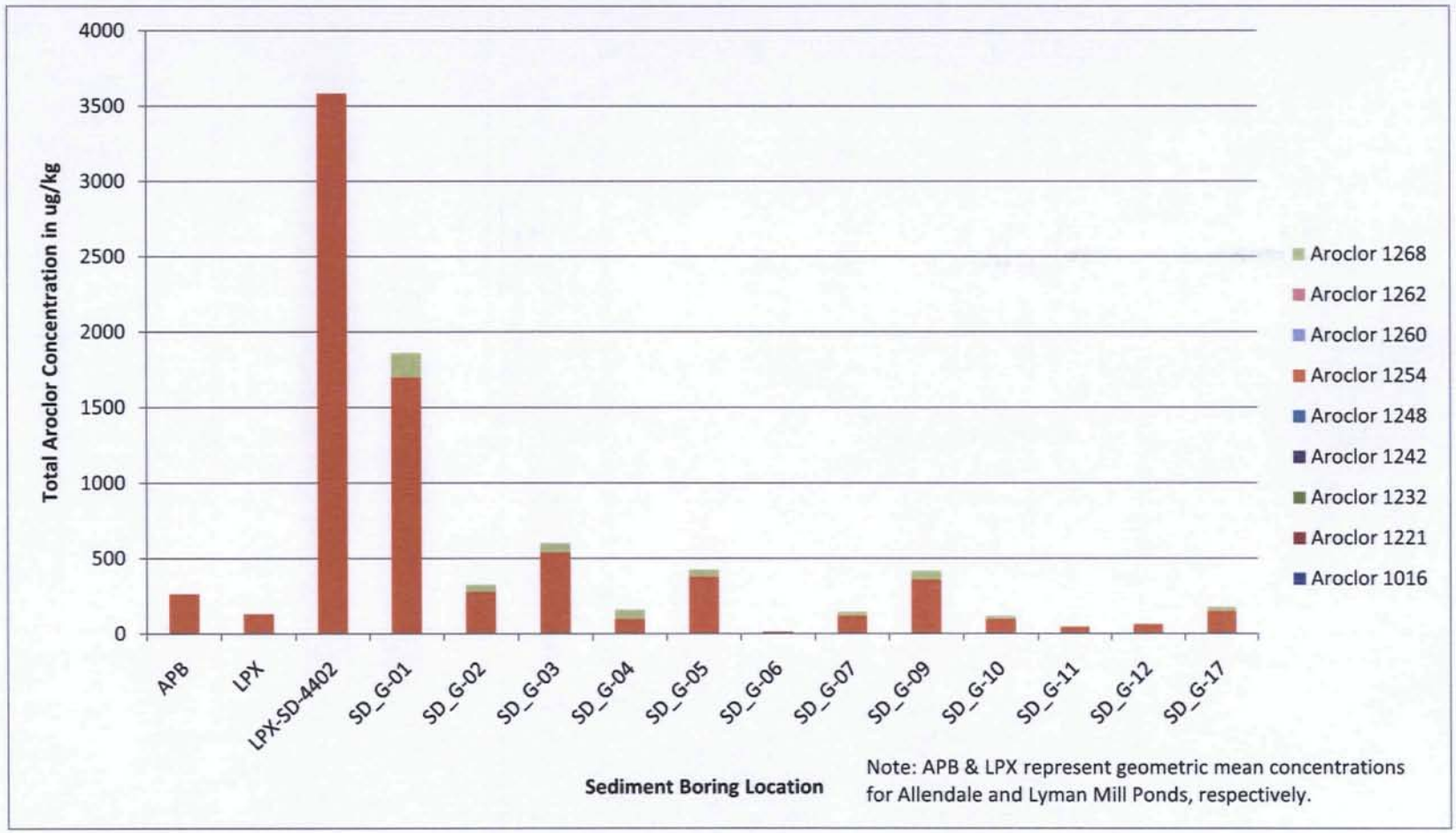


FIGURE C-4A.
PESTICIDES AND HERBICIDES IN OXBOW AREA FLOODPLAIN SURFACE SOIL

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

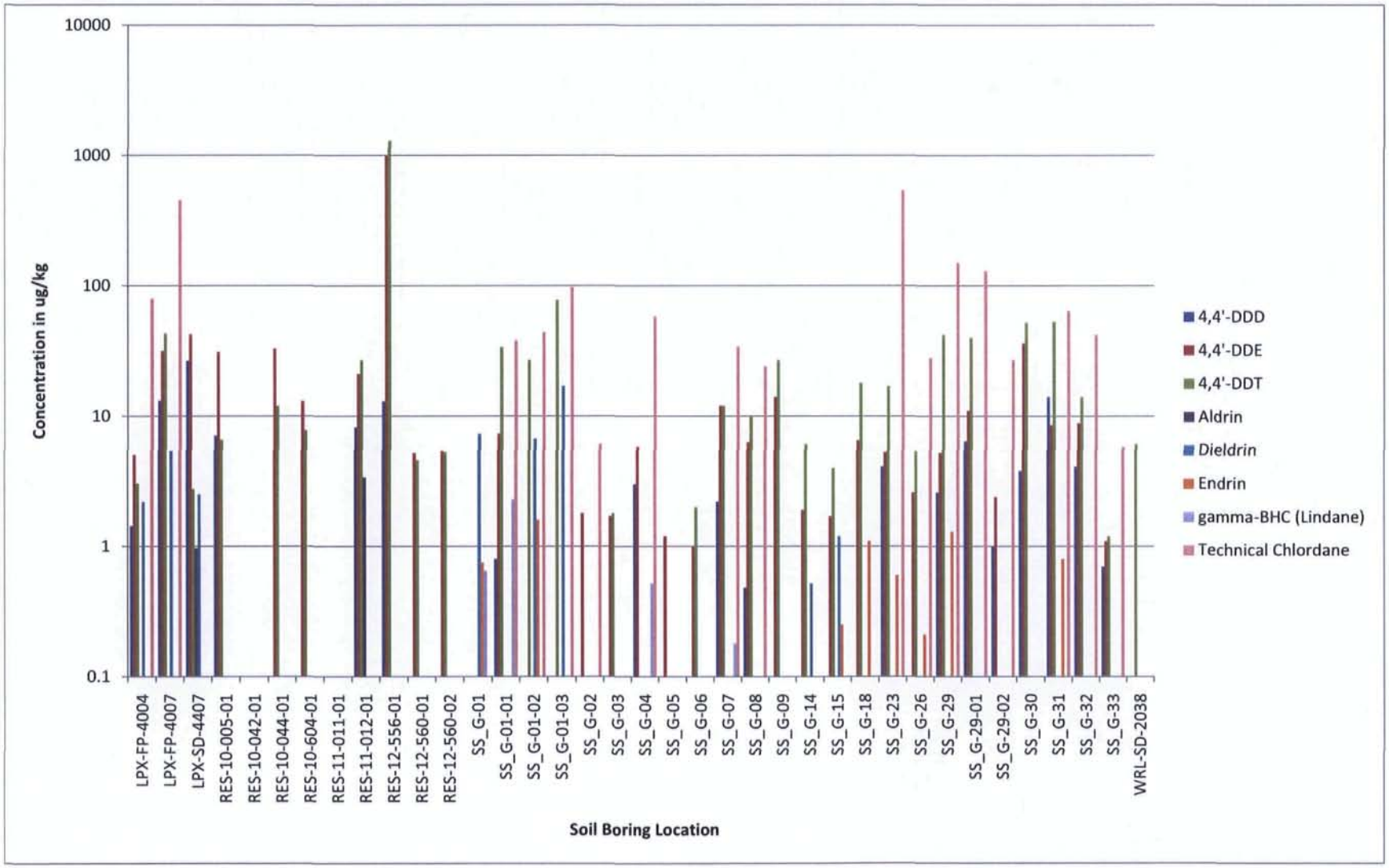


FIGURE C-4B.
PESTICIDES AND HERBIDICES IN OXBOW AREA SEDIMENTS

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

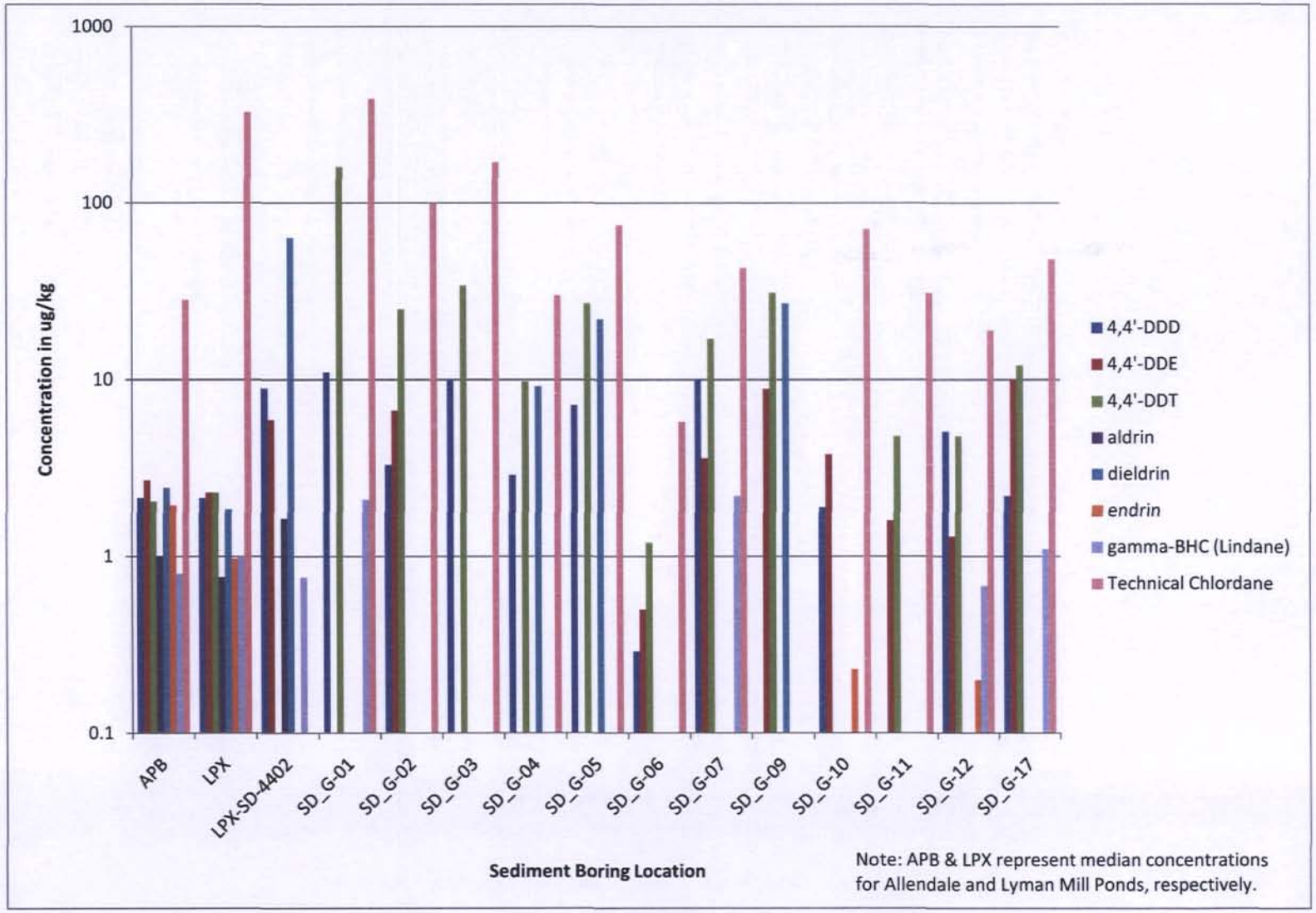


FIGURE C-5A.
SELECT PAH CONCENTRATIONS IN OXBOW AREA FLOODPLAIN SURFACE SOIL

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

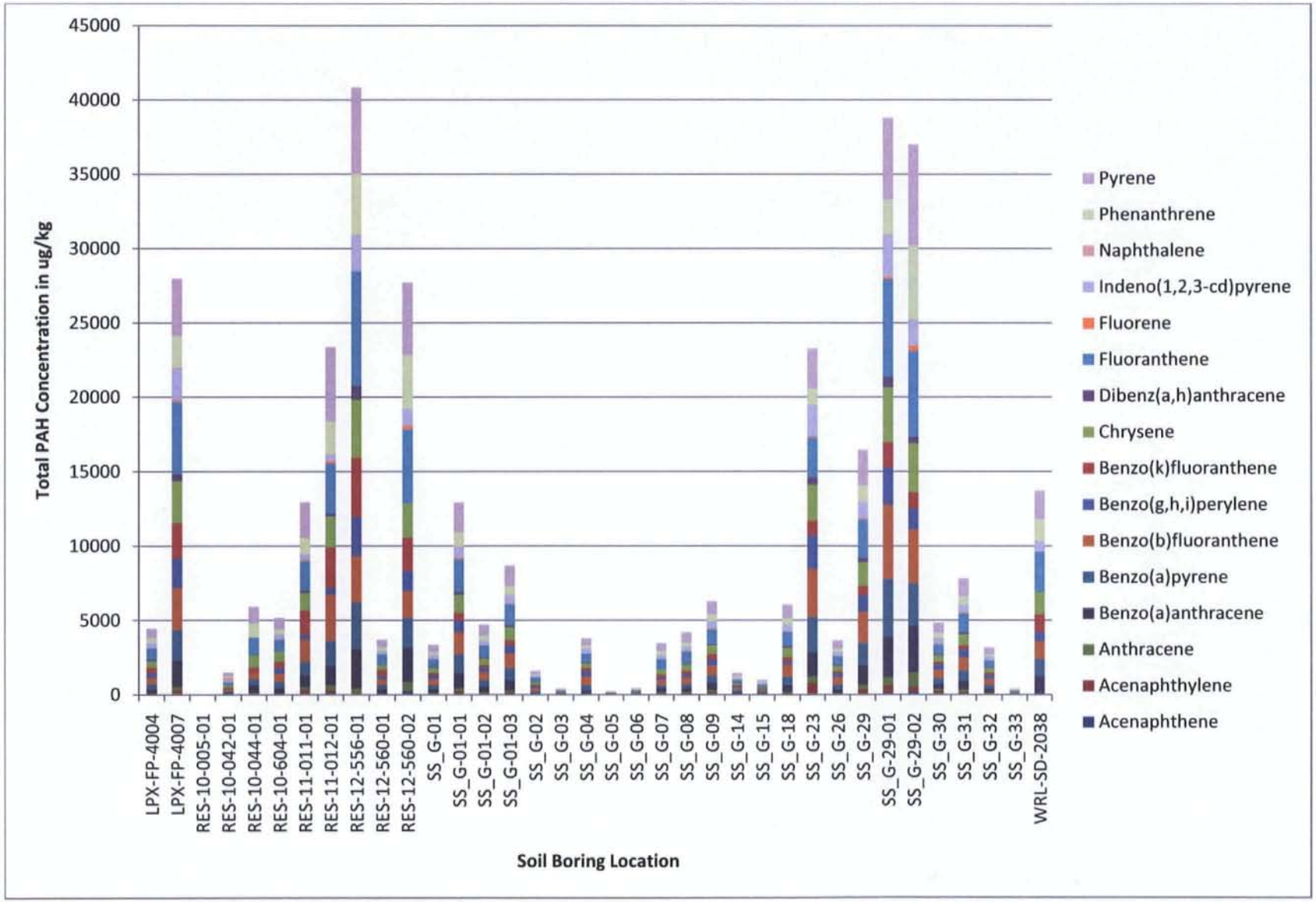


FIGURE C-5B.
SELECT PAH CONCENTRATIONS IN OXBOW AREA SURFACE SEDIMENT

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

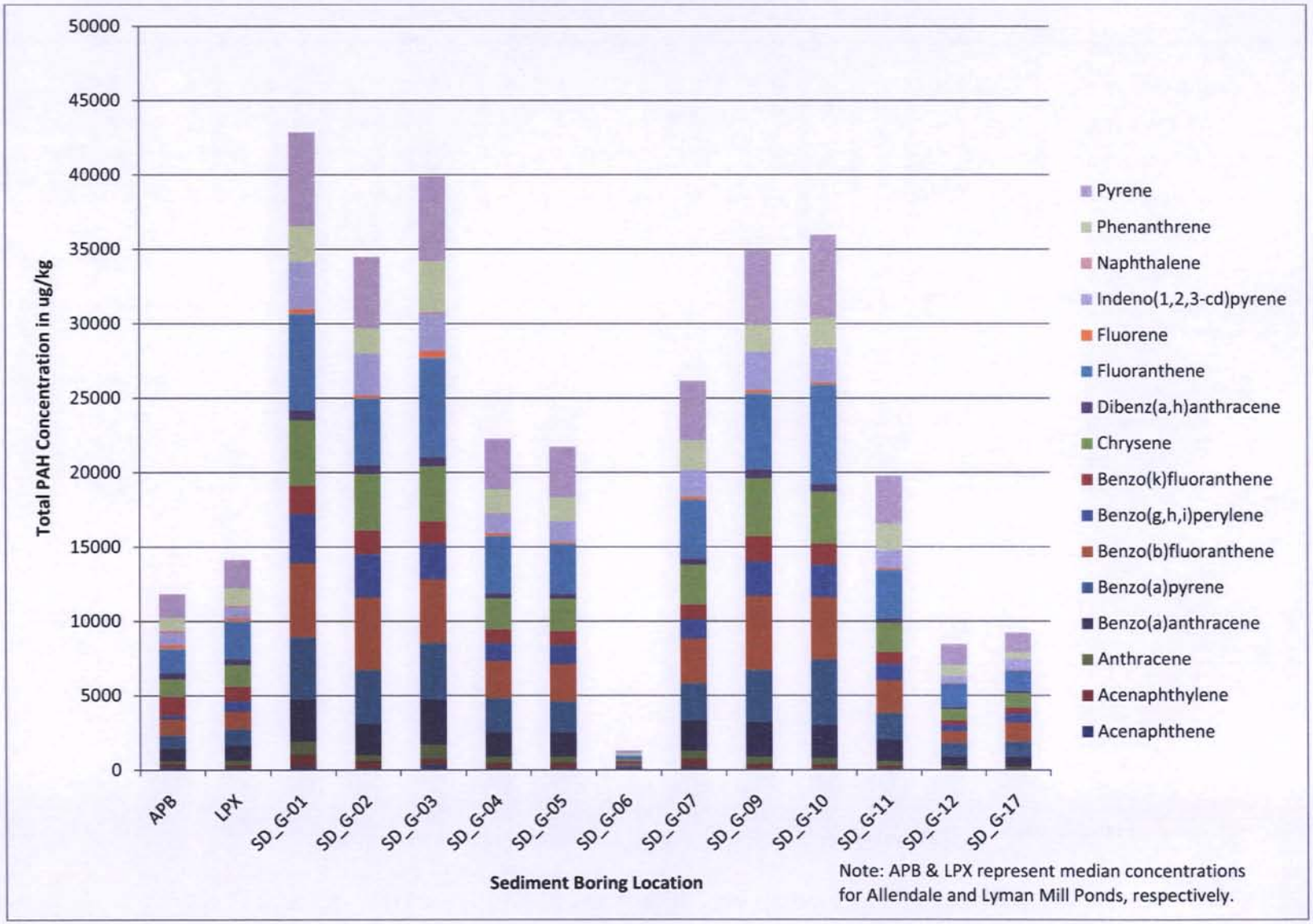


FIGURE C-6A.
SELECT METALS IN OXBOW AREA FLOODPLAIN SURFACE SOIL

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island

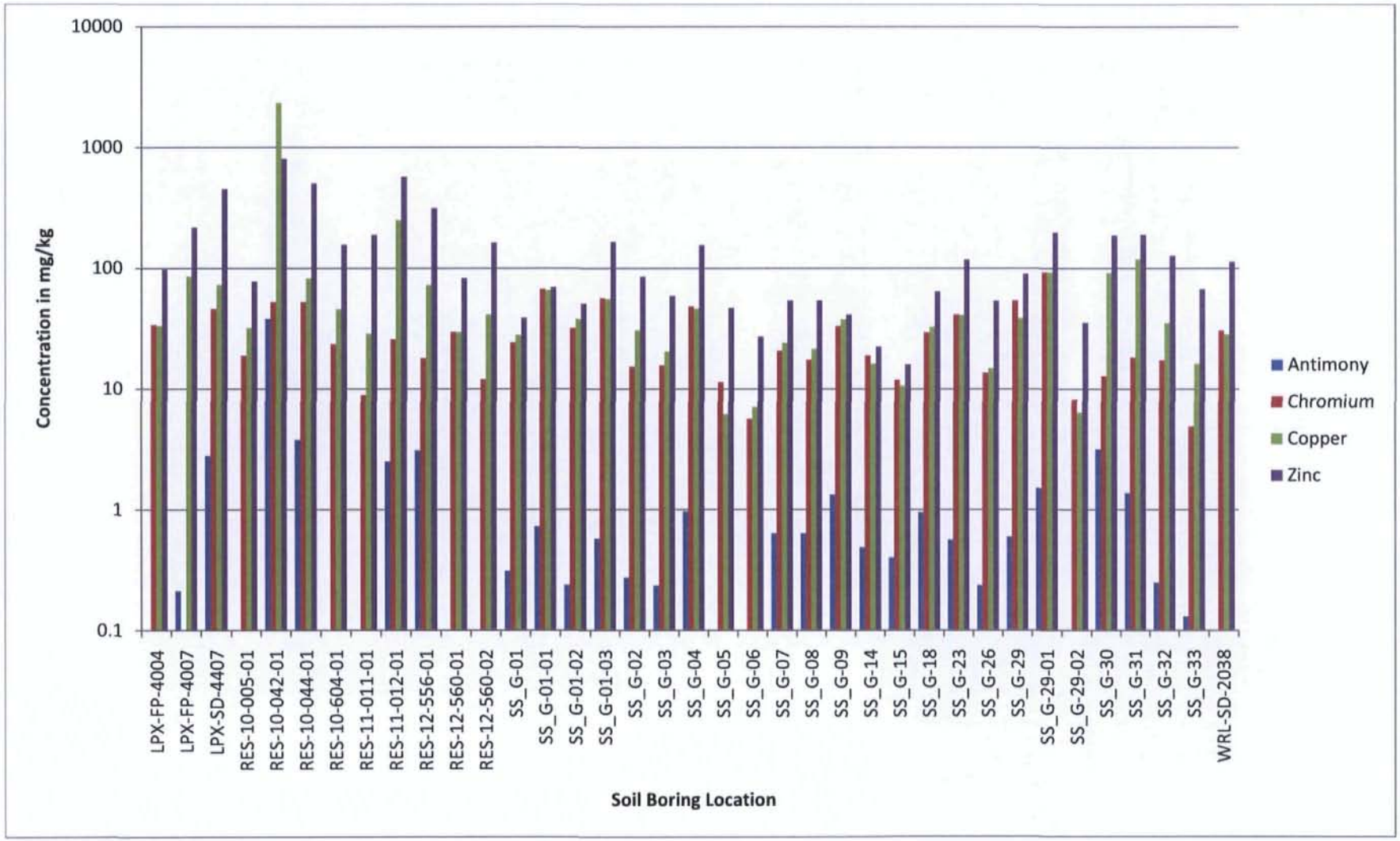
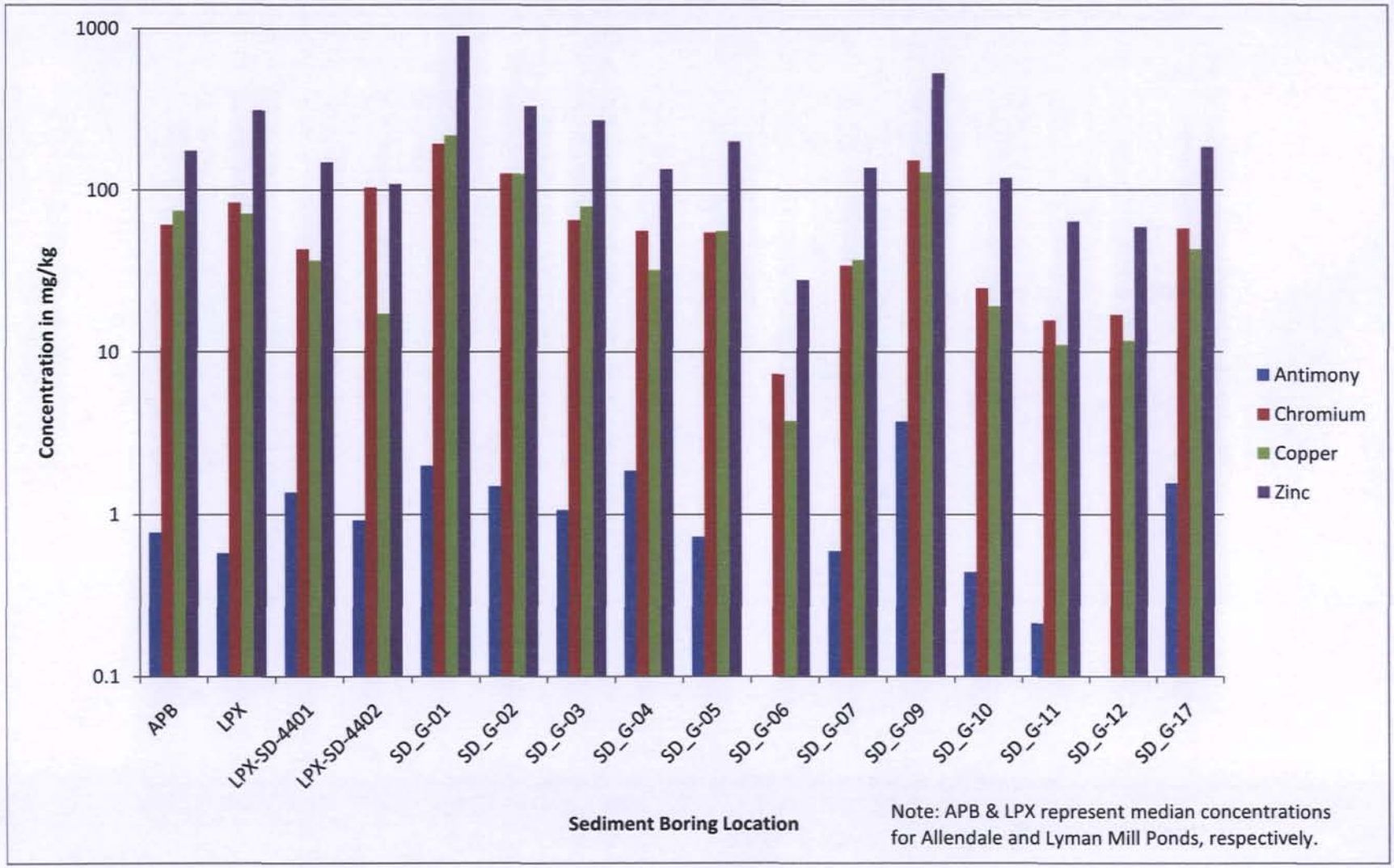


FIGURE C-6B.
SELECT METALS IN OXBOW AREA SURFACE SEDIMENT

Centredale Manor Restoration Project Superfund Site - Oxbow Area
North Providence, Rhode Island



APPENDIX D

ProUCL Inputs and Outputs

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Oxbow Area Floodplain Soil Pesticide/PCB Data
Centredale Manor Restoration Site
North Providence, Rhode Island

Soil Boring	4,4'-DDD	D_4,4'-DDD	4,4'-DDE	D_4,4'-DDE	4,4'-DDT	D_4,4'-DDT	Aldrin	D_Aldrin	Aroclor-1254	D_Aroclor-1254
RES-12-556-01	13	1	1000	1	1300	1	10	0	200	0
LPX-FP-4004	1.44	1	5.05	1	3.04	1	1.14	0	120.02	1
LPX-FP-4007	13.15	1	31.59	1	43.13	1	1.36	0	85.28	1
LPX-SD-4407	26.58	1	42.36	1	2.76	1	0.97	1	637.83	1
RES-10-005-01	7.1	1	31	1	6.6	1	3.5	0	67	0
RES-10-042-01	8.1	0	8.1	0	8.1	0	4.2	0	81	0
RES-11-011-01	5.4	0	5.4	0	5.4	0	2.8	0	54	0
RES-11-012-01	8.2	1	21	1	27	1	3.4	1	150	1
SS_G-01	0.5225	1	3.7125	1	39	1	0.37	0	337.5	1
SS_G-02	0.11	0	1.8	1	1.2	0	0.16	0	2.1	0
SS_G-03	0.11	0	1.7	1	1.8	1	0.16	0	7.7	1
SS_G-04	3	1	5.8	1	5.9	0	0.43	0	49	1
SS_G-05	0.18	0	1.2	1	0.94	0	0.16	0	2.8	0
SS_G-06	0.11	0	1	1	2	1	0.16	0	2.1	0
SS_G-07	2.2	1	12	1	12	1	0.86	0	110	1
SS_G-08	0.48	1	6.3	1	10	1	0.16	0	58	1
SS_G-09	1.1	0	14	1	27	1	0.96	0	96	1
SS_G-14	0.14	0	1.9	1	6.1	1	0.18	0	11	0
SS_G-15	0.16	0	1.7	1	4	1	0.16	0	11	0
SS_G-18	0.79	0	6.5	1	18	1	0.17	0	55	0
SS_G-23	4.1	1	5.3	1	17	1	1.4	0	100	1
SS_G-26	0.65	0	2.6	1	5.4	1	0.16	0	40	1
SS_G-29	3.333333	1	6.2	1	29.2667	1	0.98	1	240	1
SS_G-30	3.8	1	36	1	52	1	0.16	0	26	1
SS_G-31	14	1	8.5	1	53	1	0.8	0	250	1
SS_G-32	4.1	1	8.8	1	14	1	0.17	0	51	1
SS_G-33	0.7	1	1.1	1	1.2	1	0.16	0	2.1	0
WRL-SD-2038	4.2	0	4.2	0	6.1	1	2.2	0	130	1
RES-12-560-01	3.9	0	5.2	1	4.6	1	2	0	39	0
RES-12-560-02	4.3	0	5.4	1	5.3	1	2.2	0	43	0

Oxbow Area Floodplain Soil Pesticide/PCB Data
Centredale Manor Restoration Site
North Providence, Rhode Island

Soil Boring	Aroclor-1260	D_Aroclor-1260	Aroclor-1268	D_Aroclor-1268	Dieldrin	D_Dieldrin	Endrin	D_Endrin	gamma-BHC
RES-12-556-01	200	0			20	0	20	0	10
LPX-FP-4004	14.23	0	22.49	1	2.2	1	1.14	0	1.14
LPX-FP-4007	17.06	0	23.44	1	5.4	1	1.36	0	1.36
LPX-SD-4407	20.32	0	20.28	0	2.51	1	0.2	0	0.18
RES-10-005-01	67	0			6.7	0	6.7	0	3.5
RES-10-042-01	81	0			8.1	0	8.1	0	4.2
RES-11-011-01	54	0			5.4	0	5.4	0	2.8
RES-11-012-01	66	0			6.6	0	6.6	0	3.4
SS_G-01	6.55	0	25.125	1	8.475	1	1.1625	1	0.8675
SS_G-02	4.9	0	2.1	0	0.14	0	0.094	0	0.18
SS_G-03	2.1	0	2.1	0	0.45	0	0.24	0	0.08
SS_G-04	5.6	0	5.6	0	0.37	0	0.45	0	0.52
SS_G-05	4	0	2.1	0	0.14	0	0.094	0	0.08
SS_G-06	3.6	0	2.1	0	0.14	0	0.094	0	0.08
SS_G-07	2.2	0	2.2	0	1.6	0	1.1	0	0.18
SS_G-08	62	1	2.1	0	2.5	0	0.19	0	0.08
SS_G-09	120	1	2.1	0	4.9	0	0.93	0	1.5
SS_G-14	19	0	2.4	0	0.52	1	0.13	0	0.2
SS_G-15	18	0	2.1	0	1.2	1	0.25	1	0.093
SS_G-18	67	0	2.1	0	1.8	0	1.1	1	0.79
SS_G-23	2.7	0	2.7	0	1.8	0	0.6	1	2.9
SS_G-26	2.1	0	2.1	0	0.65	0	0.21	1	0.76
SS_G-29	5.166666667	1	22.36666667	1	3.333333	1	1.26	1	2.423333333
SS_G-30	29	1	2.1	0	2.4	0	0.094	0	1.7
SS_G-31	280	1	11	0	0.8	0	0.8	1	0.8
SS_G-32	92	1	2.1	0	0.81	0	0.51	0	0.16
SS_G-33	3.1	0	2.1	0	0.14	0	0.094	0	0.15
WRL-SD-2038	42	0			4.2	0	4.2	0	2.2
RES-12-560-01	39	0			3.9	0	3.9	0	2
RES-12-560-02	43	0			4.3	0	4.3	0	2.2

Oxbow Area Floodplain Soil Pesticide/PCB Data
Centredale Manor Restoration Site
North Providence, Rhode Island

Soil Boring	D_gamma-BHC	Chlordane	D_Chlordane
RES-12-556-01	0		
LPX-FP-4004	0	79.63	1
LPX-FP-4007	0	455.84	1
LPX-SD-4407	0	20.34	0
RES-10-005-01	0		
RES-10-042-01	0		
RES-11-011-01	0		
RES-11-012-01	0		
SS_G-01	1	50.5	1
SS_G-02	0	6.1	1
SS_G-03	0	4.6	0
SS_G-04	1	58	1
SS_G-05	0	3	0
SS_G-06	0	3.4	0
SS_G-07	1	34	1
SS_G-08	0	24	1
SS_G-09	0	31	0
SS_G-14	0	7.2	0
SS_G-15	0	7.7	0
SS_G-18	0	24	0
SS_G-23	0	540	1
SS_G-26	0	28	1
SS_G-29	1	102.33333	1
SS_G-30	0	9.5	0
SS_G-31	0	64	1
SS_G-32	0	42	1
SS_G-33	0	5.8	1
WRL-SD-2038	0		
RES-12-560-01	0		
RES-12-560-02	0		

Oxbow Area Floodplain Soil Total Aroclors Data
Centredale Manor Restoration Site
North Providence, Rhode Island

Soil Boring	Soil Total Aroclor	D-Soil Total Aroclor
LPX-FP-4004	142.51	1
LPX-FP-4007	108.72	1
RES-10-005-01	140	0
RES-10-042-01	160	0
RES-10-044-01	350	1
RES-10-604-01	73	1
RES-11-011-01	110	0
RES-11-012-01	150	1
RES-12-556-01	410	0
RES-12-560	83	0
SS_G-01	361.25	1
SS_G-02	4.9	0
SS_G-03	7.7	1
SS_G-04	49	1
SS_G-05	4	0
SS_G-06	3.6	0
SS_G-07	110	1
SS_G-08	120	1
SS_G-09	216	1
SS_G-14	19	0
SS_G-15	18	0
SS_G-18	67	0
SS_G-23	100	1
SS_G-26	40	1
SS_G-29	258	1
SS_G-30	55	1
SS_G-31	530	1
SS_G-32	143	1
SS_G-33	3.1	0
