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**Report on the Remedial Investigation of Bear Creek Valley
at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee**

**Volume 6. Appendix G—Baseline Ecological Risk
Assessment Report**

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Energy Systems Environmental Restoration Program

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at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee**

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Assessment Report**

Date Issued—September 1996

Prepared by
Environmental Sciences Division
Oak Ridge National Laboratory
Oak Ridge, Tennessee

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PREFACE

This Remedial Investigation Report on the Bear Creek Valley Characterization Area at the Oak Ridge Y-12 Plant (DOE/OR/01-1455/V1&D1, -1455/V2&D1, -1455/V3&D1, -1455/V4&D1, -1455/V5&D1, and -1455/V6&D1) was prepared in accordance with requirements under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for reporting the results of a site characterization for public review. This work was performed under Work Breakdown Structure 1.4.12.1.1.02.41 (Activity Data Sheet 2302 "Bear Creek Valley"). Publication of this document on September 15, 1996, will meet a Federal Facilities Agreement milestone. This document provides the Environmental Restoration Program with information on the Bear Creek Valley remedial investigations that include results of the Bear Creek Valley OU 1 (1995) and OU 4 (1994) and Bear Creek Valley Floodplain Soils (1995) investigations, plus results of numerous other investigations and monitoring conducted in Bear Creek Valley. It includes information on risk assessments that have evaluated long-term impacts to human health and the environment. Information provided in this document forms the basis for the development of the Feasibility Study/Environmental Assessment Report.

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ACRONYMS AND ABBREVIATIONS

2,4,5-T	2,4,5-trichlorophenoxyacetic acid
amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
BCBG	Bear Creek Burial Grounds
BCK	Bear Creek Kilometer
BCV	Bear Creek Valley
BHHRA	Baseline Human Health Risk Assessment
BRA	baseline risk assessment
BYBY	Boneyard/Burnyard
CA	Characterization Area
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COPC	chemical of potential concern
COPEC	contaminant of potential ecological concern
CWA	Clean Water Act
DARA	Disposal Area Remedial Action Solids Storage Unit
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DOE	Department of Energy
DQO	data quality objective
EPA	Environmental Protection Agency
ER	Environmental Restoration
FA	functional area
FFA	Federal Facilities Agreement
FPSS	Floodplain soils and sediments
FS	Feasibility Study
GWQR	Groundwater Quality Report
HCDA	Hazardous Chemicals Disposal Area
HI	hazard index
HQ	hazard quotient
IP	integration point
LNAPL	light non-aqueous phase liquid
LOAEL	lowest observed adverse effect level
LOEC	lowest observed effect concentration
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NOAEL	no observed adverse effect level
NOEC	no observed effect concentration
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
NT	North Tributaries
OLF	Oil Landfarm

ORO	Oak Ridge Operations
ORP	Oil Retention Pond
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
OU	operable unit
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
ppm	parts per million
PRG	preliminary remediation goal
RAGS	<i>Risk Assessment Guidance for Superfund</i>
RBRGO	risk-based remedial goal option
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose
RGO	remedial goal option
RI	Remedial Investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Water Drinking Act
SL 1	Sanitary Landfill 1
SMCL	secondary maximum contaminant level
SRC	site-related contaminant
SSNAEL	site-specific no adverse effect level
SVOC	semivolatile organic compound
TBC	to be considered
TCA	trichloroethane
TCE	trichloroethene
TDEC	Tennessee Department of Environment and Conservation
TSCA	Toxic Substances Control Act
UCL	upper confidence limit
UEFPC	Upper East Fork Poplar Creek
UTL	upper tolerance limit
VOC	volatile organic compound
WIP	Walk-In Pits
WQC	water quality criteria

EXECUTIVE SUMMARY

This Remedial Investigation (RI) Report characterizes the nature and extent of contamination, evaluates the fate and transport of contaminants, and assesses risk to human health and the environment resulting from waste disposal and other U.S. Department of Energy (DOE) operations in Bear Creek Valley (BCV). BCV, which is located within the DOE Oak Ridge Reservation (ORR) (Fig. ES.1), encompasses multiple waste units containing hazardous and radioactive wastes arising from operations at the adjacent Oak Ridge Y-12 Plant (Fig. ES.2). The primary waste units discussed in this RI Report are the S-3 Site, Oil Landfarm (OLF), Boneyard/Burnyard (BYBY), Sanitary Landfill 1 (SL 1), and Bear Creek Burial Grounds (BCBG). These waste units, plus the contaminated media resulting from environmental transport of the wastes from these units, are the subject of this RI.

Consistent with the Watershed Approach to remedial investigation/feasibility study (RI/FS) planning adopted by the Oak Ridge Federal Facility Agreement (FFA) parties, the environmental media and waste sites in BCV have been combined into a single Characterization Area (CA) encompassing the entire Bear Creek watershed. The benefits of this approach have included:

- a significantly reduced site investigation phase, with more reliance on historical data as the basis for remedial action decisions;
- development of more consistent Remedial Goal Options (RGOs) across the multiple source units;
- an increased focus on development of an integrated prioritization for remedial actions, particularly for sites appropriate for near-term actions; and
- an overall reduction in cost and schedule for the RI/FS process.

Accordingly, the BCV RI Report documents and interprets the results of numerous historical field characterization efforts conducted in BCV prior to 1994 as well as three limited RI field projects covering specific portions of the watershed in 1994 and 1995. This interpretation provides a comprehensive evaluation of the conditions at and risks associated with the waste sites, associated floodplain, and groundwater in the valley.

Inherent in the accelerated watershed approach is the heavy reliance on historical data to form the basis of the RI. For BCV, a significant historical data set existed, thus minimal effort was spent by the watershed RI team in gathering additional extent of contamination information. While this approach greatly reduces the schedule and cost of the RI, it does result in higher levels of uncertainty in the evaluation results. The likelihood of important data gaps in the BCV RI was minimized by adherence to the Data Quality Objective (DQO) process during the planning phase, and by proactive uncertainty management during the data collection and evaluation phases. The resulting FS will accommodate the identified uncertainties through selection of contingent actions that will allow for flexibility within the remedy selection.

This BCV RI Report represents the first major step in the decision-making process for the BCV watershed. The RI results, in concert with the follow-on FS (to be available for public review in April 1997), will form the basis for the Proposed Plan and Record of Decision for all BCV sites. This comprehensive decision document process will meet the objectives of the watershed approach for

LEGEND:

- REACH 1 OF BEAR CREEK
- NT-1 and Bear Creek to NT-3
- REACH 2 OF BEAR CREEK
- NT-3 to BCK-9.40
- REACH 3 OF BEAR CREEK
- BCK-9.47 to ET-4
- REACH 4 OF BEAR CREEK
- ET-4 to EFPC
- GROUNDWATER WELL (individual wells not labeled unless mentioned in text.)
- SS-6 MAJOR SPRINGS
- / TS1 SOIL TRANSECT LOCATION

BEAR CREEK VALLEY LOCATION MAP

Figure ES.1. Location map for the Bear Creek Valley Characterization Area showing major geographical and hydrological features.

Y-12 PLANT NORTH

BEAR CREEK VALLEY

- LEGEND:**
- ===== ROADS
 - BEAR CREEK & TRIBUTARIES
 - SS4
 - GW-684
 - ⊕ GW-684
 - WASTE AREA UNITS

Figure ES.2. Location map for waste areas in the Bear Creek Valley Characterization Area.

BCV, which include: (1) prioritization of remedial action decisions, (2) expeditious implementation of highest priority remedial actions, and (3) increased cost effectiveness of remedial action by setting watershed Remedial Action Objectives (RAOs) based on an integrated, valley-wide, future land use plan. By conducting the evaluation within the watershed framework, DOE can ensure consistent actions that achieve the RAOs across all the units and cost effectively optimize the extent and type of remedies, regardless of location.

ES.1 MAJOR CONCLUSIONS FOR THE RI REPORT

The BCV RI Report contains a detailed analysis of environmental data for BCV. The major conclusions from the analysis are conveyed via conceptual models for the nature and extent of contamination and fate and transport of contaminants. Common to each of the major waste units located on the north side of Bear Creek are the following major conclusions:

- There are a number of physical and chemical aspects of the source sites that will complicate cleanup of the sources areas and will limit the ability to allow unrestricted, e.g., residential or industrial, use at these sites (S-3 Site, BYBY, and the BCBG). These are:
 - large volumes of buried waste exist at each source area in unlined trenches;
 - portions of the waste at each source area are inundated by shallow groundwater;
 - groundwater at the sources is contaminated to over 120 m (400 ft) depth and dense non-aqueous phase liquid (DNAPL) is present; at the S-3 Site and BCBG, contamination in groundwater is a secondary source that is of equal or greater magnitude than the primary waste source; and
 - the sources are situated on low permeability, fractured shale rock. Diffusion of contaminated groundwater into the rock pores has resulted in a reservoir of contaminated groundwater that can only be released from the rock at a slow rate.
- Contaminants migrating from the waste sites in BCV converge at Bear Creek Kilometer (BCK) 9.47/South Spring (SS)-5 (Fig. ES.1): more than 99% of available water from the upper portion of the valley passes through this location as either surface water or groundwater. Thus a north-south line drawn at BCK 9.47/SS-5 is a convenient location to conduct an integrator point/plane (IP) assessment of contaminant fluxes from the waste areas (Note: in some of the FS alternatives, unrestricted land use starts to the west of this line). At the IP, potential risks from exposure to groundwater or surface water exceed 10^{-6} or a Hazard Index (HI) >1 (Fig ES.3). The chemicals of concern (COCs) at the IP are uranium, nitrate, boron, and fluoride. In addition, applicable or relevant and appropriate requirements (ARARs) for nitrate are exceeded in groundwater at the IP and also most likely for uranium (Note: uranium contamination in GW-684 at the IP does not exceed the ARAR; however, groundwater discharge at SS-5 periodically exceeds the uranium ARAR). Although it is not clear how far the elevated hazard and ARAR exceedances extend to the west, they do not extend as far as Highway 95.
- Contaminated groundwater at waste areas migrates along geological strike to nearby tributaries of Bear Creek [i.e., North Tributary (NT) -1, -2, -3, -6, -7, and -8] causing the tributaries and Bear Creek to become contaminated. This is the principal exit pathway for contaminants leaving the waste areas and moving to the IP. Figure ES.3 shows what sources and tributaries contribute the most to contamination at the IP. The S-3 Site (NT-1, NT-2, and Bear Creek above

Potential Risks and Toxic Effects at the Integrator Plane

BCK 9.4/SS-5 Aggregate

GW 684 Groundwater

*COPCs not listed individually have individual potential risk < 10⁻⁵ or HI < 0.1

Relative Contribution of Uranium and Nitrate at the IP from Source Areas

Uranium Flux

*Assumed distribution of ungauged flux is 70% BYBY, 30% S-3 Site.

Nitrate Flux

Figure ES.3. Potential risks and hazards at the Integrator point/plane and the relative magnitude of the sources for nitrate and uranium.

BCK 12.36) and BYBY (NT-3) sites are currently contributing more than 80% of the potential hazard at the IP through releases of uranium and, to a lesser extent, nitrate. The total flux from NT-1 and NT-2 is expected to increase in the foreseeable future and may result in a greater hazard at the IP. A 50 to 75% reduction in the current contaminant flux through tributaries or shallow groundwater at the S-3 Site and BYBY could reduce the total HI at the IP below 0.8.

- Discharges to surface water from a plume of contaminated groundwater at the S-3 Site are the primary causes of current impacts on the aquatic ecology in Bear Creek, east of BCK 9.47.
- Impacts of contamination at waste areas have been lessened by capping waste areas. In addition, seep collection at BCBG has lessened the downgradient impact of contamination migrating away from this source.

ES.2 BCV HYDROGEOLOGICAL CONCEPTUAL MODEL

The hydrogeological system in BCV is governed by the valley's geology. Rocks underlying BCV fall into two broad categories: those that are dominated by clastic lithologies (e.g., Nolichucky Shale) and those that are predominantly carbonates (e.g., Maynardville Limestone). The primary permeability of the rocks underlying BCV is very low. The formations are extensively fractured and, in the case of carbonate formations, karstified, creating a secondary porosity that results in substantially increased permeability.

Groundwater flows through fractures or solution conduits, which are well-connected and mostly parallel to geological strike (Fig. ES.4). Fracture aperture width generally decreases with depth, restricting the depth of active groundwater circulation. The shallow interval [top 30 m (100 ft)] of the Maynardville Limestone contains a well-connected maze of conduits that is able to transport water rapidly along strike, west in the axis of BCV. Groundwater in this interval is closely connected to flow in Bear Creek. Below 30 m (100 ft) in this formation, along strike flow occurs through discrete solution conduits and fractures that are not as well-interconnected than those in the shallow interval.

The Nolichucky Shale is the principal clastic formation that forms the northern flank of BCV. Most groundwater flow in the clastic formations occurs during and immediately following precipitation at the water table and shallow bedrock intervals [probably <15 m (50 ft) depth]. Flow is predominantly along strike, and discharge is to tributaries of Bear Creek after short flowpaths. During storms, flow in these shallow intervals may be rapid (up to 40 m/d).

As a result of predominantly short and shallow flow paths for groundwater in the clastic formations in BCV, although the largest mass of water (and consequently the largest mass of contaminants) exits BCV via surface water, groundwater is the principal pathway for contaminants leaving the waste units. The main flow and contaminant transport pathways in groundwater at the waste units are along strike with the discharge points at tributaries to Bear Creek. Fluxes in flow paths at the waste units (overland flow, soil interflow, and groundwater flow) have not been quantified but recharge followed by groundwater flow to tributaries constitutes the main water flux pathway. During a 10-month surface water monitoring program, an estimated 97% of water available for flow (precipitation and evapotranspiration) exited the section of the valley above BCK 9.47 as surface water flow.

BC-125a

ES.3 NATURE AND EXTENT OF CONTAMINATION

ES.3.1 Environmental Database

The environmental database used for the BCV RI includes 75,000 soil, sediment, groundwater, surface water, and biota analyses obtained during the RI field projects conducted during 1994 and 1995, and 20,000 soil, sediment, groundwater, and surface water analyses obtained from historical field studies conducted in the 1980s and early 1990s. A detailed data quality assessment review demonstrated that the quality of both the recent and historical chemical data is adequate: <1% of the recent data were considered unacceptable, and only 1.3% of the historical chemical data were rejected. Historical radiological data for groundwater were deemed unacceptable for use in the RI and the Human Health Risk Assessment, therefore, additional groundwater samples were taken during the RI to complete the radiological database.

ES.3.2 Waste Sites

The primary waste sites characterized in this BCV RI report are the S-3 Site, OLF, BYBY, SL 1, and BCBG (Fig. ES.2). Three other primary waste sites within BCV — Spoil Area 1, Rust Spoil Area, and SY-200 Yard — are discussed in the BCV OU 2 RI (Energy Systems 1995). Although these sources were described in the BCV OU 2 RI Report, the watershed approach dictates that their impacts on the environment in BCV are considered in this report. In addition, numerous smaller waste disposal or storage areas throughout BCV, such as the OLF Storage Containment Pad, Bear Creek Road Debris Burial area, and Creekside Debris Burial area, are also considered as potential contaminant sources.

During the DQO process for BCV, the RI team decided that direct sampling to characterize the waste materials was not feasible (DQO meeting minutes). Instead, the physical and chemical characteristics of the contaminant sources were derived from interpretation of historical data and information in waste management records: pre-closure sampling data were used to quantify waste contamination at the S-3 Ponds and OLF sites; a detailed waste inventory was used for BCBG; and data from recent (1994) soil sampling were used for BYBY and SL 1. Where possible, current conditions within each source area were estimated to allow modeling of the potential future releases and assessment of current and future risks.

The waste areas in BCV are located in the upper 3.5 km (2.2 miles) of the valley (east of the IP) (Fig ES.2). Both solid and liquid wastes were disposed of at these sites. Most liquid waste has either infiltrated to groundwater below the waste sites or has migrated in groundwater and surface water away from the source areas. The following volumes of waste, contaminated soil, and contaminated groundwater are estimated to be present in BCV (Note: volume estimates for soils and wastes do not include materials in waste area caps):

S-3 Site	1,600 m ³ waste and contaminated soils 7.1 × 10 ⁶ m ³ (5740 acre-ft) contaminated groundwater
Oil Landfarm	25,000 m ³ waste and contaminated soils
BYBY	90,000 m ³ waste and contaminated soils 0.4 × 10 ⁶ m ³ (320 acre-ft) contaminated groundwater

SL 1	110,000 m ³ waste and contaminated soils
BCBG	190,000 m ³ waste and contaminated soils 4.0 × 10 ⁶ m ³ (3200 acre-ft) contaminated groundwater

In addition, there is an estimated 5.7×10^6 m³ (4600 acre-ft) of contaminated groundwater in the Maynardville Limestone, and < 1,000 m³ of contaminated soils and waste materials on the BCV floodplain.