LPX-SD-4407-0005-(	637.83	1
WRL-SD-2038	130	1

Oxbow Area Floodplain Soil Dioxin TEQ Data
Centredale Manor Restoration Site
North Providence, Rhode Island

Soil Boring	Soil 1998 Mammal TEQ	D-Soil 1998 Mammal TEQ	Soil 2005 Mammal TEQ	D-Soil 2005 Mammal TEQ	Soil Avian TEQ	D-Soil Avian TEQ
CMS-raceway	1556	1	1556	1	1556	1
RES-SS-12-556	29.54461	1	28.10983	1	42.85021	1
LPX-FP-4004	1133.630374	1	1133.438722	1	1135.591414	1
LPX-FP-4007	81.972457	1	82.820771	1	71.841067	1
LPX-SD-4405	4289.4781	1	4288.3281	1	4297.6606	1
LPX-SD-4406	1829.966	1	1823.408	1	1851.0185	1
LPX-SD-4407	2100.9246	1	2096.681	1	2131.5066	1
RES-10-005	55.62575333	1	55.52986	1	58.62635333	1
RES-SS-10-042	124.7832533	1	113.4394267	1	288.7476867	1
RES-SS-10-044	203.1466967	1	201.9824233	1	219.1223967	1
RES-SS-10-604	27.9928	1	27.7397	1	31.339	1
RES-SS-11-011	5.90866	1	5.82373	1	6.944535	1
RES-SS-11-012	7.78241	1	7.64223	1	9.890943333	1
RES-11-419-02	147.77759	1	147.69277	1	148.73509	1
SS_G-01	6371.960928	1	6370.726758	1	6379.290803	1
SS_G-02	8.45213	1	8.28059	1	9.50883	1
SS_G-03	235.571392	1	235.247376	1	238.356122	1
SS_G-04	516.7413	1	516.4473	1	516.9013	1
SS_G-05	45.480984	1	45.374012	1	46.479469	1
SS_G-06	9.445263	1	9.292369	1	10.707423	1
SS_G-07	2071.89885	1	2070.71595	1	2085.25085	1
SS_G-08	592.47819	1	591.78697	1	597.51759	1
SS_G-09	2287.75412	1	2286.22516	1	2302.30137	1
SS_G-14	396.36571	1	395.57293	1	400.32761	1
SS_G-15	397.70177	1	397.23751	1	400.77197	1
SS_G-18	1206.4046	1	1204.4016	1	1218.516	1
SS_G-23	1013.8479	1	1013.2593	1	1014.93055	1
SS_G-26	594.4551	1	594.27242	1	595.50955	1
SS_G-29	6198.20528	1	6197.586347	1	6201.906913	1
SS_G-30	17.21285	1	14.71175	1	27.9446	1
SS_G-31	55.8016	1	48.6968	1	79.0441	1
SS_G-32	142.73603	1	141.94689	1	146.39078	1
SS_G-33	1.06871	1	0.99793	1	1.0936	1
WRL-SD-2038	629.7249	1	629.1307	1	636.7729	1

Oxbow Area Floodplain Soil Metals Data
Centredale Manor Restoration Site
North Providence, Rhode Island

BORING	Aluminum	D_Aluminum	Antimony	D_Antimony	Arsenic	D_Arsenic	Cadmium	D_Cadmium	Chromium	D_Chromiu	Copper	D_Copper	Lead	D_Lead
LPX-FP-4004	14791	1	0.112	0	4.25	1	0.463	1	33.9	1	33.4	1	158	1
LPX-FP-4007	13131	1	0.213	1	4.93	1	1.76	1	27.2	0	86	1	248	1
LPX-SD-4407			2.8	1	2.61	1	3.77	1	46.1	1	73.2	1	246	1
RES-10-005-01	10400	1	0.82	0	8.1	1	0.11	0	18.9	1	32	1	112	1
RES-10-042-01	13200	1	38.2	1	55.6	1	5	1	52.6	1	2350	1	368	1
RES-11-011-01	3520	1	1.2	0	3.9	1	0.32	1	8.9	1	28.8	1	162	1
RES-11-012-01	10600	1	2.5	1	7.8	1	1.6	1	25.7	1	251	1	2460	1
RES-12-556-01	6600	1	3.1	1	9.3	1	1.1	1	18	1	72.7	1	500	1
RES-12-560-01	4300	1	1.2	0	5.8	1	0.25	0	29.7	1	29.7	1	121	1
RES-12-560-02	6540	1	1.3	0	10.9	1	0.27	0	12	1	41.4	1	192	1
RES-SS-12-556														
SS_G-01			0.462	1	5.95	1	0.5525	1	45.025	1	46.925	1	129.93	1
SS_G-02			0.273	1	13.3	1	0.08	1	15.3	1	30.7	1	67	1
SS_G-03			0.235	1	10	1	0.24	1	15.7	1	20.5	1	48.5	1
SS_G-04			0.965	1	9.2	1	1.05	1	48.4	1	46.4	1	93	1
SS_G-05			0.089	0	7.7	1	0.11	1	11.4	1	6.2	1	26	1
SS_G-06			0.112	0	3.3	1	0.17	1	5.66	1	7.1	1	32.3	1
SS_G-07			0.638	1	4.5	1	0.16	1	20.7	1	24.2	1	334	1
SS_G-08			0.636	1	4.2	1	0.08	1	17.5	1	21.5	1	73.8	1
SS_G-09			1.33	1	6.1	1	0.04	0	33.2	1	37.7	1	161	1
SS_G-14			0.488	1	4.5	1	0.08	1	19	1	16.2	1	118	1
SS_G-15			0.402	1	3.4	1	0.04	1	11.9	1	10.7	1	83	1
SS_G-18			0.955	1	4.9	1	0.29	1	29.3	1	32.9	1	149	1
SS_G-23			0.564	1	4.8	1	0.42	1	41.4	1	41.1	1	124	1
SS_G-26			0.237	1	3.1	1	0.19	1	13.6	1	14.9	1	48	1
SS_G-29			0.719667	1	7.23333	1	0.933333	1	51.66667	1	45.9667	1	171.97	1
SS_G-30			3.18	1	6.3	1	2.43	1	12.8	1	91.9	1	337	1
SS_G-31			1.38	1	5.3	1	0.83	1	18.2	1	119	1	213	1
SS_G-32			0.249	1	13.7	1	0.44	1	17.3	1	35.3	1	93	1
SS_G-33			0.131	1	6	1	0.99	1	4.9	1	16.2	1	25	1
WRL-SD-2038	4140	1	0.54	0	1.2	1	0.06	0	30.5	1	28.5	1	139	1

Oxbow Area Floodplain Soil Metals Data
Centredale Manor Restoration Site
North Providence, Rhode Island

BORING	Manganese	D_Manganese	Mercury	D_Mercury	Molybdenum	D_Molybdenum	Nickel	D_Nickel	Selenium	D_Selenium	Silver	D_Silver
LPX-FP-4004	740	1	0.209	1	3.48	1	12.3	1	0.779	1	0.407	1
LPX-FP-4007	307	1	0.159	1	1.42	1	20.4	1	0.438	0	3.88	1
LPX-SD-4407	809	1			5.83	1	30.7	1	1.78	1	1.05	1
RES-10-005-01	217	1	0.13	1			9.9	1	0.64	0	0.79	0
RES-10-042-01	695	1	0.13	1			38	1	0.89	0	5.1	1
RES-11-011-01	149	1	0.12	0			9.6	1	1.2	0	0.9	0
RES-11-012-01	425	1	0.18	0			48.1	1	1.8	0	5.7	1
RES-12-556-01	373	1	1	1			9.2	1	2.4	1	0.8	0
RES-12-560-01	811	1	0.12	0			9.6	1	1.2	0	0.65	0
RES-12-560-02	277	1	0.14	0			14	1	1.3	0	0.68	0
RES-SS-12-556												
SS_G-01	865.5	1			11.0825	1	11.803	1	1.225	1	0.2375	1
SS_G-02	489	1			1.4	1	12.5	1	0.8	1	0.2	0
SS_G-03	2440	1			2.2	1	9.09	1	1.4	1	0.2	0
SS_G-04	1790	1			2.23	1	148	1	1.2	1	0.3	1
SS_G-05	1140	1			4.74	1	5.95	1	1.2	1	0.2	0
SS_G-06	1220	1			1.67	1	3.21	1	0.7	1	0.2	0
SS_G-07	1140	1			3.03	1	6.39	1	0.7	1	0.3	1
SS_G-08	250	1			3.26	1	4.99	1	0.7	1	0.2	1
SS_G-09	249	1			6.62	1	8.11	1	0.8	1	0.3	1
SS_G-14	187	1			2.42	1	6.25	1	1.1	1	0.3	1
SS_G-15	156	1			1.39	1	2.57	1	0.5	1	0.2	1
SS_G-18	317	1			4.51	1	8.58	1	0.7	1	0.2	0
SS_G-23	831	1			4.32	1	17.5	1	0.5	1	0.2	0
SS_G-26	178	1			1.76	1	5.95	1	0.1	1	0.2	0
SS_G-29	325.6666667	1			6	1	12.76	1	0.733333333	1	0.36667	1
SS_G-30	150	1			1.06	1	28.6	1	0.4	1	0.4	1
SS_G-31	516	1			1.73	1	28.3	1	4.5	1	2.2	1
SS_G-32	882	1			1.12	1	20.7	1	0.6	1	0.2	0
SS_G-33	65.7	1			0.53	1	5.16	1	0.1	0	0.2	0
WRL-SD-2038	1130	1	0.1	1			14.4	1	0.82	0	2.7	0

Oxbow Area Floodplain Soil Metals Data
Centredale Manor Restoration Site
North Providence, Rhode Island

BORING	Thallium	D_Thalium	Vanadium	D_Vanadium	Zinc	D_Zinc
LPX-FP-4004	0.279	1	38.6	1	97.5	1
LPX-FP-4007	0.289	1	31.6	1	218	1
LPX-SD-4407	0.401	1	62.7	1	454	1
RES-10-005-01	0.75	0	20.5	1	77.8	1
RES-10-042-01	1	0	21.5	1	808	1
RES-11-011-01	1.7	0	12.2	1	189	1
RES-11-012-01	2.5	0	36.7	1	574	1
RES-12-556-01	1.8	0	24	1	315	1
RES-12-560-01	1.7	0	27.7	1	83.1	1
RES-12-560-02	1.9	0	34.1	1	163	1
RES-SS-12-556						
SS_G-01	0.55	0	32.25	1	81.35	1
SS_G-02	0.4	0	27.7	1	85.5	1
SS_G-03	0.4	0	31	1	59	1
SS_G-04	0.7	1	27.3	1	156	1
SS_G-05	0.4	1	25.4	1	47	1
SS_G-06	0.4	0	18	1	27.1	1
SS_G-07	0.5	0	23	1	54	1
SS_G-08	0.4	0	20	1	54	1
SS_G-09	0.4	0	31	1	41.5	1
SS_G-14	0.4	0	23.8	1	22.5	1
SS_G-15	0.4	0	22.3	1	16	1
SS_G-18	0.5	0	30.3	1	64.5	1
SS_G-23	0.4	0	30.8	1	118	1
SS_G-26	0.4	0	16.2	1	53.8	1
SS_G-29	0.6	1	25.3	1	108.27	1
SS_G-30	0.4	0	13.5	1	188	1
SS_G-31	0.5	0	12.9	1	190	1
SS_G-32	0.8	1	22.8	1	127	1
SS_G-33	0.4	0	7.1	1	67.2	1
WRL-SD-2038	0.38	0	19.2	1	114	1

	General UCL Statistics for Data Sets with Non-Detects
User Selected Options	
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

4,4'-DDD

General Statistics			
Number of Valid Data	30	Number of Detected Data	16
Number of Distinct Detected Data	15	Number of Non-Detect Data	14
		Percent Non-Detects	46.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.48	Minimum Detected	-0.734
Maximum Detected	26.58	Maximum Detected	3.28
Mean of Detected	6.607	Mean of Detected	1.312
SD of Detected	7.023	SD of Detected	1.209
Minimum Non-Detect	0.11	Minimum Non-Detect	-2.207
Maximum Non-Detect	8.1	Maximum Non-Detect	2.092
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	25
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	5
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	83.33%

UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.801	Shapiro Wilk Test Statistic	0.952
5% Shapiro Wilk Critical Value	0.887	5% Shapiro Wilk Critical Value	0.887
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	4.011	Mean	0.221
SD	5.85	SD	1.852
95% DL/2 (t) UCL	5.826	95% H-Stat (DL/2) UCL	24.78
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	0.223
		SD in Log Scale	1.529
		Mean in Original Scale	3.723
		SD in Original Scale	5.947
		95% t UCL	5.568
		95% Percentile Bootstrap UCL	5.658
		95% BCA Bootstrap UCL	5.897
		95% H-UCL	9.995
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.856	**Data appear Gamma Distributed at 5% Significance Level**	

Theta Star	7.717		
nu star	27.39		
A-D Test Statistic	0.279	**Nonparametric Statistics**	
5% A-D Critical Value	0.763	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.763	Mean	3.911
5% K-S Critical Value	0.221	SD	5.78
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	1.096
		95% KM (t) UCL	5.774
Assuming Gamma Distribution		95% KM (z) UCL	5.715
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	5.735
Minimum	0.000001	95% KM (bootstrap t) UCL	6.641
Maximum	26.58	95% KM (BCA) UCL	5.967
Mean	3.524	95% KM (Percentile Bootstrap) UCL	5.856
Median	0.501	95% KM (Chebyshev) UCL	8.691
SD	6.062	97.5% KM (Chebyshev) UCL	10.76
k star	0.125	99% KM (Chebyshev) UCL	14.82
Theta star	28.24		
Nu star	7.487	**Potential UCLs to Use**	
AppChi2	2.442	95% KM (BCA) UCL	5.967
95% Gamma Approximate UCL	10.8		
95% Adjusted Gamma UCL	11.58		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

4,4'-DDE

General Statistics

Number of Valid Data	30	Number of Detected Data	27
Number of Distinct Detected Data	26	Number of Non-Detect Data	3
		Percent Non-Detects	10.00%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	1	Minimum Detected	0
Maximum Detected	1000	Maximum Detected	6.908
Mean of Detected	46.95	Mean of Detected	1.939
SD of Detected	190.8	SD of Detected	1.477
Minimum Non-Detect	4.2	Minimum Non-Detect	1.435
Maximum Non-Detect	8.1	Maximum Non-Detect	2.092
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	20
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	10
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	66.67%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.239	Shapiro Wilk Test Statistic	0.891

5% Shapiro Wilk Critical Value	0.923	5% Shapiro Wilk Critical Value	0.923
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	42.55	Mean	1.85
SD	181.2	SD	1.428
95% DL/2 (t) UCL	98.76	95% H-Stat (DL/2) UCL	39.67
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	1.829
		SD in Log Scale	1.442
		Mean in Original Scale	42.5
		SD in Original Scale	181.2
		95% t UCL	98.71
		95% Percentile Bootstrap UCL	108.2
		95% BCA Bootstrap UCL	142.8
		95% H-UCL	40.13
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.337	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	139.2		
nu star	18.22		
A-D Test Statistic	4.039	**Nonparametric Statistics**	
5% A-D Critical Value	0.841	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.841	Mean	42.52
5% K-S Critical Value	0.181	SD	178.1
Data not Gamma Distributed at 5% Significance Level		SE of Mean	33.14
		95% KM (t) UCL	98.84
Assuming Gamma Distribution		95% KM (z) UCL	97.04
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	98.73
Minimum	0.000001	95% KM (bootstrap t) UCL	780.1
Maximum	1000	95% KM (BCA) UCL	110.2
Mean	42.26	95% KM (Percentile Bootstrap) UCL	107.3
Median	5.35	95% KM (Chebyshev) UCL	187
SD	181.3	97.5% KM (Chebyshev) UCL	249.5
k star	0.216	99% KM (Chebyshev) UCL	372.3
Theta star	195.7		
Nu star	12.96	**Potential UCLs to Use**	
AppChi2	5.863	97.5% KM (Chebyshev) UCL	249.5
95% Gamma Approximate UCL	93.38		
95% Adjusted Gamma UCL	97.96		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

4,4'-DDT

General Statistics			
Number of Valid Data	30	Number of Detected Data	25
Number of Distinct Detected Data	23	Number of Non-Detect Data	5
		Percent Non-Detects	16.67%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	1.2	Minimum Detected	0.182
Maximum Detected	1300	Maximum Detected	7.17
Mean of Detected	67.61	Mean of Detected	2.44
SD of Detected	257.2	SD of Detected	1.48
Minimum Non-Detect	0.94	Minimum Non-Detect	-0.0619
Maximum Non-Detect	8.1	Maximum Non-Detect	2.092
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	17
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	13
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	56.67%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.252	Shapiro Wilk Test Statistic	0.916
5% Shapiro Wilk Critical Value	0.918	5% Shapiro Wilk Critical Value	0.918
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	56.7	Mean	2.107
SD	235.3	SD	1.589
95% DL/2 (t) UCL	129.7	95% H-Stat (DL/2) UCL	76.85
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	2.053
		SD in Log Scale	1.649
		Mean in Original Scale	56.6
		SD in Original Scale	235.4
		95% t UCL	129.6
		95% Percentile Bootstrap UCL	142.5
		95% BCA Bootstrap UCL	186.6
		95% H-UCL	85.6
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.357	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	189.6		
nu star	17.83		
A-D Test Statistic	3.315	**Nonparametric Statistics**	
5% A-D Critical Value	0.835	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.835	Mean	56.73
5% K-S Critical Value	0.188	SD	231.4
Data not Gamma Distributed at 5% Significance Level		SE of Mean	43.11
		95% KM (t) UCL	130

Assuming Gamma Distribution		95% KM (z) UCL	127.6
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	129.7
Minimum	0.000001	95% KM (bootstrap t) UCL	909.3
Maximum	1300	95% KM (BCA) UCL	144.1
Mean	56.34	95% KM (Percentile Bootstrap) UCL	142
Median	6.1	95% KM (Chebyshev) UCL	244.7
SD	235.4	97.5% KM (Chebyshev) UCL	326
k star	0.179	99% KM (Chebyshev) UCL	485.7
Theta star	314		
Nu star	10.77	**Potential UCLs to Use**	
AppChi2	4.427	97.5% KM (Chebyshev) UCL	326
95% Gamma Approximate UCL	137		
95% Adjusted Gamma UCL	144.7		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Aldrin

General Statistics

Number of Valid Data	30	Number of Detected Data	3
Number of Distinct Detected Data	3	Number of Non-Detect Data	27
		Percent Non-Detects	90.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.97	Minimum Detected	-0.0305
Maximum Detected	3.4	Maximum Detected	1.224
Mean of Detected	1.783	Mean of Detected	0.391
SD of Detected	1.4	SD of Detected	0.721
Minimum Non-Detect	0.16	Minimum Non-Detect	-1.833
Maximum Non-Detect	10	Maximum Non-Detect	2.303

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	30
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

Warning: There are only 3 Distinct Detected Values in this data set
The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
However, results obtained using 4 to 9 distinct values may not be reliable.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.753	Shapiro Wilk Test Statistic	0.756

5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.781	Mean	-1.083
SD	1.099	SD	1.354
95% DL/2 (t) UCL	1.122	95% H-Stat (DL/2) UCL	1.78
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.156
		SD in Log Scale	1.097
		Mean in Original Scale	0.274
		SD in Original Scale	0.634
		95% t UCL	0.471
		95% Percentile Bootstrap UCL	0.498
		95% BCA Bootstrap UCL	0.615
		95% H-UCL	0.359
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	N/A	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	N/A	**Nonparametric Statistics**	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	1.061
5% K-S Critical Value	N/A	SD	0.459
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.108
		95% KM (t) UCL	1.244
Assuming Gamma Distribution		95% KM (z) UCL	1.238
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.206
Minimum	N/A	95% KM (bootstrap t) UCL	14.86
Maximum	N/A	95% KM (BCA) UCL	3.4
Mean	N/A	95% KM (Percentile Bootstrap) UCL	3.4
Median	N/A	95% KM (Chebyshev) UCL	1.532
SD	N/A	97.5% KM (Chebyshev) UCL	1.736
k star	N/A	99% KM (Chebyshev) UCL	2.137
Theta star	N/A		
Nu star	N/A	**Potential UCLs to Use**	
AppChi2	N/A	95% KM (t) UCL	1.244
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	3.4
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Aroclor 1254

General Statistics			
Number of Valid Data	30	Number of Detected Data	17
Number of Distinct Detected Data	17	Number of Non-Detect Data	13
		Percent Non-Detects	43.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	7.7	Minimum Detected	2.041
Maximum Detected	637.8	Maximum Detected	6.458
Mean of Detected	146.4	Mean of Detected	4.537
SD of Detected	154.1	SD of Detected	1.038
Minimum Non-Detect	2.1	Minimum Non-Detect	0.742
Maximum Non-Detect	200	Maximum Non-Detect	5.298
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	26
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	4
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	86.67%

UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.747	Shapiro Wilk Test Statistic	0.975
5% Shapiro Wilk Critical Value	0.892	5% Shapiro Wilk Critical Value	0.892
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	92.45	Mean	3.516
SD	131.7	SD	1.757
95% DL/2 (t) UCL	133.3	95% H-Stat (DL/2) UCL	502.3
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	428.9	Mean in Log Scale	3.631
SD	161.3	SD in Log Scale	1.345
95% MLE (t) UCL	478.9	Mean in Original Scale	88.52
95% MLE (Tiku) UCL	561.4	SD in Original Scale	132.8
		95% t UCL	129.7
		95% Percentile Bootstrap UCL	131.8
		95% BCA Bootstrap UCL	142.1
		95% H UCL	194.4
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	1.072	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	136.5		
nu star	36.46		
A-D Test Statistic	0.282	Nonparametric Statistics	
5% A-D Critical Value	0.761	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.761	Mean	89.47
5% K-S Critical Value	0.214	SD	130.6
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	24.68
		95% KM (t) UCL	131.4

Assuming Gamma Distribution		95% KM (z) UCL	130.1
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	127.2
Minimum	0.000001	95% KM (bootstrap t) UCL	156.2
Maximum	637.8	95% KM (BCA) UCL	146.1
Mean	82.94	95% KM (Percentile Bootstrap) UCL	136.4
Median	33	95% KM (Chebyshev) UCL	197
SD	136.1	97.5% KM (Chebyshev) UCL	243.6
k star	0.115	99% KM (Chebyshev) UCL	335
Theta star	720.3		
Nu star	6.909	**Potential UCLs to Use**	
AppChi2	2.121	95% KM (t) UCL	131.4
95% Gamma Approximate UCL	270.2		
95% Adjusted Gamma UCL	290.7		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Aroclor 1260

General Statistics

Number of Valid Data	30	Number of Detected Data	6
Number of Distinct Detected Data	6	Number of Non-Detect Data	24
		Percent Non-Detects	80.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	5.167	Minimum Detected	1.642
Maximum Detected	280	Maximum Detected	5.635
Mean of Detected	98.03	Mean of Detected	4.013
SD of Detected	98.3	SD of Detected	1.381
Minimum Non-Detect	2.1	Minimum Non-Detect	0.742
Maximum Non-Detect	200	Maximum Non-Detect	5.298

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	29
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	1
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	96.67%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.869	*Shapiro Wilk Test Statistic*	0.944
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	32.68	Mean	2.383
SD	56.13	SD	1.599
95% DL/2 (t) UCL	50.09	95% H-Stat (DL/2) UCL	104
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	0.787
		SD in Log Scale	1.786
		Mean in Original Scale	20.48
		SD in Original Scale	56.76
		95% t UCL	38.09
		95% Percentile Bootstrap UCL	39.34
		95% BCA Bootstrap UCL	47.48
		95% H-UCL	35.71
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.615	**Data appear Normal at 5% Significance Level**	
Theta Star	159.3		
nu star	7.384		
A-D Test Statistic	0.167	**Nonparametric Statistics**	
5% A-D Critical Value	0.715	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.715	Mean	24.81
5% K-S Critical Value	0.341	SD	54.84
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	11.08
		95% KM (t) UCL	43.64
Assuming Gamma Distribution		95% KM (z) UCL	43.04
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	43.3
Minimum	0.000001	95% KM (bootstrap t) UCL	53.59
Maximum	280	95% KM (BCA) UCL	99.31
Mean	19.61	95% KM (Percentile Bootstrap) UCL	91.53
Median	0.000001	95% KM (Chebyshev) UCL	73.12
SD	57.07	97.5% KM (Chebyshev) UCL	94.02
k star	0.0803	99% KM (Chebyshev) UCL	135.1
Theta star	244.1		
Nu star	4.819	**Potential UCLs to Use**	
AppChi2	1.07	95% KM (t) UCL	43.64
95% Gamma Approximate UCL	88.33	95% KM (Percentile Bootstrap) UCL	91.53
95% Adjusted Gamma UCL	97.05		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Aroclor 1268

General Statistics

Number of Valid Data	22	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	18
Number of Missing Values	5	Percent Non-Detects	81.82%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	22.37	Minimum Detected	3.108
Maximum Detected	25.13	Maximum Detected	3.224
Mean of Detected	23.36	Mean of Detected	3.15
SD of Detected	1.273	SD of Detected	0.0537
Minimum Non-Detect	2.1	Minimum Non-Detect	0.742
Maximum Non-Detect	20.28	Maximum Non-Detect	3.01
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	18
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	4
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	81.82%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.868	Shapiro Wilk Test Statistic	0.873
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	5.823	Mean	0.855
SD	8.727	SD	1.255
95% DL/2 (t) UCL	9.025	95% H-Stat (DL/2) UCL	11.62
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	15.99	Mean in Log Scale	2.927
SD	4.885	SD in Log Scale	0.136
95% MLE (t) UCL	17.78	Mean in Original Scale	18.83
95% MLE (Tiku) UCL	20.58	SD in Original Scale	2.648
		95% t UCL	19.81
		95% Percentile Bootstrap UCL	19.73
		95% BCA Bootstrap UCL	19.84
		95% H UCL	19.84
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	114.7	**Data appear Normal at 5% Significance Level**	
Theta Star	0.204		
nu star	917.9		
A-D Test Statistic	0.412	**Nonparametric Statistics**	

5% A-D Critical Value	0.657	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.657	Mean	22.55
5% K-S Critical Value	0.394	SD	0.605
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.149
		95% KM (t) UCL	22.8
Assuming Gamma Distribution		95% KM (z) UCL	22.79
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	22.74
Minimum	0.000001	95% KM (bootstrap t) UCL	22.9
Maximum	25.13	95% KM (BCA) UCL	N/A
Mean	10.1	95% KM (Percentile Bootstrap) UCL	23.59
Median	6.488	95% KM (Chebyshev) UCL	23.2
SD	8.368	97.5% KM (Chebyshev) UCL	23.48
k star	0.24	99% KM (Chebyshev) UCL	24.03
Theta star	42.15		
Nu star	10.54	**Potential UCLs to Use**	
AppChi2	4.284	95% KM (t) UCL	22.8
95% Gamma Approximate UCL	24.85	95% KM (Percentile Bootstrap) UCL	23.59
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Dieldrin

General Statistics

Number of Valid Data	30	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	23
		Percent Non-Detects	76.67%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.52	Minimum Detected	-0.654
Maximum Detected	8.475	Maximum Detected	2.137
Mean of Detected	3.377	Mean of Detected	0.895
SD of Detected	2.742	SD of Detected	0.929
Minimum Non-Detect	0.14	Minimum Non-Detect	-1.966
Maximum Non-Detect	20	Maximum Non-Detect	2.996

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	30
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.905	Shapiro Wilk Test Statistic	0.98
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.085	Mean	-0.0118
SD	2.385	SD	1.447
95% DL/2 (t) UCL	2.825	95% H-Stat (DL/2) UCL	6.456
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-0.751
		SD in Log Scale	1.086
		Mean in Original Scale	1.025
		SD in Original Scale	1.818
		95% t UCL	1.589
		95% Percentile Bootstrap UCL	1.593
		95% BCA Bootstrap UCL	1.86
		95% H-UCL	1.434
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.067	**Data appear Normal at 5% Significance Level**	
Theta Star	3.165		
nu star	14.94		
A-D Test Statistic	0.149	**Nonparametric Statistics**	
5% A-D Critical Value	0.719	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.719	Mean	1.358
5% K-S Critical Value	0.316	SD	1.78
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.378
		95% KM (t) UCL	2.001
Assuming Gamma Distribution		95% KM (z) UCL	1.98
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.937
Minimum	0.000001	95% KM (bootstrap t) UCL	2.19
Maximum	8.475	95% KM (BCA) UCL	3.221
Mean	0.788	95% KM (Percentile Bootstrap) UCL	2.848
Median	0.000001	95% KM (Chebyshev) UCL	3.007
SD	1.915	97.5% KM (Chebyshev) UCL	3.72
k star	0.096	99% KM (Chebyshev) UCL	5.121
Theta star	8.206		
Nu star	5.761	**Potential UCLs to Use**	
AppChi2	1.519	95% KM (t) UCL	2.001
95% Gamma Approximate UCL	2.988	95% KM (Percentile Bootstrap) UCL	2.848
95% Adjusted Gamma UCL	3.247		
Note: DL/2 is not a recommended method.			
Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
For additional insight, the user may want to consult a statistician.			