ES.3.3 Nature and Extent of Contamination in Environmental Media and Wastes

The data available for the BCV CA were divided into four functional areas (FAs), each of which contains data that are logically interpreted together because of location and/or contaminant source. Three of the FAs — the S-3 FA, the OLF FA, and the BCBG FA — include data that relate to the three primary waste areas (Fig. ES.2). The fourth FA is the Maynardville Limestone and Bear Creek FA, which is located downgradient of the source FAs and acts as an integrated exit pathway for contaminants migrating away from the source units, via groundwater in the Maynardville Limestone or surface water flow in Bear Creek.

S-3 Functional Area

The S-3 FA includes the soils, groundwater, and surface water at and immediately downgradient of the S-3 Site.

Sources and contaminants. At the S-3 Site FA, primary contaminant sources are (1) a plume of contaminated groundwater derived from infiltration of nitric acid waste water and density-driven flow downward into bedrock, and (2) sludges remaining in place in the former ponds. Thirty years of disposal of concentrated (~1 molar) nitric acid solutions at the S-3 Site has resulted in a reservoir of contaminated groundwater with high (> 10,000 mg/L) total dissolved solids (TDS) in the Nolichucky Shale at this site. Discharge of groundwater from this contaminated plume results in contaminated surface water with elevated TDS (maximum > 1000 mg/L).

Contamination derived from the S-3 Site can be identified in the Maynardville Limestone as far west as Picket W and in surface water at BCK 4.55. Primary contaminants that have migrated away from the S-3 Site include (1) nitrate, uranium, ⁹⁹Tc, barium, boron, cadmium, strontium, acetone, and tetrachloroethene (PCE) in groundwater, and (2) nitrate, cadmium, uranium, and ⁹⁹Tc in surface water. Contaminant concentrations in groundwater at the S-3 Site exceed ARARs for inorganic and organic chemicals in drinking water.

S-3 Site conceptual model. At the S-3 Site, contaminated groundwater in the Nolichucky Shale is the main source of contaminants to downgradient receptors: more contaminant mass flux is discharging to the creek than is leaching from waste materials that remain in the former ponds. Historically, during operations at the S-3 Ponds, most of the acidic waste water probably migrated rapidly to the main stem of Bear Creek, NT-1, and Upper East Fork Poplar Creek via shallow groundwater flow. At the present time, contaminants in this plume are migrating in shallow and deep groundwater and discharging to Bear Creek, NT-1, and NT-2 (Fig. ES.5).

Figure ES.5. Conceptual model for Bear Creek Valley showing the main contaminant migration pathways.

Contaminants have undergone differential retardation that has resulted in different distributions and exit pathways for the primary contaminants: nitrate, metals, uranium, ⁹⁹Tc, and PCE. Uranium and some metals are made relatively immobile by geochemical reactions and have been held up in the residuum and shallow groundwater close to the S-3 Site. The exit pathway for these contaminants is via discharge of shallow groundwater to Bear Creek. Nitrate, ⁹⁹Tc, PCE, and the more mobile metals have contaminated bedrock groundwater. The main pathway for these contaminants is along strike flow in the intermediate and deep groundwater intervals, followed by upwelling and/or diffusion to the shallow groundwater interval and discharge to NT-1 and NT-2. Nitrate is least retarded and has traveled the farthest from the S-3 Site — its occurrence in groundwater marks the maximum extent of contamination resulting from the S-3 Site.

All contaminants in groundwater at the S-3 Site have been retarded by matrix diffusion. A reservoir of contaminants in the matrix porosity now exists at the S-3 Site, where these contaminants flow and/or diffuse from the rock matrix into the active flow fractures in each pathway.

The maximum concentrations of PCE found at S-3 Site (> 1% of PCE solubility) indicate the potential for PCE bearing DNAPL in the bedrock formations beneath the ponds.

The plume of contaminated groundwater derived from the S-3 Site can be traced in the Nolichucky Shale as far west as NT-2. However, although the extent west of the plume in shallow groundwater is well known, no data points exist until downgradient of SL 1 to identify the leading edge of the plume in intermediate and deep groundwater. Increasing concentrations of nitrate in shallow wells near the NT-2 catchment over the past 10 years suggest that the center of mass of the nitrate plume may be moving along strike to the west in groundwater below 30 m (100 ft) depth. The probable condition is that the plume in deep groundwater extends no further west than the plume in shallow groundwater and that much of the contaminant mass flux in the plume is discharged to NT-2.

Oil Landfarm Functional Area

The OLF FA encompasses the soils, groundwater, and surface water at and immediately downgradient of four sites: OLF, BYBY, Hazardous Chemicals Disposal Area (HCDA), and SL 1.

Sources and contaminants. Both solid and liquid wastes were disposed of at the OLF FA. There are three primary locations of solid wastes: (1) buried waste materials at BYBY, (2) buried waste materials in the SL 1 trench, and (3) contaminated soils on the former OLF plots. In addition, disposals of liquid wastes at BYBY, HCDA, and OLF have resulted in plumes of volatile organic compound (VOC) -contaminated groundwater.

Contamination at the OLF FA is diverse, including metal, radionuclide, and VOC contamination in groundwater, surface water, soils, and waste materials. Frequently detected contaminants in the OLF FA are as follows:

- At BYBY and HCDA: (1) mercury, beryllium, manganese, nickel, vanadium, PCE, trichloroethene (TCE), 1,2-dichloroethene (DCE), and uranium isotopes in groundwater; (2) mercury, lithium, and uranium isotopes in surface water; and (3) mercury, cadmium, copper, polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), phthalates, uranium isotopes, and ⁹⁹Tc in soils.

- At OLF: (1) PCBs and uranium in soils and wastes, and (2) 1,1,1-trichloroethane (TCA), 1,1-dichloroethane (DCA), 1,1-DCE, 1,2-DCE, PCE, and TCE in groundwater. There is no surface water contamination that can be attributed to OLF.
- At SL 1: (1) mercury, copper, nickel, PCB-1254, and ²³⁵U in soils and wastes, and (2) 1,1-DCA, 1,2-DCE, and vinyl chloride in groundwater. There is no surface water contamination that can be attributed to SL 1.

OLF FA conceptual model. The conceptual models for both OLF and SL 1 are that soils surrounding the waste sites are relatively uncontaminated. Groundwater below and immediately downgradient of each waste area is contaminated with VOCs as a result of liquid waste disposals.

At BYBY, uranium leaches from waste materials (some of which are most likely inundated with groundwater) and contaminated soils to groundwater, which subsequently discharges to surface water in NT-3. Uranium in groundwater that has leached from fill material in the southern portion of BYBY probably migrates directly to the Maynardville Limestone and Bear Creek via shallow groundwater flow (Fig. ES.5). Fate and transport modeling indicates that most inorganic and radiological contaminants in NT-3 have probably reached peak concentrations; however, the presence of a continuous source (leaching from waste materials) suggests that these peak values would be maintained over several hundred years.

The VOC plume at BYBY is partly located in residuum above the Maynardville Limestone and, like uranium, VOCs probably migrate directly into the Maynardville Limestone or Bear Creek. Although VOCs entering groundwater from HCDA or the Burnyard may discharge to surface water in NT-3, the extent of this discharge is low, hence, VOCs volatilize almost immediately.

Bear Creek Burial Grounds Functional Area

Sources and contaminants. At the BCBG FA, both solid and liquid wastes were disposed of in a series of unlined trenches. The waste trenches are grouped into areas BG-A, -B, -C, -D, -F, and Walk-in-Pits (WIP). Uranium dominates the wastes disposed of in each area with a total estimated mass of 18.6 million Kg. Disposals of liquid wastes have also resulted in DNAPL (PCE and TCE) in groundwater that may have reached depths of 180 m (600 ft). Dissolution of DNAPL results in plumes of VOC-contaminated groundwater.

Contamination in the BCBG FA includes VOCs and metals in groundwater, and VOCs, metals, and radionuclides in surface water, soils, waste materials, and leachate from waste trenches. In general, organic contamination of environmental media at BCBG is more widespread than inorganic and radionuclide contamination. Primary contaminants detected at the BCBG are: (1) boron, PCE, TCE, 1,1,1-TCA, and 1,2-DCE in groundwater; (2) beryllium, 1,1,2-TCA, 1,1-DCE, 1,2-DCA, vinyl chloride, 1,1-DCA, 1,1,1-TCA, chloroethane, and uranium isotopes in surface water; (3) arsenic, vanadium, PCBs, acetone, and toluene in soils surrounding the waste areas; and (4) uranium, beryllium, PCBs, TCE, and PCE in wastes. Contaminant concentrations in groundwater at BCBG exceed ARARs for inorganic and organic chemicals in drinking water at many locations.

Contamination of groundwater and surface water is dominated by VOCs at the BCBG FA. Three groundwater plumes were identified: (1) the BG-A plume is dominated by PCE, TCE, and 1,2-DCE, and includes DNAPL; (2) the WIP plume is dominated by PCE; and (3) the plume at the NT-8 catchment is dominated by 1,2-DCE, with lesser concentrations of vinyl chloride.

Radiological contamination is virtually absent from groundwater wells in the BCBG, but uranium is consistently detected in surface water. Collection of leachate in the NT-7 and NT-8 catchments has significantly reduced the concentration of radiological and other contaminants in surface water.

Radiological contamination occurs in soils in the NT-8 floodplain and is probably related to past deposition of contaminated sediments derived from drainage of the BG-B, -C, and -D areas.

BCBG conceptual model. The distribution of contaminants at BCBG reflects the type of waste materials that were disposed. The organic wastes were dense liquids and were disposed of directly into groundwater; uranium is in the solid form and is slowly leaching from trenches. The dominance of the hydrogeologic system by shallow flow restricts inorganic and radionuclide contamination to short flow paths in the shallow groundwater interval, whereas the density-driven flow of DNAPL provides a mechanism for organic contamination to enter the shallow, intermediate, and deep bedrock intervals (Fig. ES.5).

Oils and solvents were disposed of in the BG-A area by pouring the liquids into standpipes in debris- and waste-filled trenches. The bulk of these liquids migrated laterally to surface water and downward to groundwater, ultimately reaching depths of up to 180 m (600 ft) as DNAPL. Free-phase liquids occur in bedrock and probably remain in the trenches as residual droplets that have adhered to waste materials and minerals. Dissolved VOCs in the BG-A and NT-8 plumes have undergone limited chemical or biological degradation. A plume of dissolved PCE is migrating along strike in the Nolichucky Shale to the west of BG-A South. Fate and transport modeling suggests that a PCE plume may take a few hundred years to migrate along strike as far as NT-8.

Maynardville Limestone and Bear Creek Functional Area

The Maynardville Limestone and Bear Creek FA includes (1) soils and sediments in the Bear Creek floodplain, (2) groundwater in the Maynardville Limestone, and (3) surface water in the main stem of Bear Creek and in floodplain springs.

Sources and contaminants. The environmental media in this FA represent the downgradient pathways and receptors of contaminants migrating away from the sources on the Nolichucky Shale. The primary sources of contaminant input to Bear Creek and the Maynardville Limestone from the source sites are:

- S-3 Site: nitrate, radionuclides, and high TDS via discharge from NT-1 and NT-2, shallow groundwater discharges to Bear Creek, and shallow groundwater discharges directly to the Maynardville Limestone.
- BYBY: uranium via discharge from NT-3 and direct runoff to the Floodplain, and uranium and VOCs by shallow groundwater discharge into the Maynardville Limestone.
- SL 1: VOCs via shallow groundwater discharge into the Maynardville Limestone.
- BCBG: VOCs and uranium via discharge from NT-7 and NT-8.
- Past releases of TCE and 1,2-DCE from an unknown site east of BYBY FA or Rust Spoil Area.

- Past releases of TCE and 1,2-DCE from the Fire Training area in the neighboring Upper East Fork Poplar Creek (Fig. ES.1) hydrogeologic regime that may have migrated in karst in the Maynardville Limestone into the Bear Creek hydrogeologic regime at Spoil Area 1.

In addition, the Creekside Debris Burial area and the Bear Creek Road Debris Burial area are two waste areas, first identified during field operations for the BCV RI, with soil contamination on the Floodplain. These sites do not currently contribute to groundwater contamination but may have done so in the past. Primary contaminants in the Maynardville Limestone and Bear Creek FA are:

- nitrate, boron, uranium, strontium, barium, PCE, TCE, 1,2-DCE, and ^{99}Tc in groundwater; concentrations of these contaminants exceed ARARs for drinking water at many locations in the valley upgradient of BCK 9.47;
- barium, cadmium, manganese, uranium, boron, strontium, TCE, 1,2-DCE, and ^{99}Tc in springs and surface water upstream of BCK 9.47;
- nitrate, boron, strontium, and uranium in surface water downstream of BCK 9.47; and
- cadmium, uranium, and PCBs in Floodplain soils and sediments at a few locations [in general, contaminant concentrations are higher in sediments than in soils, and the highest concentrations in soils occur in the top 10 cm (4 in.) of soil].

Nitrate, uranium, and ^{99}Tc contamination occurs close to the S-3 Site and continues west as far as BCK 9.47 and Picket A. Nitrate contamination in groundwater occurs 2590 m (8500 ft) west of Picket A in Picket W, but uranium and ^{99}Tc have not reached this far west. TCE- and 1,2-DCE contaminated groundwater occurs in groundwater wells at the Spoil Area 1 and Rust Spoil Area. Concentrations of TCE and 1,2-DCE in groundwater increase downgradient of Rust Spoil Area at Picket C and adjacent to BYBY. The furthest west that TCE is detected in groundwater is in Picket B; however, discharge to SS-5 is contaminated with trace concentrations of TCE, which may indicate the presence of the leading edge of the TCE plume at Picket A.

Maynardville Limestone conceptual model. At monitoring points downgradient of BYBY (groundwater and surface water), the plumes from the S-3 Site and BYBY source areas are completely commingled (Fig. ES.5). It is only possible to identify BYBY as a contributor to the inorganic and organic Maynardville Limestone contaminant plumes because of the relative concentrations of contaminants in groundwater, surface water, and springs. Progressive changes in relative concentrations of contaminants in groundwater along the valley reflect the inputs to the Bear Creek/Maynardville Limestone system and suggest that after entering Bear Creek contaminants can migrate downward into the Maynardville Limestone (Fig. ES.5).

Surface water in Bear Creek and shallow groundwater in the Maynardville Limestone are closely interrelated and constitute 96% of water flowing along the valley. Contaminants in these media pathways are quickly diluted by rapid recharge of rainwater and inputs from noncontaminated tributaries. Concentrations of contaminants in the intermediate and deep groundwater pathways [30 to 90 m (100 to 300 ft) depth] are not attenuated as rapidly as those in shallow groundwater because this interval is somewhat isolated from inputs from recharge and tributaries. Plumes of groundwater contaminated above maximum contaminant levels in the 30 to 90 m (100 to 300 ft) depth interval are more continuous and extend further along the valley.

Groundwater contamination at Picket W is attributed both to diffuse contamination as a result of infiltration of contaminated surface water in Bear Creek and along strike migration of contaminated groundwater in intermediate and deep groundwater.

ES.4 CONTAMINANT FATE AND TRANSPORT PATHWAYS

The principal contaminant sources in BCV are located on the outcrop of the Nolichucky Shale (S-3 Site, BYBY, and BCBG), a carbonate-rich fractured shale with low permeability. Solid and liquid waste disposals have caused shallow groundwater contamination. Leaching of solid materials, particularly uranium, is a current source of shallow groundwater contamination. Where dense liquids were disposed of at the S-3 Site and BCBG, contamination of deep groundwater in the Nolichucky Shale has occurred. Contaminants migrate away from the waste disposal units using the following pathways (Fig. ES.5):

- Contaminated shallow groundwater at sources on the Nolichucky Shale migrates through fractures along geological strike and discharges to tributaries or directly to Bear Creek causing the tributaries and Bear Creek to become contaminated.
- Contaminants in deep groundwater in the Nolichucky Shale also migrate through fractures along strike and discharge to tributaries. However, contaminant pathways in the deep groundwater can underflow proximal tributaries and/or springs and be a source of contamination in neighboring tributary subwatersheds.
- After entering tributaries, contaminants migrate in surface water directly to Bear Creek. Bear Creek intermittently loses and gains water from groundwater in the Maynardville Limestone throughout the length of the valley. Losing reaches of Bear Creek cause groundwater contamination in the Maynardville Limestone. Gaining reaches of Bear Creek are associated with large springs at the base of Chestnut Ridge, some of which have contaminated discharge (SS-1, -4, -5, and -6).
- Surface water in Bear Creek and shallow groundwater in the Maynardville Limestone constitute 96% of water flowing along the valley. Contaminants in these media pathways are quickly diluted by rapid recharge of rainwater and inputs from noncontaminated tributaries.
- Deep groundwater in the Maynardville Limestone [30 to 90 m (100 to 300 ft) depth] constitutes <4% of water flowing along the valley. Concentrations of contaminants in this and in the deep groundwater pathway are not attenuated as rapidly as those in shallow groundwater; this pathway is an important source of long distance groundwater transport along the valley.
- Contaminant concentrations in shallow groundwater in the Nolichucky Shale and the Maynardville Limestone and in surface water are diluted by recharge during storm events and show seasonal trends of lower concentrations during periods of high rainfall.