Endrin

General Statistics			
Number of Valid Data	30	Number of Detected Data	7
Number of Distinct Detected Data	7	Number of Non-Detect Data	23
		Percent Non-Detects	76.67%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.21	Minimum Detected	-1.561
Maximum Detected	1.26	Maximum Detected	0.231
Mean of Detected	0.769	Mean of Detected	-0.458
SD of Detected	0.431	SD of Detected	0.74
Minimum Non-Detect	0.094	Minimum Non-Detect	-2.364
Maximum Non-Detect	20	Maximum Non-Detect	2.996
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	30
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

Warning: There are only 7 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.897	Shapiro Wilk Test Statistic	0.846
5% Shapiro Wilk Critical Value	0.803	5% Shapiro Wilk Critical Value	0.803
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	1.278	Mean	-0.797
SD	2.003	SD	1.592
95% DL/2 (t) UCL	1.899	95% H-Stat (DL/2) UCL	4.248
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-1.667
		SD in Log Scale	0.837
		Mean in Original Scale	0.286
		SD in Original Scale	0.337
		95% t UCL	0.391
		95% Percentile Bootstrap UCL	0.398
		95% BCA Bootstrap UCL	0.417
		95% H-UCL	0.382
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	

k star (bias corrected)	1.65	**Data appear Normal at 5% Significance Level**	
Theta Star	0.466		
nu star	23.09		
A-D Test Statistic	0.491	**Nonparametric Statistics**	
5% A-D Critical Value	0.713	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.713	Mean	0.409
5% K-S Critical Value	0.314	SD	0.353
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0854
		95% KM (t) UCL	0.554
Assuming Gamma Distribution		95% KM (z) UCL	0.549
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.534
Minimum	0.000001	95% KM (bootstrap t) UCL	0.558
Maximum	1.26	95% KM (BCA) UCL	0.874
Mean	0.179	95% KM (Percentile Bootstrap) UCL	0.768
Median	0.000001	95% KM (Chebyshev) UCL	0.781
SD	0.385	97.5% KM (Chebyshev) UCL	0.942
k star	0.105	99% KM (Chebyshev) UCL	1.258
Theta star	1.717		
Nu star	6.271	**Potential UCLs to Use**	
AppChi2	1.78	95% KM (t) UCL	0.554
95% Gamma Approximate UCL	0.632	95% KM (Percentile Bootstrap) UCL	0.768
95% Adjusted Gamma UCL	0.684		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

gamma-BHC

General Statistics

Number of Valid Data	30	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	26
		Percent Non-Detects	86.67%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.18	Minimum Detected	-1.715
Maximum Detected	2.423	Maximum Detected	0.885
Mean of Detected	0.998	Mean of Detected	-0.406
SD of Detected	0.991	SD of Detected	1.082
Minimum Non-Detect	0.08	Minimum Non-Detect	-2.526
Maximum Non-Detect	10	Maximum Non-Detect	2.303
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	30
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	0
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	100.00%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions			
It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.			
UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.869	Shapiro Wilk Test Statistic	0.999
5% Shapiro Wilk Critical Value	0.748	5% Shapiro Wilk Critical Value	0.748
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.842	Mean	-0.989
SD	1.035	SD	1.473
95% DL/2 (t) UCL	1.163	95% H-Stat (DL/2) UCL	2.584
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.963
		SD in Log Scale	1.197
		Mean in Original Scale	0.167
		SD in Original Scale	0.46
		95% t UCL	0.31
		95% Percentile Bootstrap UCL	0.311
		95% BCA Bootstrap UCL	0.46
		95% H-UCL	0.194
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.512	Data appear Normal at 5% Significance Level	
Theta Star	1.95		
nu star	4.094		
A-D Test Statistic	0.224	Nonparametric Statistics	
5% A-D Critical Value	0.663	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.663	Mean	0.34
5% K-S Critical Value	0.4	SD	0.47
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.115
		95% KM (t) UCL	0.535
Assuming Gamma Distribution		95% KM (z) UCL	0.529
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.573
Minimum	0.000001	95% KM (bootstrap t) UCL	0.567
Maximum	2.423	95% KM (BCA) UCL	N/A
Mean	0.133	95% KM (Percentile Bootstrap) UCL	1.009
Median	0.000001	95% KM (Chebyshev) UCL	0.841
SD	0.47	97.5% KM (Chebyshev) UCL	1.058
k star	0.0969	99% KM (Chebyshev) UCL	1.484
Theta star	1.373		
Nu star	5.814	Potential UCLs to Use	
AppChi2	1.546	95% KM (t) UCL	0.535
95% Gamma Approximate UCL	0.5	95% KM (Percentile Bootstrap) UCL	1.009
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Chlordane

General Statistics

Number of Valid Data	22	Number of Detected Data	13
Number of Distinct Detected Data	13	Number of Non-Detect Data	9
Number of Missing Values	5	Percent Non-Detects	40.91%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	5.8	Minimum Detected	1.758
Maximum Detected	540	Maximum Detected	6.292
Mean of Detected	114.6	Mean of Detected	3.915
SD of Detected	173.1	SD of Detected	1.338
Minimum Non-Detect	3	Minimum Non-Detect	1.099
Maximum Non-Detect	31	Maximum Non-Detect	3.434
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	13
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	9
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	59.09%

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.608	Shapiro Wilk Test Statistic	0.934
5% Shapiro Wilk Critical Value	0.866	5% Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	70.25	Mean	2.927
SD	141.8	SD	1.667
95% DL/2 (t) UCL	122.3	95% H-Stat (DL/2) UCL	279.2
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	2.718
		SD in Log Scale	1.805
		Mean in Original Scale	68.92
		SD in Original Scale	142.5
		95% t UCL	121.2
		95% Percentile Bootstrap UCL	121.6
		95% BCA Bootstrap UCL	136.7
		95% H-UCL	352.2
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.611	Data Follow Appr. Gamma Distribution at 5% Significance Level	
Theta Star	187.6		

nu star	15.88		
A-D Test Statistic	0.836	**Nonparametric Statistics**	
5% A-D Critical Value	0.772	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.772	Mean	70.28
5% K-S Critical Value	0.246	SD	138.6
Data follow Appr. Gamma Distribution at 5% Significance Level		SE of Mean	30.75
		95% KM (t) UCL	123.2
Assuming Gamma Distribution		95% KM (z) UCL	120.9
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	122.2
Minimum	0.000001	95% KM (bootstrap t) UCL	299.9
Maximum	540	95% KM (BCA) UCL	127.7
Mean	67.74	95% KM (Percentile Bootstrap) UCL	127.1
Median	15.05	95% KM (Chebyshev) UCL	204.3
SD	143	97.5% KM (Chebyshev) UCL	262.3
k star	0.122	99% KM (Chebyshev) UCL	376.2
Theta star	553.4		
Nu star	5.385	**Potential UCLs to Use**	
AppChi2	1.334	95% KM (BCA) UCL	127.7
95% Gamma Approximate UCL	273.4		
95% Adjusted Gamma UCL	306.2		
Note: DL/2 is not a recommended method.			

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Data Sets with Non-Detects
User Selected Options	
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Soil TotAroclor

General Statistics			
Number of Valid Data	31	Number of Detected Data	19
Number of Distinct Detected Data	19	Number of Non-Detect Data	12
		Percent Non-Detects	38.71%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	7.7	Minimum Detected	2.041
Maximum Detected	637.8	Maximum Detected	6.458
Mean of Detected	188.5	Mean of Detected	4.837
SD of Detected	169.9	SD of Detected	1.022
Minimum Non-Detect	3.1	Minimum Non-Detect	1.131
Maximum Non-Detect	410	Maximum Non-Detect	6.016
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	29
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	93.55%

UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.822	Shapiro Wilk Test Statistic	0.941
5% Shapiro Wilk Critical Value	0.901	5% Shapiro Wilk Critical Value	0.901
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		*DL/2 Substitution Method*	
Mean	132	Mean	4.006
SD	154.2	SD	1.689
95% DL/2 (t) UCL	179.1	95% H-Stat (DL/2) UCL	642.2
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	4.161
		SD in Log Scale	1.212
		Mean in Original Scale	125.2
		SD in Original Scale	154.8
		95% t UCL	172.4
		95% Percentile Bootstrap UCL	170.3
		95% BCA Bootstrap UCL	186.8
		95% H-UCL	242.1
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.203	**Data appear Gamma Distributed at 5% Significance Level**	

Theta Star	156.7		
nu star	45.72		
A-D Test Statistic	0.327	**Nonparametric Statistics**	
5% A-D Critical Value	0.76	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.76	Mean	126.2
5% K-S Critical Value	0.203	SD	154
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	28.79
		95% KM (t) UCL	175
Assuming Gamma Distribution		95% KM (z) UCL	173.5
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	170.1
Minimum	0.000001	95% KM (bootstrap t) UCL	190.9
Maximum	637.8	95% KM (BCA) UCL	191.3
Mean	117.5	95% KM (Percentile Bootstrap) UCL	181.5
Median	55	95% KM (Chebyshev) UCL	251.6
SD	160.2	97.5% KM (Chebyshev) UCL	305.9
k star	0.138	99% KM (Chebyshev) UCL	412.6
Theta star	849.7		
Nu star	8.57	**Potential UCLs to Use**	
AppChi2	3.07	95% KM (Percentile Bootstrap) UCL	181.5
95% Gamma Approximate UCL	327.9		
95% Adjusted Gamma UCL	348.5		
Note: DL/2 is not a recommended method.			

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Full Data Sets
User Selected Options	
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Soil 1998 MamTEQ

General Statistics

Number of Valid Observations	34	Number of Distinct Observations	34

Raw Statistics		**Log-transformed Statistics**	
Minimum	1.069	Minimum of Log Data	0.0665
Maximum	6372	Maximum of Log Data	8.76
Mean	1011	Mean of log Data	5.35
Median	316	SD of log Data	2.225
SD	1633		
Std. Error of Mean	280		
Coefficient of Variation	1.614		
Skewness	2.359		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.648	Shapiro Wilk Test Statistic	0.959
Shapiro Wilk Critical Value	0.933	Shapiro Wilk Critical Value	0.933
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1485	95% H-UCL	12856
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6731
95% Adjusted-CLT UCL (Chen-1995)	1593	97.5% Chebyshev (MVUE) UCL	8770
95% Modified-t UCL (Johnson-1978)	1504	99% Chebyshev (MVUE) UCL	12774
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.399	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	2532		
MLE of Mean	1011		
MLE of Standard Deviation	1600		
nu star	27.16		
Approximate Chi Square Value (.05)	16.27	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0422	95% CLT UCL	1472
Adjusted Chi Square Value	15.86	95% Jackknife UCL	1485
		95% Standard Bootstrap UCL	1450
Anderson-Darling Test Statistic	0.373	95% Bootstrap-t UCL	1752
Anderson-Darling 5% Critical Value	0.83	95% Hall's Bootstrap UCL	1691
Kolmogorov-Smirnov Test Statistic	0.0958	95% Percentile Bootstrap UCL	1504
Kolmogorov-Smirnov 5% Critical Value	0.161	95% BCA Bootstrap UCL	1625
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2232
		97.5% Chebyshev(Mean, Sd) UCL	2760

Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3798
95% Approximate Gamma UCL	1688		
95% Adjusted Gamma UCL	1732		
Potential UCL to Use		Use 95% Adjusted Gamma UCL	1732

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Soil 2005 MamTEQ

General Statistics

Number of Valid Observations	34	Number of Distinct Observations	34

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.998	Minimum of Log Data	-0.00207
Maximum	6371	Maximum of Log Data	8.759
Mean	1010	Mean of log Data	5.332
Median	315.4	SD of log Data	2.243
SD	1633		
Std. Error of Mean	280		
Coefficient of Variation	1.617		
Skewness	2.36		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.648	Shapiro Wilk Test Statistic	0.959
Shapiro Wilk Critical Value	0.933	Shapiro Wilk Critical Value	0.933
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1484	95% H-UCL	13471
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6890
95% Adjusted-CLT UCL (Chen-1995)	1592	97.5% Chebyshev (MVUE) UCL	8982
95% Modified-t UCL (Johnson-1978)	1503	99% Chebyshev (MVUE) UCL	13092
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.396	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	2551		
MLE of Mean	1010		
MLE of Standard Deviation	1605		
nu star	26.93		
Approximate Chi Square Value (.05)	16.09	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0422	95% CLT UCL	1471
Adjusted Chi Square Value	15.68	95% Jackknife UCL	1484
		95% Standard Bootstrap UCL	1463
Anderson-Darling Test Statistic	0.375	95% Bootstrap-t UCL	1782
Anderson-Darling 5% Critical Value	0.831	95% Hall's Bootstrap UCL	1700
Kolmogorov-Smirnov Test Statistic	0.0933	95% Percentile Bootstrap UCL	1513

Kolmogorov-Smirnov 5% Critical Value	0.161	95% BCA Bootstrap UCL	1584
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2231
		97.5% Chebyshev(Mean, Sd) UCL	2759
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3796
95% Approximate Gamma UCL	1690		
95% Adjusted Gamma UCL	1734		
Potential UCL to Use		Use 95% Adjusted Gamma UCL	1734

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Soil Avian TEQ

General Statistics

Number of Valid Observations	34	Number of Distinct Observations	34
Raw Statistics		**Log-transformed Statistics**	
Minimum	1.094	Minimum of Log Data	0.0895
Maximum	6379	Maximum of Log Data	8.761
Mean	1022	Mean of log Data	5.437
Median	344.5	SD of log Data	2.161
SD	1632		
Std. Error of Mean	279.9		
Coefficient of Variation	1.596		
Skewness	2.356		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.65	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.933	Shapiro Wilk Critical Value	0.933
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	1496	95% H-UCL	11208
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	6357
95% Adjusted-CLT UCL (Chen-1995)	1604	97.5% Chebyshev (MVUE) UCL	8262
95% Modified-t UCL (Johnson-1978)	1515	99% Chebyshev (MVUE) UCL	12005
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.416	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	2456		
MLE of Mean	1022		
MLE of Standard Deviation	1585		
nu star	28.3		
Approximate Chi Square Value (.05)	17.16	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0422	95% CLT UCL	1483
Adjusted Chi Square Value	16.73	95% Jackknife UCL	1496
		95% Standard Bootstrap UCL	1474

Anderson-Darling Test Statistic	0.345	95% Bootstrap-t UCL	1735
Anderson-Darling 5% Critical Value	0.826	95% Hall's Bootstrap UCL	1696
Kolmogorov-Smirnov Test Statistic	0.0974	95% Percentile Bootstrap UCL	1498
Kolmogorov-Smirnov 5% Critical Value	0.161	95% BCA Bootstrap UCL	1591
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	2242
		97.5% Chebyshev(Mean, Sd) UCL	2770
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	3807
95% Approximate Gamma UCL	1686		
95% Adjusted Gamma UCL	1729		
Potential UCL to Use		Use 95% Adjusted Gamma UCL	1729

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

	General UCL Statistics for Data Sets with Non-Detects
User Selected Options	
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Al

General Statistics			
Number of Valid Observations	10	Number of Distinct Observations	10
Number of Missing Values	21		

Raw Statistics		Log-transformed Statistics	
Minimum	3520	Minimum of Log Data	8.166
Maximum	14791	Maximum of Log Data	9.602
Mean	8722	Mean of log Data	8.953
Median	8500	SD of log Data	0.536
SD	4210		
Std. Error of Mean	1331		
Coefficient of Variation	0.483		
Skewness	0.125		

Relevant UCL Statistics			
Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.901	Shapiro Wilk Test Statistic	0.897
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Critical Value	0.842
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	11163	95% H-UCL	13387
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	15401
95% Adjusted-CLT UCL (Chen-1995)	10968	97.5% Chebyshev (MVUE) UCL	18264
95% Modified-t UCL (Johnson-1978)	11172	99% Chebyshev (MVUE) UCL	23888
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	3.085	**Data appear Normal at 5% Significance Level**	
Theta Star	2827		
MLE of Mean	8722		
MLE of Standard Deviation	4966		
nu star	61.7		
Approximate Chi Square Value (.05)	44.64	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0267	95% CLT UCL	10912
Adjusted Chi Square Value	42.13	95% Jackknife UCL	11163
		95% Standard Bootstrap UCL	10772
Anderson-Darling Test Statistic	0.481	95% Bootstrap-t UCL	11229
Anderson-Darling 5% Critical Value	0.729	95% Hall's Bootstrap UCL	10647
Kolmogorov-Smirnov Test Statistic	0.204	95% Percentile Bootstrap UCL	10830
Kolmogorov-Smirnov 5% Critical Value	0.268	95% BCA Bootstrap UCL	10827
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	14526

		97.5% Chebyshev(Mean, Sd) UCL	17037
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	21970
95% Approximate Gamma UCL	12057		
95% Adjusted Gamma UCL	12776		
Potential UCL to Use		Use 95% Student's-t UCL	11163

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Sb

General Statistics

Number of Valid Data	30	Number of Detected Data	22
Number of Distinct Detected Data	22	Number of Non-Detect Data	8
Number of Missing Values	1	Percent Non-Detects	26.67%

Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.131	Minimum Detected	-2.033
Maximum Detected	38.2	Maximum Detected	3.643
Mean of Detected	2.712	Mean of Detected	-0.225
SD of Detected	7.986	SD of Detected	1.272
Minimum Non-Detect	0.089	Minimum Non-Detect	-2.419
Maximum Non-Detect	1.3	Maximum Non-Detect	0.262
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	23
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	7
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	76.67%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.312	Shapiro Wilk Test Statistic	0.904
5% Shapiro Wilk Critical Value	0.911	5% Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	2.078	Mean	-0.583
SD	6.881	SD	1.37
95% DL/2 (t) UCL	4.213	95% H-Stat (DL/2) UCL	3.039
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.681
		SD in Log Scale	1.407
		Mean in Original Scale	2.043
		SD in Original Scale	6.889
		95% t UCL	4.18
		95% Percentile Bootstrap UCL	4.446
		95% BCA Bootstrap UCL	6.214

		95% H-UCL	3.003
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.477	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	5.69		
nu star	20.97		
A-D Test Statistic	2.436	**Nonparametric Statistics**	
5% A-D Critical Value	0.803	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.803	Mean	2.063
5% K-S Critical Value	0.196	SD	6.769
Data not Gamma Distributed at 5% Significance Level		SE of Mean	1.265
		95% KM (t) UCL	4.212
Assuming Gamma Distribution		95% KM (z) UCL	4.143
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	4.189
Minimum	0.000001	95% KM (bootstrap t) UCL	16.21
Maximum	38.2	95% KM (BCA) UCL	4.697
Mean	2.01	95% KM (Percentile Bootstrap) UCL	4.464
Median	0.475	95% KM (Chebyshev) UCL	7.577
SD	6.899	97.5% KM (Chebyshev) UCL	9.963
k star	0.186	99% KM (Chebyshev) UCL	14.65
Theta star	10.8		
Nu star	11.16	**Potential UCLs to Use**	
AppChi2	4.681	97.5% KM (Chebyshev) UCL	9.963
95% Gamma Approximate UCL	4.792		
95% Adjusted Gamma UCL	5.052		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

As

General Statistics

Number of Valid Observations	30	Number of Distinct Observations	29
Number of Missing Values	1		

Raw Statistics		***Log-transformed Statistics***	
Minimum	1.2	Minimum of Log Data	0.182
Maximum	55.6	Maximum of Log Data	4.018
Mean	7.929	Mean of log Data	1.796
Median	5.875	SD of log Data	0.661
SD	9.489		
Std. Error of Mean	1.732		
Coefficient of Variation	1.197		
Skewness	4.652		

Relevant UCL Statistics

Normal Distribution Test	**Lognormal Distribution Test**

Shapiro Wilk Test Statistic	0.464	Shapiro Wilk Test Statistic	0.928
Shapiro Wilk Critical Value	0.927	Shapiro Wilk Critical Value	0.927
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	10.87	95% H-UCL	9.693
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	11.62
95% Adjusted-CLT UCL (Chen-1995)	12.35	97.5% Chebyshev (MVUE) UCL	13.44
95% Modified-t UCL (Johnson-1978)	11.12	99% Chebyshev (MVUE) UCL	17.01
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.796	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	4.416		
MLE of Mean	7.929		
MLE of Standard Deviation	5.917		
nu star	107.7		
Approximate Chi Square Value (.05)	84.78	**Nonparametric Statistics**	
Adjusted Level of Significance	0.041	95% CLT UCL	10.78
Adjusted Chi Square Value	83.6	95% Jackknife UCL	10.87
		95% Standard Bootstrap UCL	10.69
Anderson-Darling Test Statistic	1.584	95% Bootstrap-t UCL	16.09
Anderson-Darling 5% Critical Value	0.759	95% Hall's Bootstrap UCL	21.79
Kolmogorov-Smirnov Test Statistic	0.161	95% Percentile Bootstrap UCL	11.2
Kolmogorov-Smirnov 5% Critical Value	0.162	95% BCA Bootstrap UCL	13.1
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	15.48
		97.5% Chebyshev(Mean, Sd) UCL	18.75
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	25.17
95% Approximate Gamma UCL	10.08		
95% Adjusted Gamma UCL	10.22		
Potential UCL to Use		Use 95% Approximate Gamma UCL	10.08

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Cd

General Statistics			
Number of Valid Data	30	Number of Detected Data	25
Number of Distinct Detected Data	23	Number of Non-Detect Data	5
Number of Missing Values	1	Percent Non-Detects	16.67%
Raw Statistics		**Log-transformed Statistics**	
Minimum Detected	0.04	Minimum Detected	-3.219
Maximum Detected	5	Maximum Detected	1.609
Mean of Detected	0.924	Mean of Detected	-0.815
SD of Detected	1.217	SD of Detected	1.291
Minimum Non-Detect	0.04	Minimum Non-Detect	-3.219
Maximum Non-Detect	0.27	Maximum Non-Detect	-1.309

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	14
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	16
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	46.67%
UCL Statistics			
Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.706	Shapiro Wilk Test Statistic	0.978
5% Shapiro Wilk Critical Value	0.918	5% Shapiro Wilk Critical Value	0.918
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.782	Mean	-1.16
SD	1.153	SD	1.446
95% DL/2 (t) UCL	1.14	95% H-Stat (DL/2) UCL	2.041
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	0.208	Mean in Log Scale	-1.192
SD	1.716	SD in Log Scale	1.481
95% MLE (t) UCL	0.74	Mean in Original Scale	0.779
95% MLE (Tiku) UCL	0.844	SD in Original Scale	1.155
		95% t UCL	1.138
		95% Percentile Bootstrap UCL	1.158
		95% BCA Bootstrap UCL	1.274
		95% H UCL	2.153
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.735	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1.257		
nu star	36.77		
A-D Test Statistic	0.467	**Nonparametric Statistics**	
5% A-D Critical Value	0.781	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.781	Mean	0.782
5% K-S Critical Value	0.181	SD	1.134
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.211
		95% KM (t) UCL	1.141
Assuming Gamma Distribution		95% KM (z) UCL	1.129
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.137
Minimum	0.000001	95% KM (bootstrap t) UCL	1.373
Maximum	5	95% KM (BCA) UCL	1.141
Mean	0.77	95% KM (Percentile Bootstrap) UCL	1.136
Median	0.305	95% KM (Chebyshev) UCL	1.703
SD	1.161	97.5% KM (Chebyshev) UCL	2.102
k star	0.256	99% KM (Chebyshev) UCL	2.885
Theta star	3.01		
Nu star	15.35	**Potential UCLs to Use**	
AppChi2	7.503	95% KM (Chebyshev) UCL	1.703
95% Gamma Approximate UCL	1.575		
95% Adjusted Gamma UCL	1.644		
Note: DL/2 is not a recommended method.			