Contaminants migrating from the waste sites in BCV converge at BCK 9.47/SS-5 — more than 99% of available water from the upper portion of the valley passes through this location as either surface water or groundwater.

ES.4.1 Integrator Point/Plane Assessment

To determine the contribution of each FA to the valley-wide contaminant flux migrating off site from the BCV CA, an IP assessment was completed at BCK 9.47/SS-5. Using a mass balance calculation, 69% of uranium measured at BCK 9.47 and SS-5 was measured at monitoring stations in tributaries to Bear Creek (gauged flux on Fig. ES.3). The remaining 31% was not measured in the RI (engaged flux) but is expected to be derived from migration of uranium directly to Bear Creek and the Maynardville Limestone via shallow groundwater at the BYBY and S-3 Site sources.

Assuming a similar distribution of the engaged flux as the gauged flux, then ~ 61% of the uranium found in surface water and groundwater at the IP is derived from BYBY. The S-3 Site is the second major contributor of uranium (26%), and this site contributes approximately 94% of the nitrate contamination at the IP. At the IP, 13% of the uranium is derived from BCBG. VOCs at the IP are mainly derived from BCBG; however, most VOCs (82%) discharged to surface water at source areas volatilize before reaching BCK 9.47. Boron was not measured in tributaries in the RI but is probably mostly derived from the BCBG where it was reported to be a contaminant in waste liquids that accompanied uranium tailings disposal and is found in the current leachate at BCBG.

Using these flux data, the portion of the total risk to human health and total hazard at the IP contributed by each waste site was calculated (Fig. ES.6). BYBY contributes most to the human health risk to the IP (38.5%), followed by BCBG (23.0%), and the S-3 Site (17.4%). Engaged uranium fluxes contribute 20.7% of risk at the IP. As discussed above, most of the engaged uranium flux originates in the BYBY (assumed 70%) and the S-3 Site (assumed 30%).

ES.4.2 Anticipated Future Changes

In the absence of remedial action and assuming maintenance of the current leachate collection system at BCBG, contaminant concentrations in most pathways are expected to remain at concentrations similar to those currently observed with four exceptions. These exceptions are:

- Concentrations of uranium and some metals in groundwater discharged to NT-1 are expected to increase in the foreseeable future (100 to 200 years). Concentrations of VOCs and nitrate may have peaked in this pathway but are expected to remain close to current levels for the next 100 years.
- Concentrations of nitrate, uranium, and some metals in groundwater discharged to NT-2 are expected to increase in the foreseeable future (100 to 1000 years).
- Along strike migration in the Nolichucky Shale of a plume of PCE-contaminated groundwater at BCBG may result in discharge of contaminated groundwater to NT-8 in the next 100 years. However, it is anticipated that volatilization of most of the VOCs in surface water, as is observed today, will lessen the impact of this discharge.
- Along strike migration in the Maynardville Limestone of a plume of TCE- and 1,2-DCE-contaminated groundwater at BCBG may result in discharge of increasingly contaminated groundwater at SS-5 and BCK 9.47 for the next 500 years. In addition, migration of this plume to BCK 9.47/SS-5 may result in unacceptable risk from use of groundwater at these locations and cause additional groundwater ARARs to be exceeded in the future.

Oak Ridge Reservation

BEAR CREEK WATERSHED

BEAR CREEK/MAYNARDVILLE LIMESTONE

BCK 9.47/SS-5

Figure ES.6. Relative contributions from source areas to potential risks and hazards at the IP.

In the absence of remedial actions, the resulting effect of these changes on contaminant fluxes will be to increase the fluxes of uranium, nitrate, some metals, and VOCs at the IP during the foreseeable future. The leading edge of the nitrate plume in BCV has reached Picket W wells ~ 2.3 km west of BCK 9.47 (Fig ES.1). Increased fluxes of contaminants at the IP will most likely result in extension of the plumes of contaminated groundwater west of BCK 9.47 and increased concentrations of contaminants at Picket W.

ES.5 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs and to-be-considered guidance that may be applicable to BCV have been identified so that remedial actions planned for BCV can be fully protective of human health and the environment. Chemical-specific guidance for the BCV include:

- Environmental Protection Agency's (EPA's) insufficient yield criterion for groundwater classification;
- Safe Drinking Water Act maximum contaminant levels;
- National Secondary Drinking Water Standards secondary maximum contaminant levels;
- EPA rule for natural attenuation of contaminants in groundwater in cases where active remediation is not appropriate; and
- Tennessee Department of Environment and Conservation ambient water quality criteria.

Chemical-specific ARARs for soils and sediments and location- and action-specific ARARs applicable to sensitive resources are usually invoked during remedial action. Thus, these ARARs will be analyzed and discussed as remedial alternatives are screened in the BCV FS.

ES.6 BASELINE RISK ASSESSMENT

ES.6.1 Baseline Human Health Risk Assessment

Conclusions on potential human health risks in BCV are based on four hypothetical land uses for which risks to human health were calculated; these are current hypothetical "unprotected" site maintenance workers at the source areas, future industrial workers, future recreational receptors downstream of BCK 9.47, and future residential receptors (Figs. ES.7 and ES.8).

At BCBG, S-3 Site, and OLF, there is an important distinction between contamination due to buried waste materials and soil contamination resulting from mobilization of contaminants in wastes (secondary contamination). In general, although secondary contamination is present in soils immediately surrounding the wastes, the concentrations of contaminants in these soils are lower and pose potential risks that are orders of magnitude less than those from the neighboring waste materials. Soils surrounding waste units generally pose risks to potential future residents but little risks to potential future industrial or unprotected maintenance workers; whereas exposure to contaminants in wastes poses high risks for potential future residents and future industrial workers. With the exception of BYBY and BG-D, -E, and -J, waste materials are buried and covered with multilayer RCRA caps; therefore, the scenario for exposure of future residents and industrial workers assumes degradation of these caps and eventual uncovering of the wastes.

Figure ES.7. Distribution of risks posed to potential future residents and recreational users in Bear Creek Valley.

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Figure ES.8. Distribution of risks posed to potential future industrial workers and unprotected maintenance workers in Bear Creek Valley.

Current "unprotected" maintenance worker. Risks from exposures to an unprotected maintenance worker (rather than a worker having the level of protection currently required for access at BCV sites) were evaluated to provide a conservative estimate of current risk. Assuming that existing caps at the waste areas are maintained, the only risks exceeding 10^{-4} identified for an unprotected maintenance worker at any of the BCV sites are through exposure to three chemicals of concern (COCs) (^{234}U , ^{235}U , and ^{238}U) found in hot spot soils, where waste material was exposed at the surface, at BYBY, and at BCBG (Fig. ES.8).

Future industrial worker. Risks/hazards to a future industrial worker can occur from exposure to 33 COCs:

- buried and capped wastes at the S-3 Site contain 12 COCs (beryllium, PCB-1248, and radionuclides);
- soils adjacent to the OLF cap contain 4 COCs (arsenic and radionuclides);
- soils at BYBY contain 12 COCs (metals, PAHs, and radionuclides);
- soils adjacent to caps, hot spot soils near BG-D East, and buried wastes at BCBG contain 12 COCs (metals, PCBs, VOCs, and radionuclides); and
- inventoried soils at the Disposal Area Remedial Action (DARA) Solids Storage Unit and the OLF Storage Pad contain 6 COCs (dioxins, PCB-1254, and uranium isotopes) and 4 COCs (beryllium, PCBs, and uranium isotopes), respectively.

Future recreational receptor. Risks to a future recreational user of BCV were evaluated for the BCV Floodplain, starting just west of the BCBG (BCK 9.47) and ending near Highway 95. Only one pathway was estimated to pose potential risks under this scenario: ingestion of fish that have bioaccumulated mercury (i.e., methylmercury) and PCBs (Fig. ES.7). However, there is uncertainty whether the fish analyzed in the assessment were exposed to contamination only from Bear Creek. No COCs associated with exposure to surface water, floodplain soils, and sediments were identified.

Future resident. Although a residential exposure scenario at the source areas is unlikely, it was evaluated to obtain a reasonable maximum exposure estimate of the risk to future human receptors in BCV.

West of BCK 9.47 and Picket A, total pathway risks from aggregated data do not exceed 10^{-4} (Fig. ES.7). Two individual locations have COCs associated with them. These are:

- 1 COC, PCB-1254, in soils at SP04 near Highway 95 in the BCV Floodplain;
- 4 COCs, arsenic, chromium, manganese, and PCB-1254 in sediments in Bear Creek near NT-9 and NT-11; and
- 2 COCs, boron and strontium, considered as naturally occurring and not related to activities in BCV, were identified for well GW-711 at Picket W.

In addition, low activities (< 7 pCi/L) of radium, ^{137}Cs , and ^{228}Th in groundwater at Picket W and arsenic, ^{137}Cs , and ^{238}U in surface water in Bear Creek downstream of BCK 9.47 pose risk between 10^{-6} and 10^{-4} . However, there is a high degree of uncertainty associated with these radiological data, and the lack of other radionuclides usually associated with contamination in BCV (e.g., U and ^{99}Tc) in these wells makes their occurrence at Picket W suspect.

At the IP, total pathway risks are between 10^{-4} and 10^{-6} . Specific risks and hazards are as follows:

- Ingestion of isotopic uranium in groundwater in GW-684 poses a risk between 10^{-6} and 10^{-4} to future residents. Nitrate and uranium in groundwater in this well also result in a potential HI = 1 for future residents.
- Ingestion of PCE, TCE, ^{99}Tc , ^{137}Cs , ^{237}Np , and isotopic uranium in surface water poses a potential risk between 10^{-6} and 10^{-4} to future residents. Ingestion of uranium in surface water at the IP also results in an HI > 1 for future residents with boron, fluoride, and nitrate also contributing to the hazard.
- Soils at transect TS4, located at the confluence of NT-8 and Bear Creek (Fig. ES.1), pose a potential risk > 10^{-4} to future residents via incidental ingestion or external exposure from beryllium, PCB-1260, or isotopic uranium.

East of BCK 9.47, risks and hazards posed to potential future residents are numerous, and at nearly all locations cumulative pathway risks exceed 10^{-4} and/or HIs exceed 1 via exposure to waste, soil, groundwater, or surface water (Fig. ES.7). Potential risks/hazards to future residents can occur from exposure to 94 COCs:

- at the S-3 Site FA: 34 COCs in groundwater, 13 COCs in surface water, 2 COCs in soils, and 17 COCs in buried/capped waste;
- at the OLF FA: 28 COCs in groundwater and 11 COCs in surface water, 10 COCs in OLF soils, 6 COCs in OLF Storage Pad soils, 12 COCs in SL 1 soils, and 22 COCs in BYBY soils;
- at the BCBG FA: 23 COCs in groundwater, 14 COCs in surface water, 41 COCs in leachate, 11 COCs in soils adjacent to caps and in hot spots, 16 COCs in buried waste, 7 COCs in DARA soils; an
- for the Maynardville Limestone and Bear Creek FA: 13 COCs in Bear Creek Road Debris Burial area, and 16 COCs in Creekside Debris Burial area.

In addition to the risk/hazard associated with exposure to chemicals in BCV, the BCBG site presents potential physical hazards associated with the burial of pyrophoric and explosive agents. An incompatibility study conducted in 1984 concluded that it is reasonable to expect that excavation at BCBG would foster additional reactions through re-exposure to air and unavoidable mixing as wastes are handled.

ES.6.2 Ecological Risk Assessment

Ecological risk was estimated for fish, benthic invertebrate, soil invertebrate, and plant communities and representative organisms of populations of small mammals (mice and shrew), piscivores (mink and kingfisher), large herbivores (deer), and predator/scavengers (hawks and fox). The baseline ecological risk assessment identified significant ecological risks from chemicals in water, sediment, soil, and shallow groundwater for one or more receptors. Metals and PCBs are the primary contaminants of potential ecological concern, and source area and floodplain soils, including transects west of 9.47, contribute to these risks (Fig. ES.9).

In characterizing risk to the assessment endpoints established for the BCV baseline ecological risk assessment (e.g. species richness and abundance), a 20% or greater reduction in one of the

Figure ES.9. Distribution of risks posed to aquatic and terrestrial biota in Bear Creek Valley.

endpoint properties measured in the field or a 20% reduction in survivorship, growth, or reproduction in a toxicity test was considered to be potentially significant. The assessment endpoints and their associated risks for the BCV are:

Reduction in species richness or abundance in fish communities resulting from toxicity. Risks to fish communities were evaluated for Bear Creek, which was divided into four reaches for the baseline ecological risk assessment (Fig. ES.1), and for tributaries NT-2 through NT-8. Both dissolved phase and total concentrations of metals were used in the exposure assessment for fish. The weight of evidence suggests that water from Bear Creek and NT-2 through NT-8 does not pose a significant risk of a 20% reduction in fish species richness or abundance or in the Tennessee dace population due to a toxic effect.

Reduction in species richness or abundance of benthic macroinvertebrate communities resulting from toxicity. Benthic invertebrates exposed primarily to surface water in erosional areas were evaluated separately from those exposed primarily to fine sediments in depositional areas. For benthic invertebrates in erosional areas, the weight of evidence suggests that water in Reaches 1 and 2, NT-2, SS-1, and SS-4 poses a significant risk of a 20% reduction in species richness and abundance due to a toxic effect from high concentrations of calcium, cadmium, manganese, nickel, and uranium. For benthic invertebrates in depositional areas, the weight of evidence suggests that sediment from 3 of 18 sites poses a significant risk due to a toxic effect, probably from manganese and, potentially, selenium and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). However, it is unlikely that the soft-sediment benthic invertebrate community as a whole is reduced by 20% in species richness or abundance.

Reduction in production of soil/litter invertebrates resulting from toxicity. Risk to soil invertebrates was evaluated for four source areas (S-3 Site, BYBY, combined SL 1 and OLF, and BCBG) and for the Bear Creek Floodplain. Risks of a toxic effect to soil invertebrates from mercury and, possibly, chromium, copper, and zinc, are estimated to be significant in the S-3 Site, SL 1/OLF, BYBY, Creekside Debris Burial area, and Bear Creek Road Debris Burial area.

Reduction in production of terrestrial plant communities resulting from toxicity. The plant communities in the BYBY area near HCDA are probably adversely affected by metals in shallow groundwater if they are exposed by root uptake. Soils at isolated locations along two Floodplain transects in Upper Bear Creek (transects TS3 and TS4, Fig. ES.1)) appear to pose a significant risk to plants.

Reduction in abundance or production of terrestrial wildlife populations resulting from toxicity. Risks to wide-ranging species were evaluated for the BCV as a whole. Risks to small mammals, which have more limited spatial requirements, were evaluated within the source areas and for BCV as a whole. Among the wide-ranging species, only fox were estimated to be significantly at risk of a 20% reduction in population production; this risk results from soil contamination by: antimony at BYBY; mercury at S-3 Site, BYBY, OLF, and Floodplain transect TS1; and PCBs in BCBG and Floodplain transects TS4 and TS10. Shrews are estimated to be significantly at risk of a 20% reduction in population production from high soil concentrations of metals at S-3 Site, BYBY, and OLF and PCBs at BCBG. Shrews are also estimated to be at risk from elevated chromium and PCBs in Floodplain soils in transects west of BCK 9.47. There were no risks to shrew, mouse, deer, hawk, and fox from uptake of radionuclides.

Reduction in abundance or production of piscivorous wildlife populations resulting from toxicity. Because piscivorous wildlife are highly mobile, risks to piscivores were evaluated for the BCV as a whole. Kingfishers inhabiting the watershed were estimated to be significantly at risk of a 20% reduction in population production because of mercury in fish.

ES.6.3 Conclusions about Potential Risk

At nearly all locations in BCV east of the IP, potential cumulative pathway risks posed to future residents exceed 10^{-4} and/or HIs exceed 1 via potential exposure to contaminants in waste, soil, groundwater, or surface water (Fig. ES.7). Cumulative pathway potential risks posed to future industrial workers or unprotected maintenance workers vary between 10^{-6} and 10^{-1} via exposure to buried waste and contaminated soil at hot spots (Fig. ES.8). Contamination both at the waste areas and in the floodplain poses risks to wide ranging predatory animals, fish-eating wildlife, small mammals, soil invertebrates, and plant communities (Fig. ES.9). Contaminants in surface water upstream of BCK 9.47 and in sediments in NT-2, NT-6, and reach 4 of Bear Creek pose risks to benthic invertebrates (Fig ES.9). In addition, ARARs are exceeded in groundwater at many locations east of the IP.

At the IP, potential human health risks posed from use of groundwater or surface water exceed 10^{-6} or an HI>1. The COCs at the IP are uranium, nitrate, boron, and fluoride. In addition, ARARs for nitrate, uranium, and VOCs are most likely exceeded in groundwater.