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Cr

General Statistics

Number of Valid Data	30	Number of Detected Data	29
Number of Distinct Detected Data	29	Number of Non-Detect Data	1
Number of Missing Values	1	Percent Non-Detects	3.33%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	4.9	Minimum Detected	1.589
Maximum Detected	52.6	Maximum Detected	3.963
Mean of Detected	24.46	Mean of Detected	3.02
SD of Detected	14.23	SD of Detected	0.632
Minimum Non-Detect	27.2	Minimum Non-Detect	3.303
Maximum Non-Detect	27.2	Maximum Non-Detect	3.303

UCL Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.904	Shapiro Wilk Test Statistic	0.955
5% Shapiro Wilk Critical Value	0.926	5% Shapiro Wilk Critical Value	0.926
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	24.1	Mean	3.006
SD	14.12	SD	0.625
95% DL/2 (t) UCL	28.48	95% H-Stat (DL/2) UCL	31.22
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	21.53	Mean in Log Scale	3.009
SD	17.79	SD in Log Scale	0.624
95% MLE (t) UCL	27.04	Mean in Original Scale	24.13
95% MLE (Tiku) UCL	29.76	SD in Original Scale	14.1
		95% t UCL	28.5
		95% Percentile Bootstrap UCL	28.32
		95% BCA Bootstrap UCL	28.79
		95% H UCL	31.25

Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	2.692	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	9.084		
nu star	156.1		
A-D Test Statistic	0.415	**Nonparametric Statistics**	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	

K-S Test Statistic	0.753	Mean	24.14
5% K-S Critical Value	0.164	SD	13.89
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	2.586
		95% KM (t) UCL	28.53
Assuming Gamma Distribution		95% KM (z) UCL	28.39
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	28.53
Minimum	4.9	95% KM (bootstrap t) UCL	29.14
Maximum	52.6	95% KM (BCA) UCL	28.31
Mean	24.26	95% KM (Percentile Bootstrap) UCL	28.44
Median	18.68	95% KM (Chebyshev) UCL	35.41
SD	14.02	97.5% KM (Chebyshev) UCL	40.29
k star	2.772	99% KM (Chebyshev) UCL	49.87
Theta star	8.752		
Nu star	166.3	**Potential UCLs to Use**	
AppChi2	137.5	95% KM (BCA) UCL	28.31
95% Gamma Approximate UCL	29.34		
95% Adjusted Gamma UCL	29.67		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Cu

General Statistics

Number of Valid Observations	30	Number of Distinct Observations	29
Number of Missing Values	1		

Raw Statistics		**Log-transformed Statistics**	
Minimum	6.2	Minimum of Log Data	1.825
Maximum	2350	Maximum of Log Data	7.762
Mean	123.1	Mean of log Data	3.649
Median	33.15	SD of log Data	1.108
SD	423.2		
Std. Error of Mean	77.26		
Coefficient of Variation	3.439		
Skewness	5.375		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.255	Shapiro Wilk Test Statistic	0.868
Shapiro Wilk Critical Value	0.927	Shapiro Wilk Critical Value	0.927
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	254.3	95% H-UCL	121.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	140
95% Adjusted-CLT UCL (Chen-1995)	331.2	97.5% Chebyshev (MVUE) UCL	170.8
95% Modified-t UCL (Johnson-1978)	267	99% Chebyshev (MVUE) UCL	231.4

Gamma Distribution Test		Data Distribution	
k star (bias corrected)	0.508	Data do not follow a Discernable Distribution (0.05)	
Theta Star	242.4		
MLE of Mean	123.1		
MLE of Standard Deviation	172.7		
nu star	30.46		
Approximate Chi Square Value (.05)	18.85	Nonparametric Statistics	
Adjusted Level of Significance	0.041	95% CLT UCL	250.2
Adjusted Chi Square Value	18.33	95% Jackknife UCL	254.3
		95% Standard Bootstrap UCL	246.3
Anderson-Darling Test Statistic	4.459	95% Bootstrap-t UCL	1580
Anderson-Darling 5% Critical Value	0.806	95% Hall's Bootstrap UCL	768.7
Kolmogorov-Smirnov Test Statistic	0.319	95% Percentile Bootstrap UCL	275.4
Kolmogorov-Smirnov 5% Critical Value	0.169	95% BCA Bootstrap UCL	358.2
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	459.8
		97.5% Chebyshev(Mean, Sd) UCL	605.6
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	891.8
95% Approximate Gamma UCL	198.8		
95% Adjusted Gamma UCL	204.5		
Potential UCL to Use		Use 95% Chebyshev (Mean, Sd) UCL	459.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Pb

General Statistics			
Number of Valid Observations	30	Number of Distinct Observations	29
Number of Missing Values	1		
Raw Statistics		Log-transformed Statistics	
Minimum	25	Minimum of Log Data	3.219
Maximum	2460	Maximum of Log Data	7.808
Mean	234.4	Mean of log Data	4.906
Median	134.5	SD of log Data	0.932
SD	434.7		
Std. Error of Mean	79.37		
Coefficient of Variation	1.854		
Skewness	4.938		
Relevant UCL Statistics			
Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.394	Shapiro Wilk Test Statistic	0.95
Shapiro Wilk Critical Value	0.927	Shapiro Wilk Critical Value	0.927
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	

95% Student's-t UCL	369.3	95% H-UCL	315.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	376.3
95% Adjusted-CLT UCL (Chen-1995)	441.4	97.5% Chebyshev (MVUE) UCL	450.6
95% Modified-t UCL (Johnson-1978)	381.2	99% Chebyshev (MVUE) UCL	596.6
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	0.96	**Data appear Lognormal at 5% Significance Level**	
Theta Star	244.1		
MLE of Mean	234.4		
MLE of Standard Deviation	239.2		
nu star	57.62		
Approximate Chi Square Value (.05)	41.17	**Nonparametric Statistics**	
Adjusted Level of Significance	0.041	95% CLT UCL	365
Adjusted Chi Square Value	40.37	95% Jackknife UCL	369.3
		95% Standard Bootstrap UCL	359.7
Anderson-Darling Test Statistic	1.601	95% Bootstrap-t UCL	709.1
Anderson-Darling 5% Critical Value	0.774	95% Hall's Bootstrap UCL	862.3
Kolmogorov-Smirnov Test Statistic	0.185	95% Percentile Bootstrap UCL	379.1
Kolmogorov-Smirnov 5% Critical Value	0.165	95% BCA Bootstrap UCL	472.6
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	580.4
		97.5% Chebyshev(Mean, Sd) UCL	730.1
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1024
95% Approximate Gamma UCL	328.1		
95% Adjusted Gamma UCL	334.6		
Potential UCL to Use		Use 95% H-UCL	315.6

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Mn

General Statistics			
Number of Valid Observations	30	Number of Distinct Observations	29
Number of Missing Values	1		
Raw Statistics		**Log-transformed Statistics**	
Minimum	65.7	Minimum of Log Data	4.185
Maximum	2440	Maximum of Log Data	7.8
Mean	637.5	Mean of log Data	6.124
Median	457	SD of log Data	0.861
SD	538.4		
Std. Error of Mean	98.29		
Coefficient of Variation	0.844		

Skewness	1.637		

Relevant UCL Statistics

Normal Distribution Test		Lognormal Distribution Test	
Shapiro Wilk Test Statistic	0.839	Shapiro Wilk Test Statistic	0.974
Shapiro Wilk Critical Value	0.927	Shapiro Wilk Critical Value	0.927
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	804.5	95% H-UCL	956.6
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	1148
95% Adjusted-CLT UCL (Chen-1995)	830.6	97.5% Chebyshev (MVUE) UCL	1364
95% Modified-t UCL (Johnson-1978)	809.4	99% Chebyshev (MVUE) UCL	1787
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.502	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	424.5		
MLE of Mean	637.5		
MLE of Standard Deviation	520.2		
nu star	90.1		
Approximate Chi Square Value (.05)	69.21	**Nonparametric Statistics**	
Adjusted Level of Significance	0.041	95% CLT UCL	799.2
Adjusted Chi Square Value	68.16	95% Jackknife UCL	804.5
		95% Standard Bootstrap UCL	793.6
Anderson-Darling Test Statistic	0.439	95% Bootstrap-t UCL	839.7
Anderson-Darling 5% Critical Value	0.762	95% Hall's Bootstrap UCL	882.6
Kolmogorov-Smirnov Test Statistic	0.125	95% Percentile Bootstrap UCL	805.6
Kolmogorov-Smirnov 5% Critical Value	0.163	95% BCA Bootstrap UCL	832.1
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	1066
		97.5% Chebyshev(Mean, Sd) UCL	1251
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1615
95% Approximate Gamma UCL	829.9		
95% Adjusted Gamma UCL	842.7		
Potential UCL to Use		Use 95% Approximate Gamma UCL	829.9

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Hg

General Statistics

Number of Valid Data	10	Number of Detected Data	6
Number of Distinct Detected Data	5	Number of Non-Detect Data	4
Number of Missing Values	21	Percent Non-Detects	40.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.1	Minimum Detected	-2.303
Maximum Detected	1	Maximum Detected	0

Mean of Detected	0.288	Mean of Detected	-1.631
SD of Detected	0.351	SD of Detected	0.836
Minimum Non-Detect	0.12	Minimum Non-Detect	-2.12
Maximum Non-Detect	0.18	Maximum Non-Detect	-1.715
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	8
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	80.00%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set

the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.592	Shapiro Wilk Test Statistic	0.762
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788
Data not Normal at 5% Significance Level		**Data not Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.201	Mean	-2.048
SD	0.285	SD	0.831
95% DL/2 (t) UCL	0.366	95% H-Stat (DL/2) UCL	0.392
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-1.973
		SD in Log Scale	0.783
		Mean in Original Scale	0.207
		SD in Original Scale	0.282
		95% t UCL	0.371
		95% Percentile Bootstrap UCL	0.38
		95% BCA Bootstrap UCL	0.469
		95% H-UCL	0.38
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	0.83	**Data do not follow a Discernable Distribution (0.05)**	
Theta Star	0.347		
nu star	9.96		
A-D Test Statistic	0.993	**Nonparametric Statistics**	
5% A-D Critical Value	0.709	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.709	Mean	0.216
5% K-S Critical Value	0.338	SD	0.263
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.0913
		95% KM (t) UCL	0.383
Assuming Gamma Distribution		95% KM (z) UCL	0.366
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.371

Minimum	0.000001	95% KM (bootstrap t) UCL	1.443
Maximum	1	95% KM (BCA) UCL	0.407
Mean	0.184	95% KM (Percentile Bootstrap) UCL	0.387
Median	0.115	95% KM (Chebyshev) UCL	0.614
SD	0.295	97.5% KM (Chebyshev) UCL	0.786
k star	0.253	99% KM (Chebyshev) UCL	1.124
Theta star	0.728		
Nu star	5.062	**Potential UCLs to Use**	
AppChi2	1.181	95% KM (t) UCL	0.383
95% Gamma Approximate UCL	0.789	95% KM (% Bootstrap) UCL	0.387
95% Adjusted Gamma UCL	1.047		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Mo

General Statistics

Number of Valid Observations	22	Number of Distinct Observations	22
Number of Missing Values	8		

Raw Statistics		**Log-transformed Statistics**	
Minimum	0.53	Minimum of Log Data	-0.635
Maximum	11.08	Maximum of Log Data	2.405
Mean	3.264	Mean of log Data	0.935
Median	2.325	SD of log Data	0.729
SD	2.477		
Std. Error of Mean	0.528		
Coefficient of Variation	0.759		
Skewness	1.673		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.843	Shapiro Wilk Test Statistic	0.985
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	4.172	95% H-UCL	4.74
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	5.658
95% Adjusted-CLT UCL (Chen-1995)	4.334	97.5% Chebyshev (MVUE) UCL	6.69
95% Modified-t UCL (Johnson-1978)	4.204	99% Chebyshev (MVUE) UCL	8.717
Gamma Distribution Test		**Data Distribution**	
k star (bias corrected)	1.903	**Data appear Gamma Distributed at 5% Significance Level**	
Theta Star	1.715		
MLE of Mean	3.264		
MLE of Standard Deviation	2.366		

nu star	83.71		
Approximate Chi Square Value (.05)	63.63	**Nonparametric Statistics**	
Adjusted Level of Significance	0.0386	95% CLT UCL	4.132
Adjusted Chi Square Value	62.32	95% Jackknife UCL	4.172
		95% Standard Bootstrap UCL	4.091
Anderson-Darling Test Statistic	0.331	95% Bootstrap-t UCL	4.488
Anderson-Darling 5% Critical Value	0.755	95% Hall's Bootstrap UCL	4.753
Kolmogorov-Smirnov Test Statistic	0.13	95% Percentile Bootstrap UCL	4.195
Kolmogorov-Smirnov 5% Critical Value	0.188	95% BCA Bootstrap UCL	4.371
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	5.565
		97.5% Chebyshev(Mean, Sd) UCL	6.561
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	8.517
95% Approximate Gamma UCL	4.294		
95% Adjusted Gamma UCL	4.384		
Potential UCL to Use		Use 95% Approximate Gamma UCL	4.294

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Ni

General Statistics

Number of Valid Observations	30	Number of Distinct Observations	28
Number of Missing Values	1		

Raw Statistics		**Log-transformed Statistics**	
Minimum	2.57	Minimum of Log Data	0.944
Maximum	148	Maximum of Log Data	4.997
Mean	18.75	Mean of log Data	2.5
Median	10.85	SD of log Data	0.844
SD	26.68		
Std. Error of Mean	4.871		
Coefficient of Variation	1.423		
Skewness	4.214		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.51	Shapiro Wilk Test Statistic	0.961
Shapiro Wilk Critical Value	0.927	Shapiro Wilk Critical Value	0.927
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	27.03	95% H-UCL	24.91
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	29.93
95% Adjusted-CLT UCL (Chen-1995)	30.77	97.5% Chebyshev (MVUE) UCL	35.47
95% Modified-t UCL (Johnson-1978)	27.66	99% Chebyshev (MVUE) UCL	46.35
Gamma Distribution Test		**Data Distribution**	

k star (bias corrected)	1.192	Data appear Lognormal at 5% Significance Level	
Theta Star	15.74		
MLE of Mean	18.75		
MLE of Standard Deviation	17.18		
nu star	71.51		
Approximate Chi Square Value (.05)	53.04	Nonparametric Statistics	
Adjusted Level of Significance	0.041	95% CLT UCL	26.77
Adjusted Chi Square Value	52.12	95% Jackknife UCL	27.03
		95% Standard Bootstrap UCL	26.73
Anderson-Darling Test Statistic	1.333	95% Bootstrap-t UCL	38.35
Anderson-Darling 5% Critical Value	0.768	95% Hall's Bootstrap UCL	57.81
Kolmogorov-Smirnov Test Statistic	0.195	95% Percentile Bootstrap UCL	27.1
Kolmogorov-Smirnov 5% Critical Value	0.164	95% BCA Bootstrap UCL	32.88
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	39.99
		97.5% Chebyshev(Mean, Sd) UCL	49.17
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	67.22
95% Approximate Gamma UCL	25.28		
95% Adjusted Gamma UCL	25.73		
Potential UCL to Use		Use 95% H-UCL	24.91

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)

and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

Se

General Statistics

Number of Valid Data	30	Number of Detected Data	21
Number of Distinct Detected Data	15	Number of Non-Detect Data	9
Number of Missing Values	1	Percent Non-Detects	30.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.1	Minimum Detected	-2.303
Maximum Detected	4.5	Maximum Detected	1.504
Mean of Detected	1.087	Mean of Detected	-0.171
SD of Detected	0.931	SD of Detected	0.745
Minimum Non-Detect	0.1	Minimum Non-Detect	-2.303
Maximum Non-Detect	1.8	Maximum Non-Detect	0.588
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	28
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	2
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	93.33%

UCL Statistics

Normal Distribution Test with Detected Values Only		**Lognormal Distribution Test with Detected Values Only**	
Shapiro Wilk Test Statistic	0.695	Shapiro Wilk Test Statistic	0.915
5% Shapiro Wilk Critical Value	0.908	5% Shapiro Wilk Critical Value	0.908
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.9	Mean	-0.417
SD	0.837	SD	0.856
95% DL/2 (t) UCL	1.16	95% H-Stat (DL/2) UCL	1.371
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-0.395
		SD in Log Scale	0.755
		Mean in Original Scale	0.892
		SD in Original Scale	0.836
		95% t UCL	1.151
		95% Percentile Bootstrap UCL	1.153
		95% BCA Bootstrap UCL	1.249
		95% H-UCL	1.218
Gamma Distribution Test with Detected Values Only		**Data Distribution Test with Detected Values Only**	
k star (bias corrected)	1.848	**Data appear Lognormal at 5% Significance Level**	
Theta Star	0.588		
nu star	77.63		
A-D Test Statistic	0.822	**Nonparametric Statistics**	
5% A-D Critical Value	0.753	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.753	Mean	0.902
5% K-S Critical Value	0.192	SD	0.83
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.158
		95% KM (t) UCL	1.171
Assuming Gamma Distribution		95% KM (z) UCL	1.162
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.159
Minimum	0.000001	95% KM (bootstrap t) UCL	1.307
Maximum	4.5	95% KM (BCA) UCL	1.207
Mean	0.897	95% KM (Percentile Bootstrap) UCL	1.192
Median	0.717	95% KM (Chebyshev) UCL	1.592
SD	0.852	97.5% KM (Chebyshev) UCL	1.891
k star	0.514	99% KM (Chebyshev) UCL	2.478
Theta star	1.743		
Nu star	30.86	**Potential UCLs to Use**	
AppChi2	19.17	95% KM (BCA) UCL	1.207
95% Gamma Approximate UCL	1.443		
95% Adjusted Gamma UCL	1.484		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

For additional insight, the user may want to consult a statistician.

Ag

General Statistics			
Number of Valid Data	30	Number of Detected Data	15
Number of Distinct Detected Data	11	Number of Non-Detect Data	15
Number of Missing Values	1	Percent Non-Detects	50.00%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	0.2	Minimum Detected	-1.609
Maximum Detected	5.7	Maximum Detected	1.74
Mean of Detected	1.396	Mean of Detected	-0.449
SD of Detected	1.913	SD of Detected	1.22
Minimum Non-Detect	0.2	Minimum Non-Detect	-1.609
Maximum Non-Detect	2.7	Maximum Non-Detect	0.993
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	27
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	3
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	90.00%

UCL Statistics			
Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Shapiro Wilk Test Statistic	0.664	Shapiro Wilk Test Statistic	0.798
5% Shapiro Wilk Critical Value	0.881	5% Shapiro Wilk Critical Value	0.881
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	
Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.837	Mean	-1.067
SD	1.463	SD	1.208
95% DL/2 (t) UCL	1.291	95% H-Stat (DL/2) UCL	1.322
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-1.638
		SD in Log Scale	1.607
		Mean in Original Scale	0.738
		SD in Original Scale	1.489
		95% t UCL	1.199
		95% Percentile Bootstrap UCL	1.228
		95% BCA Bootstrap UCL	1.407
		95% H-UCL	1.908
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.655	Data do not follow a Discernable Distribution (0.05)	
Theta Star	2.131		
nu star	19.66		
A-D Test Statistic	1.737	Nonparametric Statistics	
5% A-D Critical Value	0.774	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.774	Mean	0.812
5% K-S Critical Value	0.23	SD	1.434

Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.271
		95% KM (t) UCL	1.273
Assuming Gamma Distribution		95% KM (z) UCL	1.259
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	1.265
Minimum	0.000001	95% KM (bootstrap t) UCL	1.705
Maximum	5.7	95% KM (BCA) UCL	1.313
Mean	0.698	95% KM (Percentile Bootstrap) UCL	1.267
Median	0.1	95% KM (Chebyshev) UCL	1.995
SD	1.507	97.5% KM (Chebyshev) UCL	2.507
k star	0.128	99% KM (Chebyshev) UCL	3.512
Theta star	5.457		
Nu star	7.675	**Potential UCLs to Use**	
AppChi2	2.548	95% KM (BCA) UCL	1.313
95% Gamma Approximate UCL	2.102		
95% Adjusted Gamma UCL	2.25		

Note: DL/2 is not a recommended method.

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
For additional insight, the user may want to consult a statistician.

Zn

General Statistics

Number of Valid Observations	30	Number of Distinct Observations	29
Number of Missing Values	1		

Raw Statistics		**Log-transformed Statistics**	
Minimum	16	Minimum of Log Data	2.773
Maximum	808	Maximum of Log Data	6.695
Mean	155.1	Mean of log Data	4.619
Median	91.5	SD of log Data	0.909
SD	175.1		
Std. Error of Mean	31.96		
Coefficient of Variation	1.128		
Skewness	2.518		

Relevant UCL Statistics

Normal Distribution Test		**Lognormal Distribution Test**	
Shapiro Wilk Test Statistic	0.686	Shapiro Wilk Test Statistic	0.981
Shapiro Wilk Critical Value	0.927	Shapiro Wilk Critical Value	0.927
Data not Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	
Assuming Normal Distribution		**Assuming Lognormal Distribution**	
95% Student's-t UCL	209.4	95% H-UCL	228.5
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	273.2
95% Adjusted-CLT UCL (Chen-1995)	223.4	97.5% Chebyshev (MVUE) UCL	326.3
95% Modified-t UCL (Johnson-1978)	211.9	99% Chebyshev (MVUE) UCL	430.6
Gamma Distribution Test		**Data Distribution**	

k star (bias corrected)	1.209	**Data Follow Appr. Gamma Distribution at 5% Significance Level**	
Theta Star	128.3		
MLE of Mean	155.1		
MLE of Standard Deviation	141.1		
nu star	72.55		
Approximate Chi Square Value (.05)	53.93	**Nonparametric Statistics**	
Adjusted Level of Significance	0.041	95% CLT UCL	207.7
Adjusted Chi Square Value	53.01	95% Jackknife UCL	209.4
		95% Standard Bootstrap UCL	205.6
Anderson-Darling Test Statistic	0.849	95% Bootstrap-t UCL	245.6
Anderson-Darling 5% Critical Value	0.768	95% Hall's Bootstrap UCL	256.2
Kolmogorov-Smirnov Test Statistic	0.137	95% Percentile Bootstrap UCL	211.5
Kolmogorov-Smirnov 5% Critical Value	0.164	95% BCA Bootstrap UCL	218.2
Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	294.5
		97.5% Chebyshev(Mean, Sd) UCL	354.7
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	473.1
95% Approximate Gamma UCL	208.7		
95% Adjusted Gamma UCL	212.3		
Potential UCL to Use		Use 95% Approximate Gamma UCL	208.7

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL. These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002) and Singh and Singh (2003). For additional insight, the user may want to consult a statistician.