In the portion of the valley west of the IP, environmental media are contaminated as a result of releases from the waste areas east of the IP, but contamination is slight and poses relatively little risk (Figs. ES.7 to ES.8). West of the IP, the most prevalent contaminants in groundwater and surface water are chloride, fluoride, nitrate, boron, strontium, and uranium, but contamination does not exceed ARARs. For a potential future residential receptor, four COCs (As, Cr, Mn, and PCB-1254) were identified in sediments from Bear Creek at two locations, and one COC (PCB-1254) in soils at one location in the Bear Creek floodplain.

ES.7 REMEDIAL GOAL OPTIONS

Media- and chemical-specific RGOs have been developed for each chemical of concern in BCV. RGOs are target cleanup goals to be used in identifying effective remedial technologies. They are not proposed final cleanup levels. RGOs were calculated for the following three criteria:

- Chemicals of concern identified in the baseline human health risk assessment. For these chemicals of concern, RGOs were calculated to be protective of human health at target risk levels of 10^{-4} , 10^{-5} , and 10^{-6} and target HIs of 0.1, 1, and 3.
- Chemicals of concern identified in the baseline ecological risk assessment. For these chemicals of concern, RGOs represent benchmarks, probable effects levels, ambient water quality criteria, and naturally occurring background levels.
- Chemicals of concern identified as chemicals that exceed ARARs. For these COCs, RGOs represent the ARAR.

In addition, results of fate and transport modeling were used to identify chemicals that are likely to exceed ARARS or preliminary remediation goals as a result of leaching from soils to groundwater

or transport to surface water in the future. These chemicals are also considered chemicals of concern, and the RGOs for these chemicals are considered the maximum contaminant level or preliminary remediation goal in the receptor medium.

The ability to meet RGOs for primary risk drivers will be evaluated in the FS. Based on the results of the baseline risk assessments, primary risk drivers include uranium, nitrate, and VOCs in the upper third section of BCV.

ES.8 TECHNICAL CONSIDERATIONS FOR REMEDIAL ACTIONS

Contamination in groundwater and surface water at, and west of, the IP is derived from migration away from the source sites. A remedial strategy with the goal of reducing contaminant fluxes at the IP to acceptable levels will have two general options: (1) take actions at the IP to mitigate exposures downstream, or (2) take actions upstream and east of the IP that will result in achieving the remedial goals at the IP.

Actions taken at the IP would be groundwater and surface water capture/treatment type actions. Actions taken upstream of the IP would involve interception of contaminant pathways to tributaries (i.e., actions taken closer to the sources) that would result in remediation of nitrate and uranium in contaminated surface water in Bear Creek and groundwater in the Maynardville Limestone. These actions may also be groundwater and surface water treatment actions taken closer to the sources, but could also include source isolation/treatment/removal to mitigate three pathways. In addition, a plume of VOC-contaminated water in the Maynardville Limestone that has no apparent source would also need to be addressed.

The following physical, chemical, and hydrological parameters will need to be addressed to achieve the remedial action objectives for BCV.

ES.8.1 Considerations for Remedial Actions for Groundwater and Surface Water at the Sources

- Large volumes of contaminated groundwater exist in the Nolichucky Shale at the contaminant sources ($7.1 \times 10^6 \text{ m}^3$ at the S-3 Site, $0.4 \times 10^6 \text{ m}^3$ at BYBY, and $4.0 \times 10^6 \text{ m}^3$ at BCBG). Due to the fractured nature of the Nolichucky Shale, < 10% of this contaminated volume occurs in fractures that are accessible for withdrawal of water. More than 90% of this volume occurs in the very low permeability matrix and contains the highest concentrations of contaminants. The mechanism for migration of contaminants from the matrix to flowing fractures is by chemical diffusion and is termed matrix diffusion. The result of matrix diffusion is that, if pump and treat technology is used to remediate a plume in fractured bedrock, many times the contaminated volume of water will require pumping before acceptable concentrations can be achieved.
- DNAPL occurs at two locations in the Nolichucky Shale, the S-3 Site and BCBG (Fig. ES.5). The nature of migration of DNAPL in the subsurface means that small droplets of residual DNAPL exist rather than large and identifiable pools of liquids. Thus, identification and extraction of DNAPL is not possible. Dissolution of DNAPL at these sites will, therefore, act as a dispersed source of contamination to groundwater.

- Some of the solid waste at BYBY, BCBG, and most likely at the S-3 Site is inundated by shallow groundwater and will be a continuing source for groundwater contamination unless it is hydraulically isolated from groundwater.
- Contaminated shallow and deep groundwater in the Nolichucky Shale migrates rapidly through discrete fractures or preferential pathways along geological strike to discharge to tributaries or directly to Bear Creek. Most of the groundwater flux most likely flows through a few discrete fracture zones; however, the specific locations and depths of these fracture zones are not known at this time and may be difficult to ascertain.
- Flow in shallow groundwater and tributaries is "flashy." For example, flow in NT-3 varies from extremes of 0 L/s to over 150 L/s (2400 gpm). Average baseflow in NT-3 varies from 0 L/s in summer to almost 10 L/s (160 gpm) during winter months.

ES.8.2 Considerations for Remedial Actions for Groundwater and Surface Water in the Maynardville Limestone

- Water flows through a network of interconnected cavities and fractures up to 150 m (500 ft) deep in the Maynardville Limestone. Most of the groundwater flux most likely flows through a few discrete cavities, however, the flux through these cavities and the specific locations and depths of these cavities are not known at this time and may be difficult to ascertain.
- The total flux of groundwater flow at the IP was calculated as 54,000 m³ during the 10-month monitoring period for the RI (~65,000 m³/a or 52.5 acre ft/a).
- Flow in Bear Creek at BCK 9.47 is flashy and varies from extremes of < 1 L/s (~16 gpm) to over 10,000 L/s (16,000 gpm). Average baseflow varies from < 1 L/s in summer to 100 L/s (1,600 gpm) during winter months. Flow in SS-5 is more steady than in Bear Creek and varies from extremes of < 3 L/s (~48 gpm) to over 100 L/s (1600 gpm). Average baseflow varies from < 3 L/s in summer to 10 L/s (160 gpm) during winter months.
- Concentrations of contaminants in BCK 9.47 and SS-5 are relatively dilute. For example, at BCK 9.47, uranium ranges from 52 to 152 µg/L and nitrate ranges from < 1 mg/L to 46.2 mg/L.

ES.8.3 Considerations for Remedial Actions for Soils at Sources

- Large volumes of buried waste materials exist at the BCBG, some of which are potentially pyrophoric or explosive. In addition, large volumes of waste materials and contaminated fill exist at BYBY, SL 1, and the S-3 Site.
- At some locations in BCBG and BYBY, and probably at the S-3 Site, waste materials are inundated by shallow groundwater.
- At some locations in BYBY and BCBG, waste materials occur at the surface of the soil. These locations constitute the most likely areas where direct exposure to waste could occur with unrestricted use.
- Many of the source areas are covered with RCRA caps that limit the possibility of direct exposure to waste materials under the current land use.

ES.8.4 Consideration for Remedial Actions for Soils/Sediments in the Bear Creek Floodplain

- The sampling strategy for floodplain soils and sediments was, by intention, biased towards likely sediment accumulation areas. The relatively small number of samples for the area of land that constitutes the Bear Creek floodplain means that volumes of contaminated soils are not well defined. The data indicate that contaminant concentrations are low and soil volumes are small (most likely < 1000 m³).

ES.8.5 Relative Importance of Pathways

For actions taken close to the sources, the relative importance of the pathways with regard to the contaminant mass flux is a consideration for which remedial actions will be most effective from a watershed perspective. The following parameters, therefore, also need to be considered:

- Figure ES.3 shows the potential human health risk/hazard from surface water and groundwater at the IP posed by exposure to the individual COCs. Figure ES.3 also lists the relative proportions of the flux of the two principal COCs, nitrate and uranium, derived from sources in BCV. Based on this ranking of source contributions to the total potential risk/hazard at the IP (refer to Sect. 3.2.7 and Appendix E), most of the potential risk/hazard is from uranium migrating from BYBY and the S-3 Site. In addition, most of ungauged flux is most likely from BYBY and the S-3 Site, further increasing the proportion of uranium flux derived from these sites. Nitrate is the second most important COC at the IP and is 94% derived from the S-3 Site.
- Reduction of the contaminant mass flux through shallow groundwater and/or surface water discharge in tributaries at BYBY and S-3 Site will reduce the overall mass flux of uranium and nitrate at the IP and achieve a reduction of potential risks and hazards at this location. For example, a reduction of 70% in the uranium flux from NT-3 and a similar reduction in the ungauged flux derived from this site (assumed to be 70% of the total ungauged flux) would result in a 43% reduction in the total uranium flux at the IP. A reduction of 70% in the contaminant flux from S-3 Site (NT-1 and NT-2) and a similar reduction in the ungauged flux derived from this site (assumed to be 30% of the total ungauged flux) would result in an 18% reduction in the total uranium flux at the IP, and a 66% reduction in the total nitrate flux.
- COCs for ecological receptors in Bear Creek are mainly metals in reaches 1 and 2 that are derived from discharge in NT-1, -2, and -3 (with the exception of mercury for which no sources have been defined in BCV). It can be expected that actions taken to reduce the contaminant flux in any of these pathways will result in a reduction of ecological impacts in Bear Creek east of the IP and reduce impacts to piscivores in all of BCV.

ES.9 DOCUMENT LAYOUT

The BCV RI Report is contained in six volumes. Volume 1, the RI Report, summarizes the extensive data analysis and interpretation that have been completed for the RI. The eight chapters of the Report address (1) the strategy used to satisfy the regulatory requirements in BCV; (2) physical and hydrogeological properties of BCV; (3) results of environmental investigations conducted to determine the nature, extent, fate, and transportation of contamination; (4) ARARs; (5) results of baseline human health risk assessment; (6) results of baseline ecological risk assessment; (7) RGOs derived from the RI; and (8) conclusions.

The RI Report is supported by seven appendices (A through G), contained in five volumes, that provide detailed analysis and discussion corroborating the information provided and conclusions reached in Volume 1. Volume 2 contains three appendices addressing (A) the operational histories of BCV waste sites and detailed analysis of inventory records of the BCBG; (B) the historical database for BCV and a detailed description of the field activities conducted during 1994 and 1995; and (C) the valley-wide hydrogeological conceptual model for BCV. Volumes 3 through 6, each containing one appendix, address (D) nature and extent of contamination in BCV; (E) fate and transport of contaminants in BCV; (F) baseline human health risk assessment; and (G) baseline ecological risk assessment.

G.1 FORMULATION OF THE ECOLOGICAL PROBLEM

The problem formulation consists of the identification of ecological endpoints, description of the relevant features of the environment, description of the sources of contamination, and summarization of that information in terms of a conceptual model of the hazard posed by the contaminants to the endpoint biota.

G.1.1 DESCRIPTION OF THE ENVIRONMENT

The environment considered in this assessment is the Bear Creek watershed, as described in Chap. 2 of the Summary Report and in Appendix D. It consists of Bear Creek from the confluence with Lower East Fork Poplar Creek (EFPC) to the headwaters at the western edge of the Oak Ridge Y-12 Plant, the associated floodplain and tributaries, and the source areas in Bear Creek Operable Unit 1 (BC OU 1). The federally and state-listed threatened and endangered species and other state-listed rare or declining species are listed in Chap. 2 of the Summary Report and in Appendix D.

G.1.2 SOURCES

The proximate sources considered in this assessment are the contaminated media and biota in the Bear Creek Valley (BCV) Characterization Area (CA): water, sediment, soil, shallow groundwater, fish, soil invertebrates, vegetation, and small mammals. The ultimate sources of the contaminants are the U.S. Department of Energy's (DOE's) operations of the Oak Ridge Y-12 Plant, including waste disposal, spills, and the use of chemicals such as pesticides in the environment. The primary sources considered in this assessment are the waste and secondary contamination at the S-3 Ponds, Boneyard/Burnyard (BYBY), Oil Landfarm (OLF), Sanitary Landfill 1, and Bear Creek Burial Grounds (BCBG). Chapter 3 and Appendix D detail the sources and contaminants considered in this assessment.

G.1.3 ECOLOGICAL ENDPOINTS

The problem formulation must identify both the assessment endpoints, which are explicit statements of the characteristics of the environment that are to be protected, and the measurement endpoints, which are quantitative summaries of a measurement or series of measurements that are related to effects on an assessment endpoint.

G.1.3.1 Assessment Endpoints

The following assessment endpoints for aquatic and terrestrial risks have been selected for this assessment:

- reduction in species richness or abundance in fish communities resulting from toxicity,
- reduction in species richness or abundance of benthic macroinvertebrate communities resulting from toxicity,
- reduction in abundance or production of piscivorous wildlife populations resulting from toxicity,
- reduction in production of terrestrial plant communities resulting from toxicity,

- reduction in production of soil/litter invertebrates resulting from toxicity,
- reduction in abundance or production of terrestrial wildlife populations resulting from toxicity, and
- reduction in viability or fecundity of individuals of any federally or state-listed threatened or endangered species resulting from toxicity.

There is not a specific endpoint for protection of wetlands. Under the baseline scenario, the only hazard to wetlands is that posed by the contaminants. These are covered by the other endpoints. In particular, the concentrations of chemicals in shallow groundwater and seep water are compared with concentrations causing phytotoxic effects in solution cultures as a means of estimating effects on the plant communities in wetlands. Concentrations in seep water also are compared with concentrations causing effects on aquatic organisms. The special protection of wetlands becomes a distinct issue in the feasibility study where destruction of wetlands by remedial actions must be considered.

The ecological assessment endpoints have been selected based on meetings about data quality objectives (DQOs) that included representatives of DOE, the U.S. Environmental Protection Agency (EPA) Region IV, and the Tennessee Department of Environment and Conservation. The selected endpoints are explained here.

- The fish community is considered to be an appropriate endpoint community because it is ecologically important, susceptible, and has a scale appropriate to the site. The ecological significance comes from the fact that much of the energy flow in temperate streams passes through fishes and fishes are a major nutrient reservoir in those systems. In addition, most of the fish species in the BCV CA move within an area smaller than the CA, so the scale is appropriate.
- The benthic invertebrate community is considered to be an appropriate endpoint community because they are highly susceptible, and have a scale appropriate to the site. The high susceptibility is due to the association of these organisms with the sediment and water. In addition, the insects and crustaceans that dominate this community are sensitive to a variety of contaminants. Because these organisms are sedentary, their scale is highly appropriate to the scale of the site.
- Piscivorous wildlife are considered to be an appropriate endpoint trophic group because they are highly susceptible. Two of the contaminants of potential concern, polychlorinated biphenyls (PCBs) and mercury, biomagnify in aquatic food webs, leading to high levels of exposure in piscivorous wildlife. Mink have been shown to be highly sensitive to the toxic effects of PCBs and mercury in toxicity tests. Reproduction of piscivorous birds has been shown to be highly sensitive to PCBs. Although populations of piscivorous wildlife are not as clearly associated with the CA as the aquatic communities, individuals forage within an area smaller than BCV (at least during the breeding season). Although the individuals inhabiting the CA do not constitute a biological population, they have been defined as a population for regulatory purposes. By this definition, the CA is an appropriate scale for this endpoint. The chosen endpoint populations are mink and belted kingfisher.
- The terrestrial plant community is considered to be an appropriate endpoint community because it is ecologically important, susceptible, and has a scale appropriate to the site. The ecological significance comes from the fact that the plant community is responsible for primary production. This community is susceptible because it is directly exposed to the contaminants in the floodplain and source area soils. Finally, the scale is appropriate because plants are immobile and because a distinct plant community exists in BCV.
- The soil invertebrate community is considered to be an appropriate endpoint because it is ecologically important, susceptible, and has a scale appropriate to the site. The primary value of

this community is its functional role in decomposition and energy and nutrient cycling. The soil community is highly exposed to contaminated soil. The inherent sensitivity of soil processes to contaminants is low, but the sensitivity of particular taxa including earthworms is largely unknown. Earthworms are probably the most important soil invertebrate in promoting soil fertility (Edwards, 1964). Their feeding and burrowing activities act to break down organic matter resulting in release of nutrients, and to improve aeration, drainage, and aggregation of soil. Earthworms are also important components of the diets of many animals. Because of their small size and relative immobility, earthworms can be assessed on the scale of small subunits of OUs. The chosen characteristics of this endpoint are abundance or production.

- Small vermivorous wildlife are considered to be an appropriate endpoint because they are susceptible and have a scale appropriate to the site. Because vermivorous wildlife consume large volumes of invertebrates, they are highly exposed and susceptible to contaminants bioaccumulated by soil invertebrates. In addition, shrews, amphibians, and reptiles burrow and are in close physical contact with soil and may take up contaminants directly through ingestion or dermal contact. These species, however, are not known to play any particularly significant role in the ecosystems that they inhabit. Because many vermivores have limited home ranges and relatively low mobility, the CA is an appropriate scale to assess risks to their populations. The chosen characteristics of the endpoint are abundance or production of the local populations of short-tailed shrew.
- Small omnivorous wildlife are considered to be an appropriate endpoint because they are susceptible and have a scale appropriate to the site. Omnivorous wildlife are more exposed to chemicals than herbivores, possibly because of their consumption of ground invertebrates (Talmadge and Walton 1993). In addition, small omnivores burrow and are in close physical contact with soil and may take up contaminants directly through ingestion or dermal contact. Small omnivores are likely to be the most abundant mammalian group on most of the CA, though they are not known to play any particularly significant role in the ecosystems that they inhabit. Because small omnivores have limited home ranges, the CA is an appropriate scale to assess risks to their populations. The chosen characteristics of the endpoint are abundance or production of the local populations of white-footed mice.
- Large herbivorous wildlife are considered to be an appropriate endpoint because they are societally important. Most large herbivores are valued game species, conspicuous, and aesthetically pleasing and therefore have high societal value. In general, these species are not known to play any particularly significant role in the ecosystems that they inhabit. Although populations of large herbivores are not as clearly associated with the CA as the small omnivores and vermivores, individuals are likely to forage within an area the size of the Bear Creek watershed. Although the individuals inhabiting the CA do not constitute a biological population, they have been defined as a population for regulatory purposes. By this definition, the CA is an appropriate scale for this endpoint. The chosen endpoint population is the white-tailed deer.
- Predators and scavengers are considered to be an appropriate endpoint because they are susceptible and societally important. They are susceptible to contamination because they are at the top of the food web and spatially integrate chemicals bioaccumulated by lower trophic levels. Avian predators and scavengers are conspicuous and generally aesthetically appealing so they have high societal value. While most mammalian predators are not conspicuous, the status of their populations is a concern to the public. Although populations of predators and scavengers are not as clearly associated with the CA as the small omnivores and vermivores, individuals are likely to forage within an area the size of the Bear Creek watershed. Although the individuals inhabiting the CA do not constitute a biological population, they have been defined as a population for regulatory purposes. By this definition, the CA is an appropriate scale for this endpoint. The chosen endpoint populations are the red-tailed hawk and red fox.

- Threatened and endangered species are, in general, too rare to be ecologically significant, and may not be particularly susceptible or clearly associated with the site. However, they have high societal and policy importance. Because of the particular societal value placed on these organisms, as reflected in the Endangered Species Act, the endpoint properties for these species are any toxic effect that would reduce survivorship or fecundity of individuals of listed threatened or endangered species that currently occur in the CA or may occur in the future. Threatened and endangered species that occur in the region are listed in Supporting Information for Appendix D. Federally and state-listed threatened and endangered species with habitat requirements or food habits that could lead to significant exposure in the CA are evaluated in this assessment as follows:
 - There is no basis for estimating risks to particular plant species, and the available plant toxicity data are for effects on individual plants. Therefore, the results of the assessment of soil, shallow groundwater, and seep water phytotoxicity are applicable to threatened and endangered plants.
 - The northern pine snake is a state-listed threatened species that is known to occur in the CA. Toxic effects on reptiles cannot be assessed with existing toxicological data. Therefore, it must be assumed that the assessment of risks to other predator and scavenger species will serve to protect these species as well.
 - The cooper's hawk and sharp-shinned hawk are state-listed threatened species that may occur in the CA. Although these species prey primarily on small birds, the cooper's hawk also will take small mammals. There is insufficient data to estimate contaminant concentrations in birds, site-specific concentrations and transfer factors are available for small mammals, and it is unlikely that small birds are considerably more contaminated than the omnivorous small mammals collected for this assessment. Therefore, it must be assumed that the assessment of risks to the red-tailed hawk will serve to protect these species as well.
 - The endangered Indiana bat is not expected to occur in the CA, based on the results of a comprehensive survey conducted on neighboring Lower East Fork Poplar Creek. Although the gray bat is known to occur on the Oak Ridge Reservation (ORR), it forages over large bodies of open water, such as the Clinch River, and therefore is unlikely to be exposed to contaminants in Bear Creek.

In addition to defining the assessment endpoints in terms of environmental entities (e.g., the fish community) and properties of those entities (e.g., species richness), it is necessary to identify a level of effect on those properties. The level of effect is used to help determine how much sampling is needed during the DQO process and to provide a benchmark for comparison of estimates of effects obtained through different lines of evidence. A 20% or greater reduction in one of the endpoint properties measured in the field or a 20% reduction in survivorship, growth, or reproduction in a toxicity test is considered to be potentially significant. The figure 20% used in the definition of ecological assessment endpoints is based on an analysis of EPA and Tennessee regulatory practice; it was adopted by the Federal Facility Agreement parties in a DQO process (Ashwood et al. 1994) and incorporated into the plan for ecological risk assessment for the ORR (Suter et al. 1995).

G.1.3.2 Measurement Endpoints

Three basic types of effects data are potentially available to serve as measurement endpoints: results of biological surveys, toxicity tests performed on media from the CA, and toxicity test endpoints for chemicals found in the CA. Measurement endpoints for each assessment endpoint are presented here.

Fish

- Biological survey data—Species richness and abundance from Biological Monitoring and Abatement Program fish community surveys. These measurement endpoints are assumed to be direct estimates of that assessment endpoint.
- Media toxicity data—Reductions in growth and survivorship of larval fathead minnows and in fecundity and survivorship of *Ceriodaphnia dubia* (*C. dubia*) in 7-day tests of ambient water. Responses that are statistically significantly different or are inhibited by 20% or greater relative to control water are assumed to be indicative of waters that are toxic to fish.
- Single chemical toxicity data—Chronic toxicity thresholds for freshwater fish expressed as chronic EC20s or chronic values (CVs). These test endpoints correspond to the assessment endpoint for this community. That is, the sensitivity distribution of the test species is assumed to approximate the distribution of BCV species, and exceedence of the CVs and EC20s are assumed to correspond to 20% or greater reductions in abundance, with some uncertainty.

Benthic invertebrates

- Biological survey data—Species richness and abundance reported from Biological Monitoring and Abatement Program benthic invertebrates surveys. These measurement endpoints are assumed to be direct estimates of the assessment endpoint for this community.
- Media toxicity data—Reductions in survival of an amphipod [*Hyaella azteca* (*H. azteca*)] in 10-day exposures to whole sediment. Reductions in survival and fecundity of a cladoceran (*D. magna*) in 12- to 14-day exposures to water overlying sediment. Responses that are statistically significantly different or are inhibited by 20% or greater relative to reference sediments are assumed to be indicative of sediments that are toxic to benthic biota.
- Single chemical toxicity data—Chronic toxicity thresholds for freshwater invertebrates expressed as chronic EC20s or CVs. These test endpoints correspond to the assessment endpoint for this community. That is, the sensitivity distribution of the test species is assumed to approximate the distribution of BCV CA species, and exceedence of the CVs and EC20s are assumed to correspond to 20% reductions in population abundance or greater, with some uncertainty. Toxic concentrations in ambient sediments reported by the State of Florida. Two types of values were extracted from that data set. First, thresholds for modification of benthic invertebrate community properties based on co-occurrence analyses, which are assumed to correspond to the assessment endpoint. Second, thresholds for lethality in toxicity tests of contaminated sediments, which are also assumed to correspond to the assessment endpoint effect, but with greater uncertainty due to the extrapolation to the field.

Piscivorous wildlife

- Biological survey data—Limited data concerning presence/absence, movements, and bioaccumulation of contaminants are available for mink on the ORR.
- Media toxicity data—None.
- Single chemical toxicity data—Chronic toxicity thresholds for contaminants of concern (COCs) in birds and mammals with greater weight given to data from long-term feeding studies with wildlife species. Preference was given to tests that included reproductive endpoints. After

allometric scaling for the endpoint species, these test endpoints are assumed to correspond to effects on individuals that could result in exceedence of the population-level assessment endpoint. An extrapolation must be made to populations if effects on individuals are estimated to occur.

Terrestrial plants

- Biological survey data—Qualitative survey for gross phytotoxic effects only.
- Media toxicity data—Lettuce seedling tests on soil from BCV CA. These tests measure germination and growth and are assumed represent toxicity to species at the site.
- Single chemical toxicity data—EC20s for growth or production of vascular plants or equivalent chronic toxicity thresholds for COCs in soil. These test endpoints are assumed to correspond to the assessment endpoint for this community. That is, the sensitivity distribution of the test species is assumed to approximate the distribution of BCV species, and exceedence of the test endpoints is assumed to correspond to 20% reductions in population abundance or productivity, with some uncertainty.

Soil/litter invertebrates

- Biological Survey Data—None.
- Media toxicity data—Earthworm survival and growth tests on soil from BCV. These tests measure 14-day survival and growth and are assumed to represent toxicity to species at the site.
- Single chemical toxicity data—EC20s for growth or production of soil invertebrates or processes or equivalent chronic toxicity thresholds for COCs in soil. These test endpoints are assumed to correspond to the assessment endpoint for this community. That is, the sensitivity distribution of the test species is assumed to approximate the distribution of BCV species, and exceedence of the test endpoints is assumed to correspond to 20% reductions in population abundance or productivity, with some uncertainty.

Terrestrial wildlife

- Biological survey data—None.
- Media toxicity data—None.
- Single chemical toxicity data—Chronic toxicity thresholds for COCs in birds and mammals with greater weight given to data from long-term feeding studies with wildlife species. Preference was given to tests that included reproductive endpoints. These test endpoints are assumed to correspond to the assessment endpoint after allometric scaling for the endpoint species, the short-tailed shrew, white-footed mouse, white-tailed deer, red fox, and red-tailed hawk.

Threatened and endangered species

- Biological survey data—None.
- Media toxicity data—None.
- Single chemical toxicity data—The same chronic toxicity thresholds for COCs in plants, birds, and mammals used as measurement endpoints for other species are used for the federally and state-listed threatened and endangered species, but are interpreted in the risk characterization so as to provide the higher level of protection specified in the assessment endpoint.

G.1.4 CONCEPTUAL MODELS

Two baseline cases are assessed in the remedial investigation (RI). The current baseline case is the state of the BCV CA as it now exists. That is, contaminants occur in the groundwater, surface water, sediment, and soil, but the existing caps prevent direct exposure to the primary sources. The hypothetical future case assumes exposure to the primary sources via degradation or removal of the existing caps and migration of contaminated groundwater plumes. The ecological conceptual models graphically represent the relationships between the contaminant sources and the endpoint receptors. They are not intended to show all possible sources, routes of transport, modes of exposure, or effects. Rather, they concisely communicate the exposure assumptions made for this assessment. Further explanation of these assumptions (e.g., the distinction between benthic invertebrates in erosional and depositional areas) is provided in the assessment for the associated endpoint receptor (e.g., Sect. G.3, "Risks to Benthic Invertebrates").

A conceptual model of current exposures of receptors inhabiting the BCV source areas is depicted in Fig. G.1. The primary sources (e.g., pits and trenches) contaminate the secondary sources (e.g., shallow groundwater, surface water, sediment, soil) but are not considered as a source of exposure for current receptors in these areas. Plant communities and soil/litter invertebrates are directly exposed to contaminants in surface soil, and the plant community is exposed to contaminants in shallow groundwater. Contaminants are bioaccumulated in lower trophic levels (i.e., plants and invertebrates) and transferred to high trophic levels (omnivores and ground invertebrate feeders). Small omnivores and vermivores also are directly exposed to contaminants through consumption of surface water and incidental ingestion of soil and externally exposed to radiation from radionuclides in surface soil. Contaminated media in the source areas also serve as sources of contamination and exposure of the aquatic and terrestrial receptors inhabiting Bear Creek, its tributaries, and the floodplain. Contaminated media and biota in the CA are sources of exposure for the wide-ranging species inhabiting the Bear Creek watershed.

A conceptual model of current exposures of receptors inhabiting Bear Creek, tributaries and seeps, and the Bear Creek floodplain is depicted in Fig. G.2. Contaminants enter the system via surface water, groundwater, and eroded soil. Within the system, contaminants move among the abiotic components through erosional and depositional processes (e.g., erosion of floodplains and alluvial deposition of stream sediments) and adsorptive and desorptive processes. Exposure pathways for terrestrial receptors inhabiting the floodplain are the same as those for receptors in the source areas. Fish and benthic invertebrates in erosional areas are directly exposed to contaminants, and externally exposed to radiation from contaminants, in surface water. Benthic invertebrates in depositional areas are similarly exposed to contaminants in sediments. Contaminants are bioaccumulated in lower trophic levels (e.g., invertebrates) and transferred to higher trophic levels (e.g., fish).

A conceptual model of current exposures of wide-ranging receptors inhabiting the Bear Creek watershed is depicted in Fig. G.3. Piscivores are directly exposed to contaminants in surface water and contaminants bioaccumulated in lower trophic levels (e.g., fish). They also are externally exposed to radiation from contaminants in surface water. Predators and large herbivores are directly exposed to contaminants in surface water and contaminants bioaccumulated in lower trophic levels (e.g., small mammals or plant) through consumption and to contaminants in soil through incidental ingestion. They also are externally exposed to radiation from contaminants in surface soil.

A conceptual model of the additional exposure pathways evaluated for the future hypothetical case is depicted in Fig. G.4. The inventoried primary sources (e.g., pits and trenches) are considered as a

hypothetical source of direct exposure for future receptors inhabiting these areas. That is, existing caps are assumed to have been degraded or removed, and plant communities and soil/litter invertebrates are directly exposed to contaminants in wastes. Small mammals are assumed to be directly exposed to contaminants through incidental ingestion of waste. Also evaluated in the future case is migration of contaminated groundwater plumes. Additional conceptual models are not presented because the spatial distribution, intensity, and/or composition of contamination may change, but the exposure pathways are a subset of those evaluated in the current baseline case. Specifically, the exposure pathways include direct exposure of plants to shallow groundwater, direct exposure of aquatic biota to surface water, and direct exposure of piscivores through consumption of surface water.

G.1.5 ORGANIZATION OF THE ECOLOGICAL RISK ASSESSMENT

The risks to each of the ecological risk assessment endpoints are assessed separately (Sects. G.2–G.7). Each includes an exposure assessment, effects assessment, risk characterization, and characterization of uncertainty. Risks to wildlife from radionuclides are discussed separately (Sect. G.7). Finally, ecological risks are summarized (Sect. G.8) and Remedial Goal Options are presented (Sect. G.9). The components of the assessment are explained here.

- Exposure assessment characterizes the distribution in space and time of the concentrations of contaminants to which organisms are exposed. Exposure calculations are performed for each location, reach, functional area, or aggregation of areas, as appropriate for each endpoint. The functional areas and transects are described in Chap. 2 of the Summary Report and in Appendix D. For assessment of risks to aquatic biota, Bear Creek was divided into four reaches (Fig. G.5) based on contaminant sources and the availability of chemical and biological data. Reach 1 includes tributary NT-1 and Bear Creek above NT-3; Reach 2 includes Bear Creek from Bear Creek Kilometer (BCK) 9.4 to NT-3; Reach 3 includes Bear Creek from ET-4 (from the White Wing Scrap Yard) to BCK 9.4; and Reach 4 includes Bear Creek from the confluence with EFPC to ET-4. The concentrations used in the exposure assessment are summarized in Chap. 3 of the Summary Report and in Appendix D and are discussed as necessary in the respective sections of this appendix.
- Effects assessment characterizes the evidence concerning effects of contaminant exposure. The principal lines of evidence concerning effects are biological survey data that indicate the actual state of the receiving environment, media toxicity data that indicate whether the contaminated media are toxic under controlled conditions, and single chemical toxicity data that indicate the toxic effects of the concentrations measured in site media.
- Risk characterization is the phase of risk assessment in which the information concerning exposure and the information concerning the potential effects of exposure are integrated to estimate risks (the likelihood of effects given the exposure). Risk characterization in ecological risk assessment is performed by a weight-of-evidence analysis. Procedurally, the risk characterization is performed for each assessment endpoint by (1) screening all measured contaminants against toxicological benchmarks and background concentrations, (2) estimating the effects of the contaminants retained by the screening analysis, (3) estimating the toxicity of the ambient media based on the media toxicity test results, (4) estimating the effects of exposure on the endpoint biota based on the results of the biological survey data, (5) logically integrating the lines of evidence to characterize risks to the endpoint, and (6) listing and discussing the uncertainties in the assessment.

G.1.6 RISK CHARACTERIZATION TECHNIQUES

Three risk characterization techniques are used to apply literature toxicity information to chemical concentrations measured in BCV CA media. Because they are common to most or all endpoints, they are explained here. The techniques are calculation of hazard quotients (HQs), calculation and plotting of sums of toxic units (TUs), and comparison of distributions of exposure concentrations to distributions of effects.