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APPENDIX E

Food Web Exposure Models

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TABLE E.1-1

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surface Soil (0-2 feet) / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Woodcock

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		SOIL INTAKE-INGESTION
	C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
	IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.012	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Gregg, 1984	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.20	USEPA, 1993	

REFERENCES

Gregg, L., 1984. Population ecology of woodcock in Wisconsin; Wis. Dept. Nat. Resour. Tech. Bull. No. 144; 51 pp.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE E.1-2
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surface Soil (0-2 feet) / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Woodcock

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	1.0E+01	mg/kg	6.0E-01	mg/kg-d	-	-	-	-	-
Arsenic	1.0E+01	mg/kg	6.0E-01	mg/kg-d	5.1E+00	1.3E+01	mg/kg-d	1.2E-01	4.7E-02
Cadmium	1.7E+00	mg/kg	1.0E-01	mg/kg-d	1.5E+00	2.0E+01	mg/kg-d	7.0E-02	5.1E-03
Chromium	2.8E+01	mg/kg	1.7E+00	mg/kg-d	1.0E+00	5.0E+00	mg/kg-d	**1.7E+00**	3.4E-01
Copper	4.6E+02	mg/kg	2.8E+01	mg/kg-d	4.7E+01	6.2E+01	mg/kg-d	5.9E-01	4.5E-01
Lead	3.2E+02	mg/kg	1.9E+01	mg/kg-d	3.9E+00	3.9E+01	mg/kg-d	**4.9E+00**	4.9E-01
Manganese	8.3E+02	mg/kg	5.0E+01	mg/kg-d	9.8E+02	9.8E+03	mg/kg-d	5.1E-02	5.1E-03
Mercury	3.9E-01	mg/kg	2.3E-02	mg/kg-d	4.5E-01	9.0E-01	mg/kg-d	5.2E-02	2.6E-02
Molybdenum	4.3E+00	mg/kg	2.6E-01	mg/kg-d	3.5E+00	3.5E+01	mg/kg-d	7.3E-02	7.3E-03
Nickel	2.5E+01	mg/kg	1.5E+00	mg/kg-d	7.7E+01	1.1E+02	mg/kg-d	1.9E-02	1.4E-02
Selenium	1.2E+00	mg/kg	7.2E-02	mg/kg-d	4.4E-01	1.5E+00	mg/kg-d	1.6E-01	4.8E-02
Silver	1.3E+00	mg/kg	7.9E-02	mg/kg-d	9.0E+01	9.0E+02	mg/kg-d	8.8E-04	8.8E-05
Thallium	4.5E-01	mg/kg	2.7E-02	mg/kg-d	3.5E+00	5.0E+00	mg/kg-d	7.7E-03	5.4E-03
Vanadium	2.9E+01	mg/kg	1.7E+00	mg/kg-d	1.1E+01	1.1E+02	mg/kg-d	1.5E-01	1.5E-02
Zinc	2.1E+02	mg/kg	1.3E+01	mg/kg-d	1.5E+01	1.3E+02	mg/kg-d	8.6E-01	9.6E-02
4,4'-DDD	6.0E-03	mg/kg	3.6E-04	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	1.3E-01	1.3E-02
4,4'-DDE	2.5E-01	mg/kg	1.5E-02	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	**5.3E+00**	5.3E-01
4,4'-DDT	3.3E-01	mg/kg	2.0E-02	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	**7.0E+00**	7.0E-01
Aldrina	3.4E-03	mg/kg	2.0E-04	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	1.5E-03	1.5E-04
Dieldrin	2.8E-03	mg/kg	1.7E-04	mg/kg-d	7.7E-02	7.7E-01	mg/kg-d	2.2E-03	2.2E-04
Chlordane	1.3E-01	mg/kg	7.7E-03	mg/kg-d	2.8E-01	2.8E+00	mg/kg-d	2.7E-02	2.7E-03
Lindanea	2.4E-03	mg/kg	1.5E-04	mg/kg-d	2.0E+00	2.0E+01	mg/kg-d	7.3E-05	7.3E-06
Endrin	7.7E-04	mg/kg	4.6E-05	mg/kg-d	1.0E-01	1.0E-01	mg/kg-d	4.5E-04	4.5E-04
TOTAL AROCLOR	1.8E-01	mg/kg	1.1E-02	mg/kg-d	1.1E-01	2.8E-01	mg/kg-d	9.9E-02	3.9E-02
Aroclor 1254	1.3E-01	mg/kg	7.9E-03	mg/kg-d	1.8E-01	1.8E+00	mg/kg-d	4.4E-02	4.4E-03
Aroclor 1260	9.2E-02	mg/kg	5.5E-03	mg/kg-d	1.8E-01	1.8E+00	mg/kg-d	3.1E-02	3.1E-03
Aroclor 1268a	2.5E-02	mg/kg	1.5E-03	mg/kg-d	1.1E+00	1.1E+01	mg/kg-d	1.4E-03	1.4E-04
TEQ-BIRD	1.7E-03	mg/kg	1.0E-04	mg/kg-d	1.4E-05	1.4E-04	mg/kg-d	**7.4E+00**	7.4E-01
TEQ-MAMMAL	1.7E-03	mg/kg	1.0E-04	mg/kg-d			-	-	-
							-	-	-
							HAZARD INDICES:	**2.9E+01**	**3.6E+00**

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table E.1-1.

b. Reference Dose Values presented in Table D-4 in BERA (MACTEC, 2004).

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

A dash (-) indicates not available

TABLE E.1-3

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Soil Invertebrates / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Woodcock

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		$EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.082	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	100%	USEPA, 1993; Krohn, 1970.	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Gregg, 1984	$C_{invert} = C_{soil} * BAF_{invert}$*(% tissue lipid/% soil TOC)
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	Bioaccummulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.20	USEPA, 1993	

REFERENCES

Gregg, L., 1984. Population ecology of woodcock in Wisconsin; Wis. Dept. Nat. Resour. Tech. Bull. No. 144; 51 pp.

Krohn, W.B., 1970. Woodcock feeding habits as related to summer field usage in central Maine; J. Widl. Manage. 34:769-775.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE E.1-4
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Soil Invertebrates / Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Woodcock

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	2.3E+00	mg/kg	9.2E-01	mg/kg-d	-	-	-	-	-
Arsenic	3.7E-01	mg/kg	1.5E-01	mg/kg-d	5.1E+00	1.3E+01	mg/kg-d	2.9E-02	1.2E-02
Cadmium	2.2E+00	mg/kg	9.0E-01	mg/kg-d	1.5E+00	2.0E+01	mg/kg-d	6.2E-01	4.5E-02
Chromium	7.7E-01	mg/kg	3.1E-01	mg/kg-d	1.0E+00	5.0E+00	mg/kg-d	3.1E-01	6.2E-02
Copper	1.5E+01	mg/kg	6.0E+00	mg/kg-d	4.7E+01	6.2E+01	mg/kg-d	1.3E-01	9.6E-02
Lead	1.5E+01	mg/kg	6.0E+00	mg/kg-d	3.9E+00	3.9E+01	mg/kg-d	**1.6E+00**	1.6E-01
Manganese	5.5E+01	mg/kg	2.2E+01	mg/kg-d	9.8E+02	9.8E+03	mg/kg-d	2.2E-02	2.2E-03
Mercury	2.4E-02	mg/kg	9.7E-03	mg/kg-d	4.5E-01	9.0E-01	mg/kg-d	2.1E-02	1.1E-02
Molybdenum	1.2E-01	mg/kg	4.6E-02	mg/kg-d	3.5E+00	3.5E+01	mg/kg-d	1.3E-02	1.3E-03
Nickel	1.4E+01	mg/kg	5.6E+00	mg/kg-d	7.7E+01	1.1E+02	mg/kg-d	7.2E-02	5.2E-02
Selenium	6.9E-01	mg/kg	2.7E-01	mg/kg-d	4.4E-01	1.5E+00	mg/kg-d	6.2E-01	1.8E-01
Silver	4.7E-02	mg/kg	1.9E-02	mg/kg-d	9.0E+01	9.0E+02	mg/kg-d	2.1E-04	2.1E-05
Thallium	2.6E-02	mg/kg	1.0E-02	mg/kg-d	3.5E+00	5.0E+00	mg/kg-d	3.0E-03	2.1E-03
Vanadium	7.7E-01	mg/kg	3.1E-01	mg/kg-d	1.1E+01	1.1E+02	mg/kg-d	2.7E-02	2.7E-03
Zinc	4.2E+01	mg/kg	1.7E+01	mg/kg-d	1.5E+01	1.3E+02	mg/kg-d	**1.2E+00**	1.3E-01
4,4'-DDD	9.1E-04	mg/kg	3.7E-04	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	1.3E-01	1.3E-02
4,4'-DDE	4.5E-02	mg/kg	1.8E-02	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	**6.4E+00**	6.4E-01
4,4'-DDT	2.2E-02	mg/kg	9.0E-03	mg/kg-d	2.8E-03	2.8E-02	mg/kg-d	**3.2E+00**	3.2E-01
Aldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	0.0E+00	0.0E+00
Dieldrin	5.5E-04	mg/kg	2.2E-04	mg/kg-d	7.7E-02	7.7E-01	mg/kg-d	2.8E-03	2.8E-04
Chlordane	1.6E-02	mg/kg	6.6E-03	mg/kg-d	2.8E-01	2.8E+00	mg/kg-d	2.3E-02	2.3E-03
Lindane	1.1E-03	mg/kg	4.2E-04	mg/kg-d	2.0E+00	2.0E+01	mg/kg-d	2.1E-04	2.1E-05
Endrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.0E-01	1.0E-01	mg/kg-d	0.0E+00	0.0E+00
TOTAL AROCLOR	2.2E-02	mg/kg	8.7E-03	mg/kg-d	1.1E-01	2.8E-01	mg/kg-d	7.9E-02	3.2E-02
Aroclor 1254	1.5E-02	mg/kg	6.1E-03	mg/kg-d	1.8E-01	1.8E+00	mg/kg-d	3.4E-02	3.4E-03
Aroclor 1260	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.8E-01	1.8E+00	mg/kg-d	0.0E+00	0.0E+00
Aroclor 1268	3.5E-03	mg/kg	1.4E-03	mg/kg-d	1.1E+00	1.1E+01	mg/kg-d	1.3E-03	1.3E-04
TEQ-BIRD	1.9E-04	mg/kg	7.7E-05	mg/kg-d	1.4E-05	1.4E-04	mg/kg-d	**5.5E+00**	5.5E-01
TEQ-MAMMAL	2.0E-04	mg/kg	8.1E-05	mg/kg-d			-	-	-
							-	-	-
							HAZARD INDICES:	**2.0E+01**	**2.3E+00**

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table E.1-3.

b. Reference Dose Values presented in Table D-4 in BERA (MACTEC, 2004).

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

A dash (-) indicates not available

TABLE E.1-5
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Woodcock
TOTAL RISK (HI): 4.9E+01

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
Antimony		-	-	-	-	-	-	-
TEQ-BIRD		7.4E+00	-	5.5E+00	-	-	***1.3E+01***	***26%***
4,4'-DDE		5.3E+00	-	6.4E+00	-	-	***1.2E+01***	***24%***
4,4'-DDT		7.0E+00	-	3.2E+00	-	-	***1.0E+01***	***21%***
Lead		4.9E+00	-	1.6E+00	-	-	***6.5E+00***	***13%***
Zinc		8.6E-01	-	1.2E+00	-	-	***2.0E+00***	4%
Chromium		1.7E+00	-	3.1E-01	-	-	***2.0E+00***	4%
Selenium		1.6E-01	-	6.2E-01	-	-	7.9E-01	2%
Cadmium		7.0E-02	-	6.2E-01	-	-	6.9E-01	1%
Copper		5.9E-01	-	1.3E-01	-	-	7.1E-01	1%
4,4'-DDD		1.3E-01	-	1.3E-01	-	-	2.6E-01	1%
TOTAL AROCLOR		9.9E-02	-	7.9E-02	-	-	1.8E-01	0%
Vanadium		1.5E-01	-	2.7E-02	-	-	1.8E-01	0%
Arsenic		1.2E-01	-	2.9E-02	-	-	1.5E-01	0%
Nickel		1.9E-02	-	7.2E-02	-	-	9.1E-02	0%
Molybdenum		7.3E-02	-	1.3E-02	-	-	8.6E-02	0%
Aroclor 1254		4.4E-02	-	3.4E-02	-	-	7.8E-02	0%
Manganese		5.1E-02	-	2.2E-02	-	-	7.3E-02	0%
Mercury		5.2E-02	-	2.1E-02	-	-	7.3E-02	0%
Chlordane		2.7E-02	-	2.3E-02	-	-	5.0E-02	0%
Aroclor 1260		3.1E-02	-	-	-	-	3.1E-02	0%
Thallium		7.7E-03	-	3.0E-03	-	-	1.1E-02	0%
Dieldrin		2.2E-03	-	2.8E-03	-	-	5.1E-03	0%
Aroclor 1268		1.4E-03	-	1.3E-03	-	-	2.6E-03	0%
Silver		8.8E-04	-	2.1E-04	-	-	1.1E-03	0%
Aldrin		1.5E-03	-	-	-	-	1.5E-03	0%
Endrin		4.5E-04	-	-	-	-	4.5E-04	0%
Lindane		7.3E-05	-	2.1E-04	-	-	2.8E-04	0%
TOTAL MEDIUM-SPECIFIC RISK	-	**2.9E+01**	-	**2.0E+01**	-	-	**4.9E+01**	
PERCENTAGE OF TOTAL RISK		**59%**		**41%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

A dash (-) indicates not available

TABLE E.1-6
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : Woodcock

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Woodcock
TOTAL RISK (HI): 5.9E+00

Analyte	Exposure Medium[a]						Combined HQs[b]	Percent Contribution[c]
	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals		
Antimony		-	-	-	-	-	-	-
TEQ-BIRD		7.4E-01	-	5.5E-01	-	-	***1.3E+00***	***22%***
4,4'-DDE		5.3E-01	-	6.4E-01	-	-	***1.2E+00***	***20%***
4,4'-DDT		7.0E-01	-	3.2E-01	-	-	***1.0E+00***	***17%***
Lead		4.9E-01	-	1.6E-01	-	-	6.5E-01	***11%***
Copper		4.5E-01	-	9.6E-02	-	-	5.4E-01	9%
Chromium		3.4E-01	-	6.2E-02	-	-	4.0E-01	7%
Selenium		4.8E-02	-	1.8E-01	-	-	2.3E-01	4%
Zinc		9.6E-02	-	1.3E-01	-	-	2.2E-01	4%
TOTAL AROCLOR		3.9E-02	-	3.2E-02	-	-	7.1E-02	1%
Nickel		1.4E-02	-	5.2E-02	-	-	6.6E-02	1%
Arsenic		4.7E-02	-	1.2E-02	-	-	5.9E-02	1%
Cadmium		5.1E-03	-	4.5E-02	-	-	5.0E-02	1%
Mercury		2.6E-02	-	1.1E-02	-	-	3.7E-02	1%
4,4'-DDD		1.3E-02	-	1.3E-02	-	-	2.6E-02	0%
Vanadium		1.5E-02	-	2.7E-03	-	-	1.8E-02	0%
Molybdenum		7.3E-03	-	1.3E-03	-	-	8.6E-03	0%
Aroclor 1254		4.4E-03	-	3.4E-03	-	-	7.8E-03	0%
Thallium		5.4E-03	-	2.1E-03	-	-	7.5E-03	0%
Manganese		5.1E-03	-	2.2E-03	-	-	7.3E-03	0%
Chlordane		2.7E-03	-	2.3E-03	-	-	5.0E-03	0%
Aroclor 1260		3.1E-03	-	-	-	-	3.1E-03	0%
Dieldrin		2.2E-04	-	2.8E-04	-	-	5.1E-04	0%
Endrin		4.5E-04	-	-	-	-	4.5E-04	0%
Aroclor 1268		1.4E-04	-	1.3E-04	-	-	2.6E-04	0%
Silver		8.8E-05	-	2.1E-05	-	-	1.1E-04	0%
Aldrin		1.5E-04	-	-	-	-	1.5E-04	0%
Lindane		7.3E-06	-	2.1E-05	-	-	2.8E-05	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**3.6E+00**	**-**	**2.3E+00**	**-**	**-**	**5.9E+00**	
PERCENTAGE OF TOTAL RISK		**61%**		**39%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

A dash (-) indicates not available

TABLE E.2-1
ESTIMATED TERRESTRIAL PREY TISSUE CONCENTRATIONS DERIVED USING LITERATURE-BASED BAFs

Supplemental Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Soil
EXPOSURE MEDIUM: All
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL

		Literature-based BAFs[a]		Estimated Tissue Concentration	
Analyte	Soil EPC Value	Terrestial Plants	Terrestrial Inverts	Terrestial Plants[b]	Terrestrial Inverts[b]
Antimony	1.0E+01	2.0E-03	-	**2.0E-02**	0.0E+00
Arsenic	1.0E+01	1.0E-02	2.5E-02	**1.0E-01**	2.5E-01
Cadmium	1.7E+00	4.4E-02	1.0E+00	**7.4E-02**	1.8E+00
Chromium	2.8E+01	8.2E-03	6.1E-02	**2.3E-01**	1.7E+00
Copper	4.6E+02	9.7E-02	2.0E-01	**4.4E+01**	9.0E+01
Lead	3.2E+02	1.9E-02	1.0E-01	**6.1E+00**	3.3E+01
Manganese	8.3E+02	1.6E-02	4.3E-02	**1.3E+01**	3.6E+01
Mercury	3.9E-01	2.6E-02	4.7E-02	**1.0E-02**	1.8E-02
Molybdenum	4.3E+00	5.0E-02	1.9E-01	**2.1E-01**	8.2E-01
Nickel	2.5E+01	1.2E-02	2.1E-01	**3.0E-01**	5.3E+00
Selenium	1.2E+00	1.3E-01	1.0E-01	**1.6E-01**	1.2E-01
Silver	1.3E+00	2.8E-03	4.1E-01	**3.7E-03**	5.4E-01
Thallium	4.5E-01	8.0E-04	-	**3.6E-04**	0.0E+00
Vanadium	2.9E+01	9.7E-04	8.4E-03	**2.8E-02**	2.4E-01
Zinc	2.1E+02	3.5E-01	3.6E+00	**7.2E+01**	7.6E+02
4,4'-DDD	6.0E-03	2.4E-03	1.1E+00	**1.5E-05**	6.4E-03
4,4'-DDE	2.5E-01	9.6E-04	1.1E+00	**2.4E-04**	2.7E-01
4,4'-DDT	3.3E-01	1.4E-03	1.1E+00	**4.7E-04**	3.5E-01
Aldrina	3.4E-03	1.4E-03	1.1E+00	**4.6E-06**	3.7E-03
Dieldrin	2.8E-03	6.7E-03	1.1E+00	**1.9E-05**	3.0E-03
Chlordane	1.3E-01	2.6E-03	1.1E+00	**3.4E-04**	1.4E-01
Lindanea	2.4E-03	5.9E-02	1.0E+00	**1.4E-04**	2.5E-03
Endrin	7.7E-04	7.6E-03	1.1E+00	**5.9E-06**	8.1E-04
TOTAL AROCLOR	1.8E-01	6.1E-04	1.1E+00	**1.1E-04**	2.0E-01
Aroclor 1254	1.3E-01	1.4E-03	1.1E+00	**1.8E-04**	1.4E-01
Aroclor 1260	9.2E-02	3.4E-04	1.1E+00	**3.1E-05**	1.0E-01
Aroclor 1268a	2.5E-02	3.4E-04	1.1E+00	**8.4E-06**	2.8E-02
TEQ-MAMMAL	1.7E-03			**0.0E+00**	0.0E+00

Footnotes:

a. Literature-derived BAFs are summarized in Table J-1 in the BERA (MACTEC, 2004).

b. Estimated plant and invertebrate concentrations calculated by multiplying the soil EPC concentration (mg/kg[dw] by the tissue-specific BAF (mg/kg[ww]). Estimated tissue concentrations reported in units of mg/kg [wet weight tissue].

TABLE E.2-2

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surface Soil (0-2 feet) / Short-tailed Shrew

Supplemental Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Short-tailed Shrew

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		SOIL INTAKE-INGESTION
	C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
	IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.00064	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Buckner, 1966	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.017	Guilday, 1957	

REFERENCES

Buckner, C.H., 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba; J. Mammal. 47:181-194.
Guilday, J.E., 1957, Individual an dgeographic variation in Blarina brevicauda from Pennsylvania; Ann. Carnegie Mus. 35:41-68.
USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE E.2-3
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surface Soil (0-2 feet) / Short-tailed Shrew

Supplemental Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Short-tailed Shrew

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	1.0E+01	mg/kg	3.7E-01	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	**1.4E+01**	**1.4E+00**
Arsenic	1.0E+01	mg/kg	3.7E-01	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	**2.9E+00**	2.9E-01
Cadmium	1.7E+00	mg/kg	6.3E-02	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	6.3E-02	6.3E-03
Chromium	2.8E+01	mg/kg	1.0E+00	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	7.1E-04	7.1E-05
Copper	4.6E+02	mg/kg	1.7E+01	mg/kg-d	4.2E-01	4.2E+00	mg/kg-d	**4.0E+01**	**4.0E+00**
Lead	3.2E+02	mg/kg	1.2E+01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	9.2E-02	3.1E-02
Manganese	8.3E+02	mg/kg	3.1E+01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	3.5E-01	1.1E-01
Mercury	3.9E-01	mg/kg	1.4E-02	mg/kg-d	2.6E-01	2.6E+00	mg/kg-d	5.4E-02	5.4E-03
Molybdenum	4.3E+00	mg/kg	1.6E-01	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	8.3E-01	8.3E-02
Nickel	2.5E+01	mg/kg	9.2E-01	mg/kg-d	3.1E+01	5.2E+01	mg/kg-d	3.0E-02	1.8E-02
Selenium	1.2E+00	mg/kg	4.5E-02	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	2.2E-01	1.3E-01
Silver	1.3E+00	mg/kg	4.8E-02	mg/kg-d	2.2E+01	2.2E+02	mg/kg-d	2.2E-03	2.2E-04
Thallium	4.5E-01	mg/kg	1.7E-02	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	1.2E-01	1.2E-02
Vanadium	2.9E+01	mg/kg	1.1E+00	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	**2.6E+00**	5.1E-01
Zinc	2.1E+02	mg/kg	7.7E+00	mg/kg-d	1.6E+02	3.2E+02	mg/kg-d	4.8E-02	2.4E-02
4,4'-DDD	6.0E-03	mg/kg	2.2E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.8E-04	5.5E-05
4,4'-DDE	2.5E-01	mg/kg	9.2E-03	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.2E-02	2.3E-03
4,4'-DDT	3.3E-01	mg/kg	1.2E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.5E-02	3.0E-03
Aldrina	3.4E-03	mg/kg	1.3E-04	mg/kg-d	2.0E-01	1.0E+00	mg/kg-d	6.3E-04	1.3E-04
Dieldrin	2.8E-03	mg/kg	1.1E-04	mg/kg-d	2.8E-02	2.8E-01	mg/kg-d	3.8E-03	3.8E-04
Chlordane	1.3E-01	mg/kg	4.7E-03	mg/kg-d	4.6E+00	9.2E+00	mg/kg-d	1.0E-03	5.1E-04
Lindanea	2.4E-03	mg/kg	8.9E-05	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	5.6E-05	2.8E-05
Endrin	7.7E-04	mg/kg	2.8E-05	mg/kg-d	6.5E-02	6.5E-01	mg/kg-d	4.4E-04	4.4E-05
TOTAL AROCLOR	1.8E-01	mg/kg	6.7E-03	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	9.8E-02	9.8E-03
Aroclor 1254	1.3E-01	mg/kg	4.8E-03	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	7.1E-02	7.1E-03
Aroclor 1260	9.2E-02	mg/kg	3.4E-03	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	5.0E-02	5.0E-03
Aroclor 1268a	2.5E-02	mg/kg	9.3E-04	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	1.4E-02	1.4E-03
TEQ-MAMMAL	1.7E-03	mg/kg	6.4E-05	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	**6.4E+01**	**6.4E+00**

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table E.2-2.

b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE E.2-4

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Terrestrial Plants / Short-tailed Shrew

Supplemental Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Short-tailed Shrew

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{plant}	ESTIMATED DAILY INTAKE VIA PLANT INGESTION	mg/kg-d	calculated		PLANT INTAKE-INGESTION
	C_{plant}	CHEMICAL CONCENTRATION IN PLANTS	mg/kg	chemical-specific		$EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF *$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.013	USEPA, 1993	
	P_{plant}	PERCENT PLANTS IN DIET	unitless	14%	Whitaker and	Where C_{plant} is estimated using site-specific
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Buckner, 1966	$C_{plant} = C_{soil} * BAF_{plant}$
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	0.017	Guilday, 1957	

REFERENCES

Buckner, C.H., 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba; J. Mammal. 47:181-194.
Guilday, J.E., 1957, Individual an dgeographic variation in Blarina brevicauda from Pennsylvania; Ann. Carnegie Mus. 35:41-68.
EPA/600/R-93/187a; December 1993; Washington, D.C.
Whitaker, J.O., Jr., and M.G. Ferraro, 1963. Summer food of 220 short-tailed shrews from Ithica, New York; J. Mammal. 44:419.