- HQs are used in the screening phase of the risk assessment to help identify contaminants of potential ecological concern (COPECs). They are quotients of the ratios of exposure concentrations divided by ecotoxicological benchmark concentrations. HQs >1 indicate that a chemical is a COPEC for a particular medium and endpoint, unless other information such as concentrations in background samples indicate that it should not be of concern. Because the intent of this analysis is to screen out only chemicals that are clearly not of concern, conservative estimates of exposure [e.g., maxima or 95% upper confidence limit (UCL95)] and conservative benchmarks (e.g., no observed effect concentrations) or suites of benchmarks are used.
 - After the screening, the COPECs are compared with each other, and their distributions across the CA are examined. Since the relative importance of COPECs is a function of their potential toxicity rather than their concentration, toxicity normalized concentrations or TUs are calculated. This is a common technique for dealing with exposures to multiple chemicals by expressing concentration relative to a standard test endpoint (Finney 1971). TUs are quotients of the concentration of a chemical in a medium divided by the standard test endpoint concentration for that chemical. They are similar to HQs except that a common test endpoint is used rather than conservative benchmarks, because TUs are used for comparative purposes rather than to draw conclusions. The expression of concentration and the test endpoint vary among media; for water they are the UCL95 concentration and the 48-h EC50 for *D. magna*. If the TU for a chemical equals 1, the interpretation is that the aquatic community at that location is exposed to a conservatively estimated average concentration sufficient to kill or immobilize *Daphnia* within 48 h. The chemicals that constitute a major component of toxicity (i.e., TUs >0.01) are plotted for each location. The height of the plot at each location is the sum of TUs ($\sum TU$) for that medium and location. This value can be conservatively interpreted as the total toxicity-normalized concentration and therefore as a relative indication of the toxicity of the medium in that subreach. In addition, the $\sum TU$ is commonly assumed to estimate the absolute toxicity of the medium. That is, if the $\sum TU$ equals one, then the endpoint effect (e.g., *Daphnia* acute lethality) will occur. This will be the case if all of the chemicals have the same mode of action. For heterogeneous chemical mixtures, it is a likely to be a conservative assumption, because combined toxic effects of chemicals in environmental samples have been found to be additive or less than additive (Alabaster and Lloyd 1982). Because the test endpoints are chosen for their consistency rather than their relationship to an assessment endpoint, the plots of TUs are heuristic, providing an indication of the relative toxicity of sites and the relative contributions of chemicals to that toxicity.
 - Inferences about the risk posed by the COPECs are based on the distribution of concentrations relative to the distribution of effects. Distributions provide a better basis for inference than point estimates because they allow consideration of variance in concentration over space or time and of sensitivity across species, measures of effects, media properties, or chemical forms. In all cases, risk is a function of the overlap between the exposure and effects distributions, but the interpretation depends on the data that are used.
- In the case of exposure of fish and benthic invertebrates to chemicals in water, the exposure distributions are distributions of aqueous concentrations over time and the effects

distributions are distributions of sensitivities of species to acutely lethal effects (e.g., LC50s) and chronically lethal or sublethal effects (CVs). Overlap of these two distributions indicates the approximate proportion of the time when aqueous concentrations of the chemical are acutely or chronically toxic to a particular proportion of aquatic species.

- In the case of exposure of benthic invertebrates to chemicals in whole sediment, the exposure concentrations are represented as points, rather than distributions, because the sediment sampling effort was designed to identify potential hot spots. That is, these samples do not necessarily represent the full distribution of exposures within a reach. Two effects distributions are presented for each sediment COPEC: a distribution of concentrations reported to be thresholds for reductions in benthic invertebrate community parameters in various locations, and a distribution of concentrations reported to be thresholds for lethal effects in toxicity tests of various sediments. If we assume that the effects data set is drawn from studies of a random sample of sediments so that the BCV sediments can be assumed to be drawn from the same distribution, and if we assume that the two types of reported effects are independent estimates of the threshold for significance for this endpoint, then the effects distributions can be treated as distributions of the probability that the chemical causes significant toxic effects to the BCV and tributary NT-1 and tributary NT-IV benthic community. Overlap of the exposure and effects distributions represents the probability of significant toxic effects on benthic communities in a given proportion of locations in a reach. For example, the copper concentration in whole sediment from SD 4 in NT-3 is equal to or greater than the concentration at which there is a 50% likelihood of toxic effects on benthic invertebrates.
- In the case of wildlife exposure to chemicals in food and water, the exposure distributions are distributions of total intake rate of the chemical across individuals in the populations. The distributions are obtained by Monte Carlo simulation using the distributions of observed concentrations in water and various food items. If we assume that the members of a population occurring in each modeled area independently sample the water and food items, then the proportions of the exposure distributions represent estimates of the proportion of a population receiving a particular intake rate. In keeping with practice in wildlife toxicology, the effects are treated as point estimates [i.e., no observed adverse toxic effect levels (NOAEL) and lowest observed adverse effects levels (LOAEL)]. Therefore, the intersection of these points with the exposure distributions represent estimates of the proportion of the exposed population with exposure levels less than the NOAEL and LOAEL.
- The case of threatened and endangered wildlife is a little different from that of other wildlife species. Risks to these species are assessed at the organism level, so the exposure models represent exposure of individuals within their foraging areas. Therefore, the exposure distribution is a distribution of the likelihood of various exposure rates to individuals foraging in the specified areas. Effects are specified by the same point estimates as with other wildlife. Therefore, the intersection of the point estimates of effects with the exposure distributions represent the likelihood that an individual will have an intake rate less than the no observed effects level and lowest observed effects level.

These risk characterization techniques apply to one line of evidence—the concentrations of chemicals in ambient media. Other interpretation techniques applied to other lines of evidence are more specific to the endpoint, so they are not summarized here. However, for all endpoints the risk characterization ultimately depends on the weighing of all the lines of evidence.

G.2. RISKS TO FISH

Risks to the fish communities in Bear Creek and tributaries NT-2 through NT-8 were evaluated. Bear Creek was divided into four reaches (Fig. G.5) based on contaminant sources and the availability of chemical and biological data. Reach 1 includes Bear Creek above NT-3 and tributary NT-1. The S-3 Ponds are the primary contaminant source to both channels, and the location of the chemical sampling site for NT-1 precludes discriminating between the NT-1 and Bear Creek water chemistry. All of the BCV Source Areas are potential contaminant sources to Reach 2 via the NT-2 through NT-8 tributaries and Reach 1. The tributaries along Reach 3 change the exposures by adding dilution water rather than contaminants. ET-4, from the White Wing Scrap Yard, is a potential source to Reach 4. These also are the most appropriate reach designations given the available data. That is, excepting Reach 4 there is at least one chemical, toxicity, and biosurvey measurement for each reach. Toxicity testing was not conducted in Reach 4. Further refinement of exposures in Reaches 2 and 3 is not possible given the available chemical data. Seeps were evaluated for risks to benthic invertebrates in erosional areas, rather than fish, because of considerations of scale.

G.2.1 EXPOSURE ASSESSMENT FOR FISH

G.2.1.1 Aqueous Chemical Exposures

Fish are exposed primarily to contaminants in water. Contaminants in water may come from upstream aqueous sources, exchange of materials between the surface water and contaminated sediments, or exchange of contaminants between the biota and the water column. The consensus of the scientific community and of the EPA Office of Water is that aquatic biota should be assumed to be exposed to the dissolved fraction of the chemicals in water, because that is the bioavailable form (HECD 1992, Prothro 1993). However, the EPA Region IV prefers to use total concentrations as conservative estimates of the exposure concentration. Therefore, both dissolved phase and total concentrations of metals are used in the exposure assessment for fish.

Because water in Bear Creek is likely to be more variable in time than space, due to the rapid replacement of water, the mean water concentration within a reach or tributary is an appropriate estimate of the chronic exposure experienced by fishes. The UCL95 on the mean is an appropriately conservative estimate of this exposure for use in the contaminant screening. However, the distribution of observed concentrations is used to estimate risks.

The fish community in upper Reach 3 is exposed to a combination of Bear Creek and SS-5 water. This exposure was estimated by calculating the flow-weighted average concentration of each detected chemical. The flow measurements were those used in the Integration Point assessment (Sect. E.3). However, the mean daily concentration, rather than the flux, was estimated for each chemical. These estimated exposure concentrations were evaluated following the same procedures used for all other sites. That is, the UCL95 was screened against benchmarks, and the distribution of estimated mean daily concentrations was compared with the toxicological data.

Future exposures are based on the range of predicted maximum surface water concentrations presented in Appendix E. These concentrations were derived using source terms for the S-3 Ponds, the Bone Yard/Burn Yard, and the Bear Creek Burial Grounds; groundwater transport models; and surface water dilution ratios. These are assumed to be dissolved phase concentrations. Also presented in

Appendix E are the predicted time ranges for the peak concentrations in years from the start of waste operations at each site. Predicted peak times are not available for NT-8 from BG C-west because the model was not used. Rather, predicted seep concentrations and surface water dilution factors were used for that location. Calcium concentrations (mg/L) were assumed to be 1.4 times the nitrate concentrations (mg nitrate as N/L), based on predicted and observed solution chemistry in BCV (Appendix E).

G.2.1.2 Fish Chemical Body Burdens

Although nearly all toxicity data for fishes is expressed in terms of aqueous concentrations, fish body burdens potentially provide an exposure metric that is more strongly correlated with effects (McCarty and Mackay 1993). This is particularly likely to be the case for chemicals that bioaccumulate in fish and other biota to concentrations greater than in water. For such chemicals, dietary exposure may be more important than direct aqueous exposures and concentrations that are not detectable in water may result in high body burdens in fish. Sufficient toxicological data are available for three potential Bear Creek contaminants that bioaccumulate in that manner: mercury, PCBs, and selenium. Only mercury and PCBs are considered in this assessment, because selenium was not found to be significantly elevated in fish from Bear Creek (Hinzman et al. 1995). Since the individual body burden measurements correspond to an exposure level for an individual fish, the maximum value is used for screening purposes, and the risk estimate is based on the distribution of individual observations. Measurements were performed on whole central stone rollers (*Camptostoma anomalum*) and the muscle (fillet) of rock bass (*Ambloplites rupestris*) and redbreast sunfish (*Lepomis auritus*). Since whole fish measurements are most commonly used in the literature, we used measured and estimated whole fish concentrations. The methods of estimation and the summary results for each of five sites are presented as part of the exposure assessment for wildlife (refer to Sect. G.6.1 and Table G.48).

G.2.1.3 Radiation Exposures

Exposures to radionuclides are expressed as the dose rate received by the organism. The total dose rate is the sum of the internal and external dose rates, which are a function of exposure to the radionuclide and the characteristics of the radiation. Radiation exposures to fish in surface water are likely to be driven by internal exposures, especially for alpha-emitters such as ^{234}U and ^{230}Th . Internal dose rates are based on the concentrations of the radionuclide in the organism, which were estimated by multiplying the water concentration times the biological concentration factors provided in Blaylock et al. (1993). External dose rates are based on the concentrations of the radionuclides in the surrounding water. Because the radiation exposure rate is expressed as absorbed dose per unit time (rads per day), the dose rates for each isotope and pathway can be added to determine the total dose rate.

As with estimates of aqueous chemical exposure, the UCL95 on the mean is an appropriately conservative estimate of exposure for use in the screening. Also, the dissolved fraction of the radionuclides in water is the most appropriate measure for estimating internal dose rates, because internal concentrations are a function of bioavailability. Concentrations in unfiltered water are more appropriate for estimating external dose rates, which are independent of bioavailability. Therefore, both dissolved phase and total concentrations of radionuclides were used in the radiation exposure assessment for fish.

G.2.1.4 Toxicity Test Exposures

The water toxicity tests include direct exposure of *C. dubia* and the fathead minnow (*Pimephales promelas*) to whole water. It is assumed that the form and bioavailability of chemicals is not altered by water collection and handling, so these tests represent exposures in the field.

G.2.2 EFFECTS ASSESSMENT

G.2.2.1 Single-Chemical Aqueous Toxicity

The sets of screening benchmarks for aquatic biota (described in Table G.1) are taken from Suter and Mabrey (1994). Ecotox Threshold values were issued by the EPA Office of Solid Waste and Emergency Response (OSWER 1996) subsequent to the screening of surface water data for this assessment and are not included herein. However, the OSWER values were either from, or consistent with, the Suter and Mabrey (1994) benchmarks. The benchmarks used in this assessment also are consistent with the EPA Region IV surface water screening values (Region IV 1995). The Region IV BTAG Coordinator has indicated that on the ORR the Region IV screening values need not be used in addition to the more extensive set of benchmarks presented in Suter and Mabrey (1994). The Region IV screening values for chloride were used because a benchmark for total chloride is not included in Suter and Mabrey (1994). The benchmark preferred by the regulatory agencies is the chronic national ambient water quality criteria (NAWQC), but they are available for relatively few industrial chemicals. Secondary chronic values, which are conservative estimates of chronic NAWQC, were calculated for chemicals that do not have NAWQC. Other benchmarks are included to provide greater assurance of detecting all COPECs.

NAWQC that are functions of water hardness are corrected for site-specific conditions. For purposes of screening out COPECs, a conservative estimate of hardness (100 mg/L) was used. For purposes of risk estimation, a hardness of 200 mg/L is more appropriate. Although 200 mg/L is still conservative, it more closely approximates the typical site conditions. That is, hardness measurements for Bear Creek ranged from 102 mg/L to 2,000 mg/L, and the mean hardness ranged from 241 mg/L to 632 mg/L (Hinzman et al. 1995).

Toxicity profiles are presented in the Supporting Information for COPECs. The toxicity profiles summarize the existing toxicity information for each chemical, including concentrations causing acute lethality and chronic lethal and sublethal effects, and physical-chemical conditions that modify toxicity. For chemicals with hardness-dependent criteria, test endpoints were corrected to 100 mg/L and 200 mg/L hardness using EPA's formula.

G.2.2.2 Fish Body Burdens

There are no standard benchmarks for effects on fish from internal chemical exposures. The body burdens associated with effects in toxicity tests and field studies and body burdens found at other sites are discussed in the following text. To be consistent with EPA practices in calculating CVs, thresholds for toxic effects are expressed as geometric means of body burdens measured at the no observed effect concentration and lowest observed effect concentration. Only mercury and PCBs were considered because they are the COPECs known to significantly bioaccumulate in fish through dietary exposure.

Mercury. Estimates of body burdens of mercury that constitute a threshold for toxic effects on fish range from 0.66 mg/kg to 5.6 mg/kg wet wt. The lower figure is the geometric mean of body burdens in fathead minnows showing significant reproductive effects and those of fish showing no significant effects in a chronic test of mercuric chloride that included dietary exposures (Snarski and Olson 1982). The higher figure is the geometric mean of body burdens associated with reproductive effects and no significant effects in exposures of brook trout to methyl mercury (McKim et al. 1976). Mercury concentrations in sunfish from streams in the vicinity of the ORR that were not mercury contaminated ranged from 0.06 to 0.11 mg/kg wet wt (Southworth et al. 1994).

PCBs. Estimates of body burdens of PCBs that constitute thresholds for toxic effects in fish are presented in the Supporting Information, Toxicity Profiles for Bear Creek. They are presented on a whole-body basis, and, when possible, on a lipid-normalized basis. A very large range of values has been reported to constitute thresholds for toxic effects in toxicity tests, including one incredibly low value for lake trout.

G.2.2.3 Radiological Effects

The recommended acceptable dose rate to natural populations of aquatic biota is 1 rad/d (NCRP 1991). Although there are no standard screening benchmarks for radionuclide concentrations in surface water, Blaylock et al. (1993) provide formulas and exposure factors estimating the dose rates to representative aquatic organisms. These formulas were used to calculate the water concentration that results in a total dose rate of 1 rad per day to a small fish for each radionuclide detected in the water samples from BCV. The exposure factors used in this assessment are from Blaylock et al. (1993) and are presented in Table G.2. The screening values include internal and external exposures from the detected isotope and all short-lived daughter products. All major alpha, beta, and gamma emissions for each isotope were included and the absorbed fraction of each was estimated from the graphs provided in Blaylock et al (1993). Internal exposures from radionuclides in water were estimated using the biological concentration factors for the detected parent isotopes.

G.2.2.4 Ambient Water Toxicity

Methods and results of toxicity tests of ambient water are summarized in Sect. D.9 and detailed in Hinzman et al. (1995). The tests employed include the standard 7-d tests of growth and survival in fathead minnow larvae and fecundity and survival of *C. dubia*. Because these subchronic tests were developed for testing effluents and ambient waters rather than pure chemicals, their relationship to levels of contaminant exposure must be related to the patterns of contamination in BCV and related to effects levels for individual contaminants in other tests (Sect. G.2.2.1).

Water from one to six sites in main stream Bear Creek has been tested periodically since 1984. Water from BCK 12.36 was tested the most frequently. Other sites included BCKs 11.83, 11.09, 9.91, 9.40, and 7.87. Additionally, tests of water from these main stream sites, BCK 3.25, NT-1 through NT-8, and seeps SS-1, SS-4, SS-5, SS-6, and SS-8 were conducted in May (19–26) and August (4–10) of 1994 for this investigation.

The May test period appears to be representative of base flow conditions, whereas the August test period appears to be more representative of storm flow conditions. Significant rainfall occurred during the August test period. Grab samples for toxicity testing were collected on August 3, 5, and 8. Rainfall amounts of 0.08, 0.07, and 0.57 were recorded in Oak Ridge on August 3, 4, and 5, respectively (NOAA 1994a). Sampling logs from the toxicity laboratory for August 5 indicate high flow and turbid conditions were observed at all sites except seeps SS-4, SS-5, SS-6, and SS-8, which were characterized as “clear.” No rain events occurred during the May testing period. Grab samples for toxicity testing were collected on May 18, 20, and 23. Rainfall amounts of 0.15 and 0.85 were recorded in Oak Ridge on May 14 and 15 (NOAA 1994b), and the toxicity sampling logs do not indicate high flow or turbid conditions at any site.

G.2.2.5 Fish Community Survey

Analysis of fish population and community survey data provides a direct measure of impacts of human activities on aquatic ecosystems. These data can provide an additional line of evidence relating to potential impacts of DOE operations on Bear Creek. Quantitative sampling of the fish population by electrofishing has been conducted biannually at seven locations in Bear Creek since 1984. Sampling at BCK 0.7 was initiated in the spring of 1993. Methods and the results of fish surveys through the fall of 1993 are summarized in Sect. D.9 and detailed in Hinzman et al. (1995). In addition, the total fish densities, species richness, and Tennessee dace (*Phoxinus tennesseensis*) densities for the spring and fall of 1994 are summarized in Table G.3 (Schilling 1996). These data also were collected and analyzed using the methods described in Hinzman et al. (1995).

G.2.3 RISK CHARACTERIZATION FOR FISH

G.2.3.1 Single-Chemical Aqueous Toxicity

Screening of current aqueous exposures against chemical benchmarks

Measured concentrations of inorganic chemicals were compared with the background screening criteria (Sect D.4). Inorganics that exceeded the background criterion and all detected organic chemicals were screened against benchmarks and evaluated as COPECs. This was done by dividing the UCL95 concentration by each of the aqueous screening benchmarks (Table G.1). Chemicals that exceeded any benchmark (i.e., the quotient of UCL95/aqueous screening benchmark was >1) were examined further to determine whether they were credible COPECs (Table G.4).

A second step in the screening process involved determining the relative contribution of the COPECs to the distribution of toxicity in BCV. This was done by converting the concentrations from unfiltered and filtered water to equivalent toxicity normalized concentrations and then plotting the values for each reach or location (Figs. G.6 and G.7). The standard toxic value used in the normalization is the *D. magna* EC50, the only test endpoint that is available for all of the aqueous COPECs. Concentration in TUs was calculated as:

$$TU = UCL95/EC50$$

If the combined toxic effects of the COPECs are concentration additive, then, if the sum across chemicals of TU ($\sum TU$) is >1 , one would expect acute lethality to *Daphnia*. $\sum TU$ values >0.2 are suggestive of chronic toxic effects.

The $\sum TU$ graphs reveal some interesting trends and differences among sites and chemical measures. For example, aluminum and iron primarily occur bound to filterable particulate matter and the chemical toxicity and concentration gradients along Bear Creek are masked by the variability of the suspended particulate concentrations. The $\sum TU$ graph for filtered water suggests that the highest toxicity occurs in Reach 1 and SS-1 and calcium is the primary contributor to toxicity. This is consistent with the concept that discharge from the S-3 Ponds is the primary contributor of metals and inorganics to Bear Creek.

Exposure—effects profiles for current aqueous exposures

For each COPEC, the distribution of observed concentrations is compared to the distribution of toxic concentrations for fish and aquatic invertebrates. Toxicity information is drawn from the toxicity profiles (Supporting Information). If sufficient toxicity data exist, the empirical distribution functions are presented graphically (Figs. G.8–G.14).

Table G.4 summarizes, for each COPEC, which benchmarks were exceeded at each site. Table G.5 details the exposure estimates (UCL95) for each location, benchmark values, and the corresponding HQs. Therefore, this section addresses only that information that aids in characterizing the risks associated with these COPECs. Based on this information, a weight-of-evidence determination is made as to whether each chemical appears to present significant, marginal, or negligible risks to the fish community. Factors considered include exposure information (e.g., relationship of measured concentrations to potential contaminant sources, detection frequency, and detection limits), effects information (e.g., availability of chronic toxicity test results, number of test results, and number and representativeness of tested organisms), and exposure-effects information (e.g., overlap of exposure and effects distributions and the bioavailability in Bear Creek versus bioavailability under reported test conditions). NAWQC are included in the screening against benchmarks, but are not the sole factor in characterizing risks and are not evaluated as ARARs in this section. For example, although nickel does not exceed the NAWQC, it appears to present a significant risk to sensitive species in Reach 1.

Five chemicals were detected in BCV surface water for which appropriate toxicological data are not available: fluoride, nitrate, silicon, sulfate, and chloromethane. The lack of toxicological data precludes the evaluation of these chemicals.

An additional sample of unfiltered NT-1 surface water was collected in December 1995 to support technology demonstration efforts for the S 3 Ponds groundwater plume (Section D.6 and Table D.27). These data are not validated and were not available when the screening of COPECs was performed. One source of uncertainty in the screening of Reach 1 surface water data is that most samples were collected from lower Reach 1 and may underestimate the risks in upstream areas of NT-1. The December 1995 data are briefly evaluated herein because they represent the high concentration discharge area of the S 3 plume. The NT-1 concentrations that exceeded the Reach 1 exposure concentrations (UCL95 for unfiltered water) and the background criteria were screened against the aforementioned benchmarks (Table G.6).

Aluminum appears to present a negligible risk to aquatic biota in BCV. Total aluminum exceeded background and at least one benchmark in Reaches 1 and 2, upper Reach 3 (BCK 9.4–SS5), NT-2, NT-7, NT-8, SS-1, SS-4, and SS-6. However, total aluminum is likely to overestimate the bioavailable fraction, and dissolved aluminum was within background at all locations. Also, a consistent downstream gradient of aluminum concentrations did not exist, as indicated by the ΣTU plots for unfiltered and filtered water (Figs. G.6 and G.7). Total aluminum exceeded the acute and chronic NAWQC in at least one sample from each site.

Barium appears to present a marginal risk to aquatic biota in Reaches 1 and 2 and in NT-2, SS-1, and SS-4. Total barium exceeded background and the secondary acute and CVs in Reach 1, NT-2, and SS-1 only. Dissolved barium exceeded the background value for filtered water and the secondary values at these locations and at BCK 9.4 (Reach 2) and SS-4. Although unfiltered barium measurements may overestimate exposures, the dissolved barium levels in BCV were similar to total barium levels. The apparent downstream gradient suggests that barium may be associated with the S-3 plume, which is consistent with observations for other common inorganic constituents (e.g., calcium). However, only

weak evidence exists for acute or chronic toxicity of barium in BCV. Although relatively little toxicity data exist for barium, only the very lowest acute toxicity value (0.33 mg/L for a Gastropod snail) was exceeded. Dissolved barium at all sites was less than the three other acute values from the same study and was 10 to 1,000 times less than the acute values for the standard test organism *D. magna* (14.5 and 410 mg/L). The only chronic value was 5.8 mg/L for *D. magna*, which also was not exceeded at any site.

Boron appears to present a marginal risk of chronic toxicity at BCK 9.4, a negligible risk of chronic toxicity at all other sites, and a negligible risk of acute toxicity at all sites. Total and dissolved boron exceeded background in all Bear Creek reaches and seeps. Total levels were similar to dissolved levels, and a consistent downstream gradient was not observed. BCK 9.4 was the only location at which concentrations exceeded 1 mg/L (i.e., 20% of the samples were between 1 and 4.4 mg/L). Thus, boron at BCK 9.4 exceeded the conservative secondary chronic value 20% of the time, but was always less than the lowest CVs of 8.83 and 9.33 mg/L for *D. magna*. The LTV_{DAHP} (0.007 mg/L) was exceeded at all locations because it is well below local background levels (Table D.11). Hence, exceedence of this benchmark alone is not considered evidence of toxicity in BCV.

Cadmium appears to present a significant risk of chronic toxicity in Reach 1 and at BCK 9.4 and SS-1, a marginal risk of acute toxicity in Reach 1 and SS-1, and a negligible risk of acute toxicity at BCK 9.4. The distributions of ambient cadmium concentrations and aqueous test endpoints are shown in Fig. G.8. The ambient concentrations are dissolved phase concentrations at each site where cadmium was detected above background and at least one benchmark. The toxicity data are normalized to 200 mg/L hardness. Because cadmium was detected in only one sample from BCK 9.4 and SS-1, the single concentrations are depicted as 100th percentile points.

Although unfiltered cadmium measurements may overestimate exposures, the dissolved concentrations in BCV were similar to the total concentrations. The highest concentrations were ~0.02 mg/l and occurred at SS-1 and in Reach 1 at NT-1. Cadmium is not expected to be acutely toxic to invertebrates at any location. That is, the distributions of observed concentrations do not overlap the distribution of acute toxicity values for invertebrates. Acute toxicity to fish is possible in Reach 1 and SS-1, given that the observed values exceed ~10% of the acute values for fish. Cadmium is likely to be chronically toxic to fish and invertebrates in Reach 1, especially above BCK 11.97. The distributions for sites NT-1 and BCK 11.97 suggest that a downstream gradient exists within Reach 1. Chronic toxicity from cadmium is considered likely at BCK 9.4 and SS-1. Although it was detected only once at each site, the detected values exceeded at least the 50th percentile of the chronic effects distribution for invertebrates, and the detection limit was approximately equal to the 50th percentile for chronic effects for invertebrates. All detected concentrations in filtered water exceeded the chronic NAWQC at 200 mg/L hardness (NCHR₂₀₀). The NACU₂₀₀ was exceeded at least once in Reach 1 and SS-1, but not at BCK 9.4.

Calcium appears to present a significant risk to aquatic biota in Reach 1, NT-2, and SS-1. Total and dissolved calcium were detected in all samples for BCV and exceeded background at all locations except SS-6 and SS-8. Although unfiltered calcium measurements generally overestimate exposures, the dissolved concentrations in BCV were similar to the total concentrations. Calcium exhibited a consistent downstream gradient in BCV surface waters, as indicated by the ΣTU plot for filtered water samples (Fig. G.7) and the results of the screening against benchmarks. The only available benchmark is the lowest chronic value (LCV) for daphnids, which was exceeded in Reach 1, NT-2, and SS-1 only. The maximum measured calcium concentrations in BCV did not exceed the acute toxicity value for *D. magna* in tests with food added (464 mg/L). Forty-eight-hour exposures without food added were toxic at much lower concentrations (52 mg/L). This concentration, which may be representative of the initial exposures in the tests of Bear Creek surface water, was exceeded by 50% to 100% of the measured dissolved

calcium concentrations in Reach 1, NT-2, and SS-1. Also, chronic toxicity is likely in Reach 1, NT-2, and SS-1. Twenty-five percent of the dissolved calcium concentrations at NT-2 exceeded the chronic value for *D. magna* (116 mg/L). The chronic value was exceeded by 70% to 100% of the dissolved calcium concentrations at sites in Reach 1 and 95% of measurements at SS-1. The acute and CVs are based on test concentrations made with calcium chloride, which is likely to result in a higher rate of dissociation than calcium carbonate. Therefore, measured concentrations of calcium carbonate in ambient surface waters are likely to overestimate the Ca(II) fraction. However, dissolved calcium in upper BCV surface waters may be more available, and thus more toxic, than in other surface waters because of the elevated nitrate concentrations. That is, dissolved calcium is likely to be present as both calcium nitrate and calcium carbonate.

Cobalt appears to present a marginal risk of chronic toxicity to the aquatic communities of Reach 1 and a negligible risk of toxicity elsewhere in BCV. Total cobalt was less than background at all locations, and dissolved cobalt marginally exceeded the background criterion (0.014 mg/L) in one sample from Reach 1 (0.020 mg/L). The secondary chronic value was the only benchmark exceeded in Reach 1. A general downstream gradient appears to exist within Reach 1. That is, the average dissolved cobalt concentration at the NT-1 site (0.0085 mg/L) was higher than the average for BCK 12.36 (0.0025 mg/L), and cobalt was not detected in filtered samples from BCK 11.97. All detected cobalt concentrations were at least 100 times less than the acute toxicity values for fish and invertebrates. The mean and UCL95 of the concentrations from all sites in Reach 1 were less than the LCV_{DAHP}, but all of the detected concentrations in NT-1 exceeded the LCV_{DAHP}. Therefore, chronic toxicity is considered to be possible within Reach 1 as a whole and likely in the uppermost areas of Reach 1.

Copper appears to present a marginal risk of acute toxicity in Reach 1 and SS-1, a negligible risk of acute toxicity elsewhere in BCV, a marginal risk of chronic toxicity in Reaches 1, 2, and 3 and SS-1, SS-5, and SS-6, and a negligible risk of chronic toxicity in Reach 4 and SS-4. The distributions of ambient copper concentrations and aqueous test endpoints are shown in Fig. G.9. The ambient concentrations are dissolved phase concentrations at each site where copper was detected above background and at least one benchmark. The toxicity data are normalized to 200 mg/L hardness. Because copper was detected in only one sample from NT-1, the single concentration is depicted as the 100th percentile.

Although unfiltered copper measurements may overestimate exposures, the dissolved concentrations in BCV were similar to the total concentrations. Also, the number of reliable measurements (i.e., detects) was generally greater for the filtered water samples than for the unfiltered samples. A consistent downstream gradient is not evident within Reach 1 or Bear Creek as a whole. The highest concentrations were 0.070 mg/L at SS-8 and 0.044 mg/L in Reach 1 at the NT-1 site. These maximum concentrations exceeded <10% of the acute toxicity values for invertebrates and were less than all acute values for fish. Also, copper was infrequently detected at these sites: 1 of 6 samples at NT-1 and 2 of 25 samples at SS-8. Therefore, acute toxicity is considered possible, but not likely, at NT-1 and SS-8 and unlikely at all other sites. The maximum detected concentrations at NT-1 and SS-8 exceeded nearly all of the CVs for invertebrates and 20 to 50% of the CVs for fish. However, all but one of the sample detection limits was <0.004 mg/L, which is well below the CVs for copper. Hence, ~10% of the exposures received at these sites are likely to be chronically toxic to aquatic biota. This also is true for BCKs 11.97, 9.4, and 4.55, and SS-1, SS-5, and SS-6, given the relatively low frequency of detects and the low detection limits. Chronic exposures are not expected in Reach 4 or SS-4. All detected concentrations in filtered water exceeded the chronic NAWQC at 200 mg/L hardness (NCHR₂₀₀). The NACU₂₀₀ was exceeded at least once at all of the aforementioned sites except BCK 0.63 and SS-4.

Cyanide appears to present a negligible risk to aquatic biota in BCV. The distributions of ambient cyanide concentrations and aqueous test endpoints are shown in Fig. G.10. The ambient concentrations are total cyanide concentrations at each site where cyanide was detected. The toxicity distributions are for free cyanide and the NAWQC are for total cyanide. Because cyanide was detected in only one sample from each site except NT-2, the single concentrations are depicted as the 100th percentiles. None of the detected cyanide concentrations exceeded the lowest acute toxicity values for fish or invertebrates. The detected concentrations did exceed between 10% and 80% of the chronic effects data. However, the toxicity data are reported on a free cyanide basis and measured concentrations are for total cyanide, which is likely to overestimate the free cyanide fraction (see the Supporting Information, "Toxicity Profiles"). Also, cyanide was rarely detected in BCV (i.e., <5% in Reach 1 and NT-7 and <10% elsewhere). Based on these results, cyanide is not expected to be an important contributor to risk under current conditions. All detected concentrations in BCV exceeded the chronic NAWQC. The highest measured concentrations were from BCK 12.36 and NT-8 and were marginally less than the acute NAWQC.

Iron appears to present a marginal risk of toxicity to the aquatic biota in BCK 9.4-SS5, BCK 9.4, and SS-1 and a negligible risk in NT-7. The iron concentration in one unfiltered sample from each of four locations (BCK 9.4-SS5, BCK 9.4, NT-7, and SS-1) was greater than background, but dissolved iron was less than background at all locations. There is not a consistent downstream gradient of iron concentrations, as indicated by the Σ TU plot for unfiltered water (Fig. G.6).

There is relatively little information on the toxicity of iron in surface waters. The chronic toxicity data for iron in streams that do not receive acidic discharges is most appropriate for NT-7. About 30% of the total iron concentrations from NT-7 exceed the CVs for *D. magna* (4.38 mg/L) and brown trout (5.17 mg/L). Total iron at NT-7 appears to overestimate toxicity of iron, given that dissolved iron was always less than the acute and CVs. Hence, iron is not expected to be toxic in NT-7. Iron appears to be acutely and chronically toxic in SS-1, BCK 9.4, and BC9.4-SS5, based solely on the concentrations from unfiltered samples and the toxicity data for iron in streams receiving acidic discharges. However, only one dissolved iron concentration (0.29 mg/L at BCK 9.4) exceeded the acute (0.256 mg/L) or chronic (0.158 mg/L) toxicity values. Based on the Σ TU plot for unfiltered water (Fig. G.6), NT-7 appears to contribute more iron to BCK 9.4 than does Reach 1. Consequently, the toxicity values for acidic discharges are likely to overestimate iron bioavailability at BCK 9.4. At least one total iron concentration from each of four locations (BCK 9.4-SS5, BCK 9.4, NT-7, and SS-1) was greater than background and the chronic NAWQC for iron (1 mg/L).