TABLE E.2-5
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Terrestrial Plants / Short-tailed Shrew

Supplemental Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Short-tailed Shrew

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	2.0E-02	mg/kg	2.1E-03	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	8.2E-02	8.2E-03
Arsenic	1.0E-01	mg/kg	1.1E-02	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	8.4E-02	8.4E-03
Cadmium	7.4E-02	mg/kg	7.8E-03	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	7.8E-03	7.8E-04
Chromium	2.3E-01	mg/kg	2.4E-02	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	1.7E-05	1.7E-06
Copper	4.4E+01	mg/kg	4.7E+00	mg/kg-d	4.2E-01	4.2E+00	mg/kg-d	**1.1E+01**	**1.1E+00**
Lead	6.1E+00	mg/kg	6.4E-01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	5.1E-03	1.7E-03
Manganese	1.3E+01	mg/kg	1.4E+00	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	1.6E-02	4.9E-03
Mercury	1.0E-02	mg/kg	1.1E-03	mg/kg-d	2.6E-01	2.6E+00	mg/kg-d	4.0E-03	4.0E-04
Molybdenum	2.1E-01	mg/kg	2.3E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.2E-01	1.2E-02
Nickel	3.0E-01	mg/kg	3.2E-02	mg/kg-d	3.1E+01	5.2E+01	mg/kg-d	1.0E-03	6.1E-04
Selenium	1.6E-01	mg/kg	1.6E-02	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	8.2E-02	5.0E-02
Silver	3.7E-03	mg/kg	3.9E-04	mg/kg-d	2.2E+01	2.2E+02	mg/kg-d	1.7E-05	1.7E-06
Thallium	3.6E-04	mg/kg	3.8E-05	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	2.7E-04	2.7E-05
Vanadium	2.8E-02	mg/kg	3.0E-03	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	7.1E-03	1.4E-03
Zinc	7.2E+01	mg/kg	7.6E+00	mg/kg-d	1.6E+02	3.2E+02	mg/kg-d	4.8E-02	2.4E-02
4,4'-DDD	1.5E-05	mg/kg	1.5E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.9E-06	3.8E-07
4,4'-DDE	2.4E-04	mg/kg	2.5E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	3.1E-05	6.3E-06
4,4'-DDT	4.7E-04	mg/kg	5.0E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	6.2E-05	1.2E-05
Aldrina	4.6E-06	mg/kg	4.8E-07	mg/kg-d	2.0E-01	1.0E+00	mg/kg-d	2.4E-06	4.8E-07
Dieldrin	1.9E-05	mg/kg	2.0E-06	mg/kg-d	2.8E-02	2.8E-01	mg/kg-d	7.3E-05	7.3E-06
Chlordane	3.4E-04	mg/kg	3.5E-05	mg/kg-d	4.6E+00	9.2E+00	mg/kg-d	7.7E-06	3.9E-06
Lindanea	1.4E-04	mg/kg	1.5E-05	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	9.3E-06	4.7E-06
Endrin	5.9E-06	mg/kg	6.2E-07	mg/kg-d	6.5E-02	6.5E-01	mg/kg-d	9.5E-06	9.5E-07
TOTAL AROCLOR	1.1E-04	mg/kg	1.2E-05	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	1.7E-04	1.7E-05
Aroclor 1254	1.8E-04	mg/kg	1.9E-05	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	2.8E-04	2.8E-05
Aroclor 1260	3.1E-05	mg/kg	3.2E-06	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	4.7E-05	4.7E-06
Aroclor 1268a	8.4E-06	mg/kg	8.8E-07	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	1.3E-05	1.3E-06
TEQ-MAMMAL	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	**1.2E+01**	**1.2E+00**

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table E.2-4.

b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE E.2-6

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Soil Invertebrates / Short-tailed Shrew

Supplemental Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Short-tailed Shrew

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION $EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	0.013	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	85%	USEPA, 1993; Whitaker and Feraro, 1963	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation: $C_{invert} = C_{soil} * BAF_{invert}$*(% tissue lipid/% soil TOC) Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	SFF	SITE FORAGING FREQUENCY	unitless	100%	Buckner, 1966	
	EF	EXPOSURE FREQUENCY	unitless	100%	USEPA, 1993	
	BW	BODY WEIGHT	kg	0.017	Guilday, 1957	

REFERENCES

Buckner, C.H., 1966. Populations and ecological relationships of shrews in tamarack bogs of southeastern Manitoba; J. Mammal. 47:181-194.

Guilday, J.E., 1957, Individual an dgeographic variation in Blarina brevicauda from Pennsylvania; Ann. Carnegie Mus. 35:41-68.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

Whitaker, J.O., Jr., and M.G. Ferraro, 1963. Summer food of 220 short-tailed shrews from Ithica, New York; J. Mammal. 44:419.

TABLE E.2-7
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Soil Invertebrates / Short-tailed Shrew

Supplemental Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Short-tailed Shrew

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	2.3E+00	mg/kg	1.4E+00	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	**5.5E+01**	**5.5E+00**
Arsenic	3.7E-01	mg/kg	2.3E-01	mg/kg-d	1.3E-01	1.3E+00	mg/kg-d	**1.8E+00**	1.8E-01
Cadmium	2.2E+00	mg/kg	1.4E+00	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	**1.4E+00**	1.4E-01
Chromium	7.7E-01	mg/kg	4.9E-01	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	3.3E-04	3.3E-05
Copper	1.5E+01	mg/kg	9.4E+00	mg/kg-d	4.2E-01	4.2E+00	mg/kg-d	**2.2E+01**	**2.2E+00**
Lead	1.5E+01	mg/kg	9.5E+00	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	7.5E-02	2.5E-02
Manganese	5.5E+01	mg/kg	3.4E+01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	3.9E-01	1.2E-01
Mercury	2.4E-02	mg/kg	1.5E-02	mg/kg-d	2.6E-01	2.6E+00	mg/kg-d	5.8E-02	5.8E-03
Molybdenum	1.2E-01	mg/kg	7.3E-02	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	3.8E-01	3.8E-02
Nickel	1.4E+01	mg/kg	8.8E+00	mg/kg-d	3.1E+01	5.2E+01	mg/kg-d	2.8E-01	1.7E-01
Selenium	6.9E-01	mg/kg	4.3E-01	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	**2.2E+00**	**1.3E+00**
Silver	4.7E-02	mg/kg	3.0E-02	mg/kg-d	2.2E+01	2.2E+02	mg/kg-d	1.3E-03	1.3E-04
Thallium	2.6E-02	mg/kg	1.6E-02	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	1.2E-01	1.2E-02
Vanadium	7.7E-01	mg/kg	4.8E-01	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	**1.2E+00**	2.3E-01
Zinc	4.2E+01	mg/kg	2.7E+01	mg/kg-d	1.6E+02	3.2E+02	mg/kg-d	1.7E-01	8.3E-02
4,4'-DDD	9.1E-04	mg/kg	5.8E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	7.2E-04	1.4E-04
4,4'-DDE	4.5E-02	mg/kg	2.8E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	3.5E-02	7.1E-03
4,4'-DDT	2.2E-02	mg/kg	1.4E-02	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.8E-02	3.5E-03
Aldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	2.0E-01	1.0E+00	mg/kg-d	0.0E+00	0.0E+00
Dieldrin	5.5E-04	mg/kg	3.4E-04	mg/kg-d	2.8E-02	2.8E-01	mg/kg-d	1.3E-02	1.3E-03
Chlordane	1.6E-02	mg/kg	1.0E-02	mg/kg-d	4.6E+00	9.2E+00	mg/kg-d	2.3E-03	1.1E-03
Lindane	1.1E-03	mg/kg	6.7E-04	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	4.2E-04	2.1E-04
Endrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.5E-02	6.5E-01	mg/kg-d	0.0E+00	0.0E+00
TOTAL AROCLOR	2.2E-02	mg/kg	1.4E-02	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	2.0E-01	2.0E-02
Aroclor 1254	1.5E-02	mg/kg	9.6E-03	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	1.4E-01	1.4E-02
Aroclor 1260	0.0E+00	mg/kg	0.0E+00	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	0.0E+00	0.0E+00
Aroclor 1268	3.5E-03	mg/kg	2.2E-03	mg/kg-d	6.8E-02	6.8E-01	mg/kg-d	3.3E-02	3.3E-03
TEQ-BIRD	1.9E-04	mg/kg	1.2E-04	mg/kg-d					
TEQ-MAMMAL	2.0E-04	mg/kg	1.3E-04	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	**1.3E+02**	**1.3E+01**
							HAZARD INDICES:	**2.1E+02**	**2.3E+01**

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table E.2-6.

b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE E.2-8
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : Short-tailed Shrew

Supplemental Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Short-tailed Shrew
TOTAL RISK (HI): 3.5E+02

	Exposure Medium[a]							
Analyte	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals	Combined HQs[b]	Percent Contribution[c]
TEQ-MAMMAL		6.4E+01	-	1.3E+02			***1.9E+02***	***54%***
Copper		4.0E+01	1.1E+01	2.2E+01			***7.4E+01***	***21%***
Antimony		1.4E+01	8.2E-02	5.5E+01			***6.9E+01***	***20%***
Arsenic		2.9E+00	8.4E-02	1.8E+00			***4.9E+00***	1%
Vanadium		2.6E+00	7.1E-03	1.2E+00			***3.7E+00***	1%
Selenium		2.2E-01	8.2E-02	2.2E+00			***2.5E+00***	1%
Cadmium		6.3E-02	7.8E-03	1.4E+00			***1.5E+00***	0%
Molybdenum		8.3E-01	1.2E-01	3.8E-01			***1.3E+00***	0%
Manganese		3.5E-01	1.6E-02	3.9E-01			7.6E-01	0%
Nickel		3.0E-02	1.0E-03	2.8E-01			3.2E-01	0%
TOTAL AROCLOR		9.8E-02	1.7E-04	2.0E-01			3.0E-01	0%
Zinc		4.8E-02	4.8E-02	1.7E-01			2.6E-01	0%
Thallium		1.2E-01	2.7E-04	1.2E-01			2.4E-01	0%
Aroclor 1254		7.1E-02	2.8E-04	1.4E-01			2.1E-01	0%
Lead		9.2E-02	5.1E-03	7.5E-02			1.7E-01	0%
Mercury		5.4E-02	4.0E-03	5.8E-02			1.2E-01	0%
Aroclor 1260		5.0E-02	4.7E-05	-			5.0E-02	0%
4,4'-DDE		1.2E-02	3.1E-05	3.5E-02			4.7E-02	0%
Aroclor 1268		1.4E-02	1.3E-05	3.3E-02			4.6E-02	0%
4,4'-DDT		1.5E-02	6.2E-05	1.8E-02			3.3E-02	0%
Dieldrin		3.8E-03	7.3E-05	1.3E-02			1.6E-02	0%
Silver		2.2E-03	1.7E-05	1.3E-03			3.5E-03	0%
Chlordane		1.0E-03	7.7E-06	2.3E-03			3.3E-03	0%
Chromium		7.1E-04	1.7E-05	3.3E-04			1.1E-03	0%
4,4'-DDD		2.8E-04	1.9E-06	7.2E-04			1.0E-03	0%
Endrin		4.4E-04	9.5E-06	-			4.5E-04	0%
Aldrin		6.3E-04	2.4E-06	-			6.3E-04	0%
Lindane		5.6E-05	9.3E-06	4.2E-04			4.8E-04	0%
TOTAL MEDIUM-SPECIFIC RISK	-	**1.3E+02**	**1.2E+01**	**2.1E+02**	-	-	**3.5E+02**	
PERCENTAGE OF TOTAL RISK		**36%**	**3%**	**61%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE E.2-9

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : Short-tailed Shrew

Supplemental Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Short-tailed Shrew
TOTAL RISK (HI): 3.7E+01

	Exposure Medium[a]							
Analyte	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals	Combined HQs[b]	Percent Contribution[c]
TEQ-MAMMAL		6.4E+00	-	1.3E+01			***1.9E+01***	***51%***
Copper		4.0E+00	1.1E+00	2.2E+00			***7.4E+00***	***20%***
Antimony		1.4E+00	8.2E-03	5.5E+00			***6.9E+00***	***19%***
Selenium		1.3E-01	5.0E-02	1.3E+00			***1.5E+00***	4%
Vanadium		5.1E-01	1.4E-03	2.3E-01			7.4E-01	2%
Arsenic		2.9E-01	8.4E-03	1.8E-01			4.9E-01	1%
Manganese		1.1E-01	4.9E-03	1.2E-01			2.3E-01	1%
Nickel		1.8E-02	6.1E-04	1.7E-01			1.9E-01	1%
Cadmium		6.3E-03	7.8E-04	1.4E-01			1.5E-01	0%
Zinc		2.4E-02	2.4E-02	8.3E-02			1.3E-01	0%
Molybdenum		8.3E-02	1.2E-02	3.8E-02			1.3E-01	0%
Lead		3.1E-02	1.7E-03	2.5E-02			5.8E-02	0%
TOTAL AROCLOR		9.8E-03	1.7E-05	2.0E-02			3.0E-02	0%
Thallium		1.2E-02	2.7E-05	1.2E-02			2.4E-02	0%
Aroclor 1254		7.1E-03	2.8E-05	1.4E-02			2.1E-02	0%
Mercury		5.4E-03	4.0E-04	5.8E-03			1.2E-02	0%
4,4'-DDE		2.3E-03	6.3E-06	7.1E-03			9.4E-03	0%
4,4'-DDT		3.0E-03	1.2E-05	3.5E-03			6.6E-03	0%
Aroclor 1260		5.0E-03	4.7E-06	-			5.0E-03	0%
Aroclor 1268		1.4E-03	1.3E-06	3.3E-03			4.6E-03	0%
Dieldrin		3.8E-04	7.3E-06	1.3E-03			1.6E-03	0%
Chlordane		5.1E-04	3.9E-06	1.1E-03			1.6E-03	0%
Silver		2.2E-04	1.7E-06	1.3E-04			3.5E-04	0%
4,4'-DDD		5.5E-05	3.8E-07	1.4E-04			2.0E-04	0%
Chromium		7.1E-05	1.7E-06	3.3E-05			1.1E-04	0%
Lindane		2.8E-05	4.7E-06	2.1E-04			2.4E-04	0%
Aldrin		1.3E-04	4.8E-07	-			1.3E-04	0%
Endrin		4.4E-05	9.5E-07	-			4.5E-05	0%
TOTAL MEDIUM-SPECIFIC RISK	-	**1.3E+01**	**1.2E+00**	**2.3E+01**	-	-	**3.7E+01**	
PERCENTAGE OF TOTAL RISK		**35%**	**3%**	**61%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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TABLE E.3-1
ESTIMATED TERRESTRIAL PREY TISSUE CONCENTRATIONS DERIVED USING LITERATURE-BASED BAFs

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Soil
EXPOSURE MEDIUM: All
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL

		Literature-based BAFs[a]		Estimated Tissue Concentration	
Analyte	Medium EPC Value	Terrestial Plants	Terrestrial Inverts	Terrestial Plants[b]	Terrestrial Inverts[b]
Antimony	1.0E+01	2.0E-03	-	**2.0E-02**	0.0E+00
Arsenic	1.0E+01	1.0E-02	2.5E-02	**1.0E-01**	2.5E-01
Cadmium	1.7E+00	4.4E-02	1.0E+00	**7.4E-02**	1.8E+00
Chromium	2.8E+01	8.2E-03	6.1E-02	**2.3E-01**	1.7E+00
Copper	4.6E+02	9.7E-02	2.0E-01	**4.4E+01**	9.0E+01
Lead	3.2E+02	1.9E-02	1.0E-01	**6.1E+00**	3.3E+01
Manganese	8.3E+02	1.6E-02	4.3E-02	**1.3E+01**	3.6E+01
Mercury	3.9E-01	2.6E-02	4.7E-02	**1.0E-02**	1.8E-02
Molybdenum	4.3E+00	5.0E-02	1.9E-01	**2.1E-01**	8.2E-01
Nickel	2.5E+01	1.2E-02	2.1E-01	**3.0E-01**	5.3E+00
Selenium	1.2E+00	1.3E-01	1.0E-01	**1.6E-01**	1.2E-01
Silver	1.3E+00	2.8E-03	4.1E-01	**3.7E-03**	5.4E-01
Thallium	4.5E-01	8.0E-04	-	**3.6E-04**	0.0E+00
Vanadium	2.9E+01	9.7E-04	8.4E-03	**2.8E-02**	2.4E-01
Zinc	2.1E+02	3.5E-01	3.6E+00	**7.2E+01**	7.6E+02
4,4'-DDD	6.0E-03	2.4E-03	1.1E+00	**1.5E-05**	6.4E-03
4,4'-DDE	2.5E-01	9.6E-04	1.1E+00	**2.4E-04**	2.7E-01
4,4'-DDT	3.3E-01	1.4E-03	1.1E+00	**4.7E-04**	3.5E-01
Aldrina	3.4E-03	1.4E-03	1.1E+00	**4.6E-06**	3.7E-03
Dieldrin	2.8E-03	6.7E-03	1.1E+00	**1.9E-05**	3.0E-03
Chlordane	1.3E-01	2.6E-03	1.1E+00	**3.4E-04**	1.4E-01
Lindanea	2.4E-03	5.9E-02	1.0E+00	**1.4E-04**	2.5E-03
Endrin	7.7E-04	7.6E-03	1.1E+00	**5.9E-06**	8.1E-04
TOTAL AROCLOR	1.8E-01	6.1E-04	1.1E+00	**1.1E-04**	2.0E-01
Aroclor 1254	1.3E-01	1.4E-03	1.1E+00	**1.8E-04**	1.4E-01
Aroclor 1260	9.2E-02	3.4E-04	1.1E+00	**3.1E-05**	1.0E-01
Aroclor 1268a	2.5E-02	3.4E-04	1.1E+00	**8.4E-06**	2.8E-02
TEQ-BIRD	1.7E-03			**0.0E+00**	0.0E+00
TEQ-MAMMAL	1.7E-03			**0.0E+00**	0.0E+00

Footnotes:

a. Literature-derived BAFs are summarized in Table J-1 in the BERA (MACTEC, 2004).

b. Estimated plant and invertebrate concentrations calculated by multiplying the soil EPC concentration (mg/kg[dw] by the tissue-specific BAF (mg/kg[ww]). Estimated tissue concentrations reported in units of mg/kg [wet weight tissue].

TABLE E.3-2

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Surface Soil (0-2 feet) / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Raccoon

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{soil}	ESTIMATED DAILY INTAKE VIA SOIL INGESTION	mg/kg-d	calculated		SOIL INTAKE-INGESTION
	C_{soil}	CHEMICAL CONCENTRATION IN SOIL	mg/kg	chemical-specific		$EDI_{soil} = C_{soil} * IR_{soil} * SFF * EF * 1/BW$
	IR_{soil}	INGESTION RATE OF SOIL	kg/day	0.087	assumption	
	SFF	SITE FORAGING FREQUENCY	unitless	10%	Stuewer, 1943	
	EF	EXPOSURE FREQUENCY	unitless	50%	USEPA, 1993	
	BW	BODY WEIGHT	kg	6.2	Sanderson, 1984	

REFERENCES

Sanderson, G.C., 1984. Cooperative raccoon collections; Ill. Nat. Hist. Survey Div.; Pittman-Robertson Proj. W-49-31.

Stuewer, R.W., 1943. Raccoons: their habits and management in Michigan; Ecol. Monogr. 13:203-257.

USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE E.3-3

CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Surface Soil (0-2 feet) / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Soil
EXPOSURE MEDIUM: Surface Soil (0-2 feet)
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Raccoon

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	1.0E+01	mg/kg	7.3E-03	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	2.8E-01	2.8E-02
Arsenic	1.0E+01	mg/kg	7.3E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	1.5E-01	1.5E-02
Cadmium	1.7E+00	mg/kg	1.2E-03	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	1.2E-03	1.2E-04
Chromium	2.8E+01	mg/kg	2.1E-02	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	1.4E-05	1.4E-06
Copper	4.6E+02	mg/kg	3.3E-01	mg/kg-d	1.2E+01	1.5E+01	mg/kg-d	2.9E-02	2.2E-02
Lead	3.2E+02	mg/kg	2.3E-01	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	1.8E-03	6.1E-04
Manganese	8.3E+02	mg/kg	6.0E-01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	6.9E-03	2.1E-03
Mercury	3.9E-01	mg/kg	2.8E-04	mg/kg-d	2.6E-01	2.6E+00	mg/kg-d	1.1E-03	1.1E-04
Molybdenum	4.3E+00	mg/kg	3.1E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.6E-02	1.6E-03
Nickel	2.5E+01	mg/kg	1.8E-02	mg/kg-d	2.5E+01	6.3E+01	mg/kg-d	7.3E-04	2.9E-04
Selenium	1.2E+00	mg/kg	8.8E-04	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	4.4E-03	2.7E-03
Silver	1.3E+00	mg/kg	9.6E-04	mg/kg-d	2.2E+01	2.2E+02	mg/kg-d	4.3E-05	4.3E-06
Thallium	4.5E-01	mg/kg	3.3E-04	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	2.3E-03	2.3E-04
Vanadium	2.9E+01	mg/kg	2.1E-02	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	5.1E-02	1.0E-02
Zinc	2.1E+02	mg/kg	1.5E-01	mg/kg-d	2.0E+02	3.9E+02	mg/kg-d	7.8E-04	3.9E-04
4,4'-DDD	6.0E-03	mg/kg	4.3E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	5.4E-06	1.1E-06
4,4'-DDE	2.5E-01	mg/kg	1.8E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.3E-04	4.5E-05
4,4'-DDT	3.3E-01	mg/kg	2.4E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	3.0E-04	5.9E-05
Aldrina	3.4E-03	mg/kg	2.5E-06	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	1.7E-04	1.7E-05
Dieldrin	2.8E-03	mg/kg	2.1E-06	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	1.4E-04	1.4E-05
Chlordane	1.3E-01	mg/kg	9.3E-05	mg/kg-d	4.6E+00	9.2E+00	mg/kg-d	2.0E-05	1.0E-05
Lindanea	2.4E-03	mg/kg	1.8E-06	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	1.1E-06	5.5E-07
Endrin	7.7E-04	mg/kg	5.6E-07	mg/kg-d	2.5E-02	5.0E-02	mg/kg-d	2.2E-05	1.1E-05
TOTAL AROCLOR	1.8E-01	mg/kg	1.3E-04	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	2.6E-02	6.6E-03
Aroclor 1254	1.3E-01	mg/kg	9.6E-05	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.9E-02	4.8E-03
Aroclor 1260	9.2E-02	mg/kg	6.7E-05	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.3E-02	3.3E-03
Aroclor 1268a	2.5E-02	mg/kg	1.8E-05	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	3.7E-03	9.2E-04
TEQ-MAMMAL	1.7E-03	mg/kg	1.3E-06	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	1.3E+00	1.3E-01
							HAZARD INDICES:	1.9E+00	2.3E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table E.3-2.

b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE E.3-4
PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Terrestrial Plants / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Raccoon

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{plant}	ESTIMATED DAILY INTAKE VIA PLANT INGESTION	mg/kg-d	calculated		PLANT INTAKE-INGESTION $EDI_{plant} = C_{plant} * IR_{food} * P_{plant} * SFF * EF * 1/BW$
	C_{plant}	CHEMICAL CONCENTRATION IN PLANTS	mg/kg	chemical-specific		
	IR_{food}	INGESTION RATE OF FOOD	kg/day	1.7	USEPA, 1993	
	P_{plant}	PERCENT PLANTS IN DIET	unitless	71%	USEPA, 1993; Llewllyn and Uhler, 1952	Where C_{plant} is estimated using site-specific tissue data or calculated using the following equation: $C_{plant} = C_{soil} * BAF_{plant}$
	SFF	SITE FORAGING FREQUENCY	unitless	10%	Stuewer, 1943	
	EF	EXPOSURE FREQUENCY	unitless	50%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	6.2	Sanderson, 1984	

REFERENCES

Llewellyn, L.M., and F.M. Uhler, 1952. The foods of fur animals of the Patuxent Research Refuge, Maryland; Am. Midl. Nat. 48:193-203.
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USEPA, 1993. Wildlife Exposure Factors Handbook; United States Environmental Protection Agency, Office of Research and Development; EPA/600/R-93/187a; December 1993; Washington, D.C.

TABLE E.3-5
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Terrestrial Plants / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 1
EXPOSURE MEDIUM: Terrestrial Plants
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Raccoon

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	2.0E-02	mg/kg	2.1E-04	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	8.1E-03	8.1E-04
Arsenic	1.0E-01	mg/kg	1.0E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	2.2E-02	2.2E-03
Cadmium	7.4E-02	mg/kg	7.7E-04	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	7.7E-04	7.7E-05
Chromium	2.3E-01	mg/kg	2.4E-03	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	1.6E-06	1.6E-07
Copper	4.4E+01	mg/kg	4.6E-01	mg/kg-d	1.2E+01	1.5E+01	mg/kg-d	4.0E-02	3.1E-02
Lead	6.1E+00	mg/kg	6.3E-02	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	5.0E-04	1.7E-04
Manganese	1.3E+01	mg/kg	1.4E-01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	1.6E-03	4.8E-04
Mercury	1.0E-02	mg/kg	1.0E-04	mg/kg-d	2.6E-01	2.6E+00	mg/kg-d	3.9E-04	3.9E-05
Molybdenum	2.1E-01	mg/kg	2.2E-03	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	1.2E-02	1.2E-03
Nickel	3.0E-01	mg/kg	3.1E-03	mg/kg-d	2.5E+01	6.3E+01	mg/kg-d	1.3E-04	5.0E-05
Selenium	1.6E-01	mg/kg	1.6E-03	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	8.1E-03	4.9E-03
Silver	3.7E-03	mg/kg	3.8E-05	mg/kg-d	2.2E+01	2.2E+02	mg/kg-d	1.7E-06	1.7E-07
Thallium	3.6E-04	mg/kg	3.8E-06	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	2.7E-05	2.7E-06
Vanadium	2.8E-02	mg/kg	2.9E-04	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	7.0E-04	1.4E-04
Zinc	7.2E+01	mg/kg	7.5E-01	mg/kg-d	2.0E+02	3.9E+02	mg/kg-d	3.9E-03	1.9E-03
4,4'-DDD	1.5E-05	mg/kg	1.5E-07	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.9E-07	3.8E-08
4,4'-DDE	2.4E-04	mg/kg	2.5E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	3.1E-06	6.2E-07
4,4'-DDT	4.7E-04	mg/kg	4.9E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	6.1E-06	1.2E-06
Aldrina	4.6E-06	mg/kg	4.8E-08	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	3.2E-06	3.2E-07
Dieldrin	1.9E-05	mg/kg	2.0E-07	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	1.3E-05	1.3E-06
Chlordane	3.4E-04	mg/kg	3.5E-06	mg/kg-d	4.6E+00	9.2E+00	mg/kg-d	7.6E-07	3.8E-07
Lindanea	1.4E-04	mg/kg	1.5E-06	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	9.2E-07	4.6E-07
Endrin	5.9E-06	mg/kg	6.1E-08	mg/kg-d	2.5E-02	5.0E-02	mg/kg-d	2.4E-06	1.2E-06
TOTAL AROCLOR	1.1E-04	mg/kg	1.2E-06	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	2.3E-04	5.8E-05
Aroclor 1254	1.8E-04	mg/kg	1.9E-06	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	3.7E-04	9.3E-05
Aroclor 1260	3.1E-05	mg/kg	3.2E-07	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	6.4E-05	1.6E-05
Aroclor 1268a	8.4E-06	mg/kg	8.8E-08	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.8E-05	4.4E-06
TEQ-MAMMAL	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	0.0E+00	0.0E+00
							HAZARD INDICES:	9.8E-02	4.3E-02

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table E.3-4.

b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE E.3-6

PARAMETER VALUES USED TO CALCULATE ESTIMATED DAILY INTAKE : Soil Invertebrates / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Raccoon

EXPOSURE ROUTE	PARAMETER SYMBOL	PARAMETER DEFINITION	UNITS	RME VALUE	RME RATIONALE/ REFERENCE	INTAKE EQUATION/ MODEL NAME
INGESTION	EDI_{invert}	ESTIMATED DAILY INTAKE VIA INVERTEBRATE INGESTION	mg/kg-d	calculated		INVERTEBRATE INTAKE-INGESTION
	C_{invert}	CHEMICAL CONCENTRATION IN INVERTEBRATES	mg/kg	chemical-specific		$EDI_{invert} = C_{invert} * IR_{food} * P_{invert} * SFF * EF * 1/BW$
	IR_{food}	INGESTION RATE OF FOOD	kg/day	1.7	USEPA, 1993	
	P_{invert}	PERCENT INVERTEBRATES IN DIET	unitless	29%	USEPA, 1993; Llewllyn and Uhler, 1952	Where C_{invert} is estimated using site-specific tissue data or calculated using the following equation:
	SFF	SITE FORAGING FREQUENCY	unitless	10%	Stuewer, 1943	$C_{invert} = C_{soil} * BAF_{invert}$*(% tissue lipid/% soil TOC)
	EF	EXPOSURE FREQUENCY	unitless	50%	USEPA, 1993	Bioaccumulation Factors [mg(ww tissue)/ kg(dw sediment)] provided separately.
	BW	BODY WEIGHT	kg	6.2	Sanderson, 1984	

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TABLE E.3-7
CALCULATION OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS : Soil Invertebrates / Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
MEDIUM: Biota 2
EXPOSURE MEDIUM: Soil Invertebrates
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Raccoon

Analyte	Medium EPC	Medium EPC Units	Estimated Daily Intake[a]	Daily Intake Units	Reference Dose (NOAEL)[b]	Reference Dose (LOAEL)[b]	Reference Dose Units	Hazard Quotient (NOAEL)[c]	Hazard Quotient (LOAEL)[c]
Antimony	2.3E+00	mg/kg	9.5E-03	mg/kg-d	2.6E-02	2.6E-01	mg/kg-d	3.6E-01	3.6E-02
Arsenic	3.7E-01	mg/kg	1.5E-03	mg/kg-d	4.8E-02	4.8E-01	mg/kg-d	3.2E-02	3.2E-03
Cadmium	2.2E+00	mg/kg	9.4E-03	mg/kg-d	1.0E+00	1.0E+01	mg/kg-d	9.4E-03	9.4E-04
Chromium	7.7E-01	mg/kg	3.2E-03	mg/kg-d	1.5E+03	1.5E+04	mg/kg-d	2.2E-06	2.2E-07
Copper	1.5E+01	mg/kg	6.2E-02	mg/kg-d	1.2E+01	1.5E+01	mg/kg-d	5.3E-03	4.1E-03
Lead	1.5E+01	mg/kg	6.3E-02	mg/kg-d	1.3E+02	3.8E+02	mg/kg-d	5.0E-04	1.7E-04
Manganese	5.5E+01	mg/kg	2.3E-01	mg/kg-d	8.8E+01	2.8E+02	mg/kg-d	2.6E-03	8.0E-04
Mercury	2.4E-02	mg/kg	1.0E-04	mg/kg-d	2.6E-01	2.6E+00	mg/kg-d	3.8E-04	3.8E-05
Molybdenum	1.2E-01	mg/kg	4.8E-04	mg/kg-d	1.9E-01	1.9E+00	mg/kg-d	2.5E-03	2.5E-04
Nickel	1.4E+01	mg/kg	5.8E-02	mg/kg-d	2.5E+01	6.3E+01	mg/kg-d	2.3E-03	9.2E-04
Selenium	6.9E-01	mg/kg	2.9E-03	mg/kg-d	2.0E-01	3.3E-01	mg/kg-d	1.4E-02	8.7E-03
Silver	4.7E-02	mg/kg	2.0E-04	mg/kg-d	2.2E+01	2.2E+02	mg/kg-d	8.9E-06	8.9E-07
Thallium	2.6E-02	mg/kg	1.1E-04	mg/kg-d	1.4E-01	1.4E+00	mg/kg-d	7.8E-04	7.8E-05
Vanadium	7.7E-01	mg/kg	3.2E-03	mg/kg-d	4.2E-01	2.1E+00	mg/kg-d	7.6E-03	1.5E-03
Zinc	4.2E+01	mg/kg	1.8E-01	mg/kg-d	2.0E+02	3.9E+02	mg/kg-d	9.0E-04	4.5E-04
4,4'-DDD	9.1E-04	mg/kg	3.8E-06	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	4.8E-06	9.5E-07
4,4'-DDE	4.5E-02	mg/kg	1.9E-04	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	2.3E-04	4.7E-05
4,4'-DDT	2.2E-02	mg/kg	9.4E-05	mg/kg-d	8.0E-01	4.0E+00	mg/kg-d	1.2E-04	2.3E-05
Aldrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	0.0E+00	0.0E+00
Dieldrin	5.5E-04	mg/kg	2.3E-06	mg/kg-d	1.5E-02	1.5E-01	mg/kg-d	1.5E-04	1.5E-05
Chlordane	1.6E-02	mg/kg	6.8E-05	mg/kg-d	4.6E+00	9.2E+00	mg/kg-d	1.5E-05	7.4E-06
Lindane	1.1E-03	mg/kg	4.4E-06	mg/kg-d	1.6E+00	3.2E+00	mg/kg-d	2.8E-06	1.4E-06
Endrin	0.0E+00	mg/kg	0.0E+00	mg/kg-d	2.5E-02	5.0E-02	mg/kg-d	0.0E+00	0.0E+00
TOTAL AROCLOR	2.2E-02	mg/kg	9.1E-05	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.8E-02	4.5E-03
Aroclor 1254	1.5E-02	mg/kg	6.4E-05	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	1.3E-02	3.2E-03
Aroclor 1260	0.0E+00	mg/kg	0.0E+00	mg/kg-d	#N/A	#N/A			
Aroclor 1268	3.5E-03	mg/kg	1.5E-05	mg/kg-d	5.0E-03	2.0E-02	mg/kg-d	2.9E-03	7.4E-04
TEQ-MAMMAL	2.0E-04	mg/kg	8.4E-07	mg/kg-d	1.0E-06	1.0E-05	mg/kg-d	8.4E-01	8.4E-02
							HAZARD INDICES:	**1.3E+00**	1.5E-01

Notes:

a. Estimated Daily Intake (EDI) calculated using parameters presented in Table E.3-6.

b. Reference Dose Values presented in Table D-4 in the BERA (MACTEC, 2004).

c. Hazard Quotients (HQs) calculated by dividing the Estimated Daily Intake dose by either the NOAEL- or LOAEL-based Reference Dose.

TABLE E.3-8

SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING NOAEL-BASED TRVs : Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Raccoon
TOTAL RISK (HI): 3.3E+00

	Exposure Medium[a]							
Analyte	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals	Combined HQs[b]	Percent Contribution[c]
TEQ-MAMMAL		1.3E+00	-	8.4E-01	-	-	*2.1E+00*	*64%*
Antimony		2.8E-01	8.1E-03	3.6E-01	-	-	6.5E-01	*20%*
Arsenic		1.5E-01	2.2E-02	3.2E-02	-	-	2.1E-01	6%
Copper		2.9E-02	4.0E-02	5.3E-03	-	-	7.3E-02	2%
Vanadium		5.1E-02	7.0E-04	7.6E-03	-	-	5.9E-02	2%
TOTAL AROCLOR		2.6E-02	2.3E-04	1.8E-02	-	-	4.5E-02	1%
Aroclor 1254		1.9E-02	3.7E-04	1.3E-02	-	-	3.2E-02	1%
Molybdenum		1.6E-02	1.2E-02	2.5E-03	-	-	3.1E-02	1%
Selenium		4.4E-03	8.1E-03	1.4E-02	-	-	2.7E-02	1%
Aroclor 1260		1.3E-02	6.4E-05		-	-	1.3E-02	0%
Cadmium		1.2E-03	7.7E-04	9.4E-03	-	-	1.1E-02	0%
Manganese		6.9E-03	1.6E-03	2.6E-03	-	-	1.1E-02	0%
Aroclor 1268		3.7E-03	1.8E-05	2.9E-03	-	-	6.6E-03	0%
Zinc		7.8E-04	3.9E-03	9.0E-04	-	-	5.5E-03	0%
Nickel		7.3E-04	1.3E-04	2.3E-03	-	-	3.2E-03	0%
Thallium		2.3E-03	2.7E-05	7.8E-04	-	-	3.1E-03	0%
Lead		1.8E-03	5.0E-04	5.0E-04	-	-	2.8E-03	0%
Mercury		1.1E-03	3.9E-04	3.8E-04	-	-	1.8E-03	0%
4,4'-DDE		2.3E-04	3.1E-06	2.3E-04	-	-	4.6E-04	0%
4,4'-DDT		3.0E-04	6.1E-06	1.2E-04	-	-	4.2E-04	0%
Dieldrin		1.4E-04	1.3E-05	1.5E-04	-	-	3.0E-04	0%
Aldrin		1.7E-04	3.2E-06	-	-	-	1.7E-04	0%
Silver		4.3E-05	1.7E-06	8.9E-06	-	-	5.4E-05	0%
Chlordane		2.0E-05	7.6E-07	1.5E-05	-	-	3.6E-05	0%
Endrin		2.2E-05	2.4E-06	-	-	-	2.5E-05	0%
Chromium		1.4E-05	1.6E-06	2.2E-06	-	-	1.8E-05	0%
4,4'-DDD		5.4E-06	1.9E-07	4.8E-06	-	-	1.0E-05	0%
Lindane		1.1E-06	9.2E-07	2.8E-06	-	-	4.8E-06	0%
TOTAL MEDIUM-SPECIFIC RISK	-	**1.9E+00**	**9.8E-02**	**1.3E+00**	-	-	**3.3E+00**	
PERCENTAGE OF TOTAL RISK		**57%**	**3%**	**40%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

TABLE E.3-9
SUMMARY OF EXPOSURE PATHWAY/MEDIUM-SPECIFIC HAZARD QUOTIENTS USING LOAEL-BASED TRVs : Raccoon

Screening Level Ecological Risk Assessment
Centredale Manor River Restoration Superfund Site
North Providence, Rhode Island

SCENARIO TIMEFRAME: Current
EXPOSURE POINT: Oxbow Area Floodplain - 95% UCL
RECEPTOR: Raccoon
TOTAL RISK (HI): 4.2E-01

	Exposure Medium[a]							
Analyte	Surface Water	Soil	Terrestrial Plants	Terrestrial Inverts	Small Birds	Small Mammals	Combined HQs[b]	Percent Contribution[c]
TEQ-MAMMAL		1.3E-01	-	8.4E-02	-	-	2.1E-01	***50%***
Antimony		2.8E-02	8.1E-04	3.6E-02	-	-	6.5E-02	***16%***
Copper		2.2E-02	3.1E-02	4.1E-03	-	-	5.7E-02	***14%***
Arsenic		1.5E-02	2.2E-03	3.2E-03	-	-	2.1E-02	5%
Selenium		2.7E-03	4.9E-03	8.7E-03	-	-	1.6E-02	4%
Vanadium		1.0E-02	1.4E-04	1.5E-03	-	-	1.2E-02	3%
TOTAL AROCLOR		6.6E-03	5.8E-05	4.5E-03	-	-	1.1E-02	3%
Aroclor 1254		4.8E-03	9.3E-05	3.2E-03	-	-	8.1E-03	2%
Manganese		2.1E-03	4.8E-04	8.0E-04	-	-	3.4E-03	1%
Aroclor 1260		3.3E-03	1.6E-05		-	-	3.3E-03	1%
Molybdenum		1.6E-03	1.2E-03	2.5E-04	-	-	3.1E-03	1%
Zinc		3.9E-04	1.9E-03	4.5E-04	-	-	2.8E-03	1%
Aroclor 1268		9.2E-04	4.4E-06	7.4E-04	-	-	1.7E-03	0%
Nickel		2.9E-04	5.0E-05	9.2E-04	-	-	1.3E-03	0%
Cadmium		1.2E-04	7.7E-05	9.4E-04	-	-	1.1E-03	0%
Lead		6.1E-04	1.7E-04	1.7E-04	-	-	9.4E-04	0%
Thallium		2.3E-04	2.7E-06	7.8E-05	-	-	3.1E-04	0%
Mercury		1.1E-04	3.9E-05	3.8E-05	-	-	1.8E-04	0%
4,4'-DDE		4.5E-05	6.2E-07	4.7E-05	-	-	9.3E-05	0%
4,4'-DDT		5.9E-05	1.2E-06	2.3E-05	-	-	8.4E-05	0%
Dieldrin		1.4E-05	1.3E-06	1.5E-05	-	-	3.0E-05	0%
Chlordane		1.0E-05	3.8E-07	7.4E-06	-	-	1.8E-05	0%
Endrin		1.1E-05	1.2E-06	-	-	-	1.2E-05	0%
Aldrin		1.7E-05	3.2E-07	-	-	-	1.7E-05	0%
Silver		4.3E-06	1.7E-07	8.9E-07	-	-	5.4E-06	0%
4,4'-DDD		1.1E-06	3.8E-08	9.5E-07	-	-	2.1E-06	0%
Chromium		1.4E-06	1.6E-07	2.2E-07	-	-	1.8E-06	0%
Lindane		5.5E-07	4.6E-07	1.4E-06	-	-	2.4E-06	0%
TOTAL MEDIUM-SPECIFIC RISK	**-**	**2.3E-01**	**4.3E-02**	**1.5E-01**	**-**	**-**	**4.2E-01**	
PERCENTAGE OF TOTAL RISK		**54%**	**10%**	**36%**			**100%**	

Footnotes:

a. Hazard Quotients presented by exposure medium; a blank cell indicates that the analyte was not a COPEC for that medium; a dash entry indicates that there was no assumed exposure to that medium.

b. Combined risk across all media exposures.

c. Relative contribution of COPEC to total risk associated with the ingestion exposure pathway.

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