Lead appears to present a negligible risk of acute and chronic toxicity in BCV. The distributions of ambient lead concentrations and aqueous test endpoints are shown in Fig. G.11. The ambient concentrations are dissolved phase concentrations at each site where lead was detected above background and at least one benchmark. The toxicity data are normalized to 200 mg/L hardness. Because lead was detected in only one sample from each site, the single concentrations are depicted as the 100th percentiles.

Total lead exceeded background and benchmarks at only two locations, SS-1 and SS-5. However, total lead was detected in only 1 of 12 samples from each site; unfiltered lead measurements may overestimate exposures; and dissolved lead was never detected at these sites. Dissolved lead was detected in two samples from Reach 1 (once each at BCK 11.97 and NT-1) and one sample from SS-4 at concentrations that exceeded background criteria and the NCHR_200. However, the measured concentrations were less than all acute and chronic toxicity values for fish and invertebrates, and the detection limits were less than the NCHR_200.

Hence, there is little evidence of chronic toxicity from lead in BCV. All detected lead levels (i.e., total and dissolved) at the aforementioned sites exceeded the chronic NAWQC at 200 mg/L hardness (NCHR_200). The NACU_200 was not exceeded at any site.

Lithium appears to present a marginal risk of chronic toxicity to aquatic biota at BCK 9.4, BC9.4-SS5, NT-3, NT-7, NT-8, and SS-4, and a negligible risk of acute toxicity at all sites in BCV. A background criterion was not available for lithium. Although unfiltered lithium measurements may overestimate exposures, the dissolved lithium levels in BCV were similar to the total lithium levels. Unlike several other inorganic chemicals, no downstream gradient appears to be associated the S-3 ponds. Rather, lithium in Bear Creek appears to come primarily from NT-8 and NT-3. That is, the dissolved lithium concentrations were higher in these tributaries and in Bear Creek downstream of these tributaries than in Reach 1. However, it is unlikely that lithium is acutely toxic in BCV surface waters. The concentrations at NT-3 and NT-8 exceeded only 1 of the 17 acute toxicity values for lithium. Most of the other acute toxicity values were 11 to 1000 times higher than the lithium concentrations measured in BCV. Also, lithium did not exceed the secondary acute value at any location. Chronic toxicity is considered to be possible at the five sites where dissolved lithium exceeded the secondary chronic value (i.e., BCK 9.4, BC9.4-SS5, NT-3, NT-7, NT-8, and SS-4). All detected lithium concentrations at these sites exceeded the secondary value. However, chronic toxicity values for lithium were not found, and the secondary chronic value is based on only a few standard acute toxicity tests. Also, lithium toxicity has been shown to decrease with increasing water hardness or sodium levels.

Manganese appears to present a marginal risk of chronic toxicity at SS-1 and a negligible risk at SS-4. Manganese exceeded background at SS-1 and SS-4, but was less than background at all other sites in BCV. Manganese in unfiltered samples from SS-1 and SS-4 was greater than the secondary chronic value. However, only one sample from SS-1 exceeded the LCV and all samples from SS-1 and SS-4 were less than the lowest acute value. Hence, acute toxicity is unlikely and chronic toxicity is possible, but unlikely, at these seeps.

Mercury appears to present a marginal risk of chronic toxicity in NT-8 and a negligible risk of acute and chronic toxicity elsewhere in BCV. The distributions of ambient mercury concentrations and aqueous test endpoints are shown in Fig. G.12. The ambient concentrations are dissolved phase concentrations at each site where mercury was detected above background and at least one benchmark. Mercury in unfiltered water samples from NT-3 was greater than background and the chronic value for fish. However, total mercury is likely to overestimate the bioavailable fraction, and dissolved mercury was less than background and benchmarks at NT-3. Hence, mercury toxicity is not expected at NT-3. Mercury in filtered water samples from NT-8 exceeded background and the CVs for fish and daphnids, but was less than the lowest acute values for fish and invertebrates. Dissolved mercury was detected in only 3 of 14 samples, and all of the sample detection limits (0.0001 and 0.0002 mg/L) were less than the CVs. These results suggest that there is a moderate risk of short-term toxic effects of mercury during episodic exposures in NT-8. All detected mercury levels (i.e., total and dissolved) were less than the acute NAWQC. The chronic NAWQC is only protective of the usage of fish and is not appropriate for the protection of aquatic biota.

Nickel appears to present a significant risk to sensitive species in Reach 1 and SS-1; a marginal risk to sensitive species in Reach 2, SS-4, SS-5, SS-6, and SS-8; a marginal risk to less-sensitive species in Reach 1 and SS-1; a negligible risk to less-sensitive species in Reach 2, SS-4, SS-5, SS-6, and SS-8. The distributions of ambient nickel concentrations and aqueous test endpoints are shown in Fig. G.13. The ambient concentrations are dissolved phase concentrations at each site where nickel was detected above background and at least one benchmark. The toxicity data are normalized to 200 mg/L hardness.

A downstream gradient of nickel appears to exist in Bear Creek, having the S-3 Ponds as the primary source. That is, total and dissolved nickel concentrations were highest in Reach 1, moderate in Reach 2, and lowest in Reaches 3 and 4. The frequency of detected concentrations also was highest in Reach 1. Nickel did not exceed the NAWQC criteria, or the acute and CVs used to calculate these criteria, at any site. However, Kszos, Stewart, and Taylor (1992) identified nickel as a significant contributor of toxicity to *C. dubia* in water from Bear Creek and Upper East Fork Poplar Creek. This toxicity identification evaluation used a nickel-selective resin to reduce the toxicity of BCK 12.36 water to *C. dubia*. Kszos, Stewart, and Taylor (1992) used a series of dilution tests to determine that reproduction of *C. dubia* was significantly reduced by as little as 0.0086 mg/L of nickel in Bear Creek water. This study also determined that *C. dubia* was more sensitive to nickel than *D. magna* and the fathead minnow. Based on these site-specific estimates, nickel is likely to be toxic to sensitive species at every site where dissolved nickel was detected (i.e., Reaches 1 and 2, SS-1, SS-4, SS-5, SS-6, and SS-8). Nickel toxicity is considered possible at these locations for less-sensitive species. The magnitude and frequency of detects suggests that these effects are most likely in Reach 1. All detected nickel levels (i.e., total and dissolved) at the aforementioned sites were less than the acute and chronic NAWQC at 200 mg/L hardness.

Silver appears to present a marginal risk of chronic toxicity and a negligible risk of acute toxicity in BCV. The distributions of ambient silver concentrations and aqueous test endpoints are shown in Fig. G.14. The ambient concentrations are dissolved phase concentrations at each site where silver was detected above background and at least one benchmark. The acute toxicity data are normalized to 200 mg/L hardness. Because silver was detected in only one sample from each site, the single concentrations are depicted as the 100th percentiles.

A consistent downstream gradient is not evident within Reach 1 or Bear Creek as a whole. All silver concentrations were less than the acute values for fish and invertebrates, but greater than the single chronic value for fish (0.0012 mg/L for the rainbow trout). Silver was rarely detected (i.e., <5% detects at most sites), and only one concentration (0.0079 mg/L total silver at SS-8) was equal to or greater than the chronic value for *D. magna* (0.00791 mg/L). Total silver was detected twice in Reach 1 at BCK 11.97, and dissolved silver was detected in 1 of 38 samples from Reach 1 and 1 of 14 samples from BCK 4.55. However, the sample detection limits also exceeded the chronic value for the rainbow trout. Hence, silver was rarely detected, but the ambient concentrations may be chronically toxic to fish. This is suggestive of a small risk to aquatic biota, given the paucity of chronic toxicity data. EPA could not determine a chronic NAWQC from the available data, and the acute NAWQC at 200 mg/L hardness (NACU_200) was not exceeded at any site.

Strontium appears to present a negligible risk to aquatic biota in BCV. Total and dissolved strontium exceeded background and the secondary chronic value in Reach 1 only. Although unfiltered strontium measurements may overestimate exposures, the dissolved strontium levels in BCV were similar to the total strontium levels. The apparent downstream gradient suggests that strontium may be associated with the S-3 plume. However, all strontium measurements in BCV were at least 10 times below the lowest chronic and acute toxicity values (42 and 94 mg/L, respectively, for *D. magna*). The exceedence of the secondary chronic value in the screening assessment is attributable to the large safety factors used with minimal data sets.

Uranium appears to present a significant risk of chronic effects in Reach 1; a marginal risk in Reach 2, upper Reach 3, SS-4, and SS-6; and a negligible risk elsewhere in BCV. The risk of acute effects is considered negligible in BCV. Dissolved uranium levels in BCV were similar to the total uranium levels, and a downstream gradient appears to be associated with the S-3 plume. Little acute toxicity data and no chronic toxicity data exist for uranium. All measured concentrations in BCV were less than the lowest

reported toxic concentration (a fathead minnow LC50 of 2.8 mg/L) by at least a factor of 10. The acute toxicity data were used to estimate a chronic value and lowest test value for fish (Suter and Mabrey 1994). This estimated chronic value for fish was exceeded by 75% of the samples from BCK 11.97 and 20% to 50% of the samples from SS-4, SS-6, Reach 2, and upper Reach 3. None of the samples from BCKs 4.55 or 0.63 exceeded the chronic value. The exceedence of the secondary values in the screening assessment is attributable to the large safety factors used with minimal data sets. Given the uncertainty associated with the toxicity data, chronic toxicity is only considered likely in Reach 1 and possible in Reach 2, upper Reach 3, SS-4, and SS-6.

Zinc appears to present a negligible risk to aquatic biota in BCV. Total zinc exceeded background and the lowest CVs for fish and aquatic plants in Reach 3 at BC9.4-SS5 and NT-7 only. However, total zinc is likely to overestimate the bioavailable fraction, and dissolved zinc did not exceed background and benchmarks at any location in BCV. Based on the observed concentrations and the extensive toxicity data set, acute and chronic toxicity is considered unlikely.

1,2-Dichloroethene 1,2-Dichloroethene appears to present a negligible risk in BCV. 1,2-dichloroethene exceeded the secondary chronic value in NT-7 and NT-8. However, all measured concentrations were at least 10 times below the estimated lowest CVs for fish and 1,000 times below the acute toxicity value for fish (135 mg/L for a bluegill). The exceedence of the secondary value in the screening assessment is attributable to the large safety factors used with minimal data sets.

NT-1 Technology Demonstration Data December 1995 concentrations of nine inorganics and one organic chemical were greater than background and the Reach 1 exposure concentration (Table G.6). Of these chemicals, only concentrations of cobalt and nickel exceeded more benchmarks than the Reach 1 exposure values. Cobalt marginally exceeded the background criterion (0.017 mg/L). Nickel exceeded two more benchmarks than the Reach 1 value but did not exceed the acute or chronic NAWQC. Given the uncertainties in the December 1995 data (e.g., unfiltered concentrations likely overestimate bioavailability and only one unvalidated sample was available), The characterization of risks based on Reach 1 UCL95s appears to be adequately conservative to account for the downstream concentration gradient in NT-1.

Summary of current chemical risks

Four chemicals in surface water appear to present significant risks at one or more locations in BCV: calcium, cadmium, uranium, and nickel for sensitive species. The highest risks appear to be in Reach 1 and SS-1. Cadmium and uranium also present marginal risks at one or more other locations, and nickel presents marginal risks to sensitive species in several areas. Seven chemicals present, at most, marginal risks in BCV: barium, boron, copper, iron, lithium, mercury, and manganese. Risks from chronic exposures to silver are marginal at all sites. Six chemicals appear to present a negligible risk in BCV: aluminum, cyanide, lead, strontium, zinc, and 1,2-dichloroethene.

Screening of future aqueous exposures against chemical benchmarks

A simplified chemical screening approach was used to evaluate future risks because of the considerable uncertainties associated with long-term predictions of surface water chemical concentrations (Appendix E). These predicted concentration ranges are the only line of evidence for characterizing future risks. Hence, this screening is intended to identify chemicals that would require actions to reduce future risks, rather than to identify all chemicals that should be evaluated against the toxicity and biosurvey results. To that end, the predicted range of maximum surface water concentrations from Appendix E were compared to the risk-based remedial goal option concentrations (RBRGOs). The

RBRGOs were selected from the available aqueous benchmarks in the following order of preference. The preferred benchmark is the chronic NAWQC, adjusted to 200 mg/L hardness for hardness dependent metals. The secondary chronic values are used for mercury and total PCBs because these NAWQCs are not based on the protection of aquatic life. If a NAWQC is not available, the lower of the LCV for daphnids and the LCV for fish is used. If these are not available (e.g., for lithium), the secondary chronic value is used. If the selected benchmark is less than the background criterion, the RBRGO defaults to the background criterion.

Surface water concentrations due to contaminant loading from the following sources were predicted for six locations: NT-1 and NT-2 due to the S-3 plume, NT-3 due to the BYBY, NT-7 due to BG A, NT-8 due to BG C-west and the Walk-in Pits, and BCK 9.47 due to all modeled sources. A concentration range for NT-8 from all sources was estimated by summing the contributions from both modeled sources (i.e., BG C-west and the Walk-in Pits). This is conservative, given that the peak contributions from these sources probably will not occur at the same time.

Screening results for chemicals for which all predicted maximum concentrations are less than the RBRGOs are presented in Table G.7. Although concentrations of some of these chemicals may increase in the future, effects are not expected and these chemicals are not considered further in this section. Predicted maximum concentration ranges for chemicals for which at least one range included the RBRGO are presented by chemical in Figs. G.15 through G.22. Adverse effects are expected if the entire range of predicted concentrations at a location exceeds the RBRGO. Adverse effects are considered possible if the range of predicted concentrations includes the RBRGO. The characterization of future risks under the no action scenario is based on the likelihood of adverse effects and the Appendix E evaluation of the predicted time range for the peak concentrations. These characterizations are summarized by area in Table G.8 and discussed below.

Risks in NT-1 are expected to increase in the future due to loading of four inorganic chemicals (cadmium, calcium, nickel, and uranium) from the S-3 plume. Increased risks also are possible due to mercury loading. Peak concentrations are predicted to occur within the next 50 to 150 years.

Risks in NT-2 are expected to increase in the future due to loading of calcium and, possibly, barium loading from the S-3 plume. Peak concentrations are predicted to occur within the next 50 to 350 years.

Risks in NT-3 are not expected to increase in the future due to loading from the BYBY. Adverse effects in NT-3 are expected from cadmium, nickel, and uranium and are possible from mercury. However, the modeling results indicate that the concentrations of these chemicals are at steady-state.

Risks in NT-7 are expected to increase slowly over the next 1000 years due to loading of beryllium, cadmium, copper, lead, lithium, nickel, and uranium. Increased risks due to cyanide exposures are expected peak in the next 50 years. Risks also may increase due to tetrachloroethylene exposures, which are predicted to peak within the next 150 years.

Risks in NT-8 from all sources are expected to increase slowly over the next 1000 years due to loading of beryllium, copper, lead, lithium, nickel, and uranium. Increased risks due to cyanide exposures are expected peak in the next 50 years. Risks also may increase slowly over the next 1000 years due to cadmium. Loading of boron, cadmium, selenium, total PCBs, and bis(2-ethylhexyl)phthalate from burial ground C-West is considered to be at steady-state. Hence, risks due to these chemicals are not expected to increase.

Risks in Bear Creek above NT-1 due to loading from the S-3 plume are expected to decrease in the future. The model predictions were used to estimate the time required for concentrations of the chemicals currently presenting a significant risk in Reach 1 to decrease to acceptable levels, defined here as the RBRGO concentrations, under the no action scenario. Based on these estimates, calcium and uranium will meet the RBRGO in 5 to 10 years, nickel will meet it in 20 to 25 years, and cadmium will meet it in 30 to 40 years.

Risks in Bear Creek between BCK 9.47 and NT-1 were not modeled in Appendix E. However, given that loading of S-3 contaminants via NT-1 and NT-2 will increase, it should not be assumed that risks in this stretch of Bear Creek will decrease as the loading above NT-1 decreases.

Risks at BCK 9.47 from all sources are expected to increase due to loading of cadmium, cyanide, and uranium. Increased risks are possible due to loading of beryllium and copper. However, the methods used to predict the loading at BCK 9.47 from all sources precluded the prediction of peak times.

G.2.3.2 Single-Chemical Internal Toxicity

Mercury concentrations in fish do not appear to present a significant risk to fish in BCV. The only location where the body burdens of mercury fell within the potentially toxic range was at BCK 0.6 in Reach 4. The maximum whole body concentration of 0.884 mg/kg (Table G.48) exceeded the 0.66 mg/kg concentration that corresponded to a CV for fathead minnows, but was well below the value for brook trout (5.6 mg/kg). The mean concentration at BCK 0.6 (0.355 mg/kg) and all concentrations for the upstream sites were below 0.66 mg/kg. Interestingly, mercury body burdens are highest in the most downstream site, near EFPC, and appear to be steadily increasing through time. The cause of this phenomenon, which also is evident in EFPC, is as yet unknown (Hinzman et al. 1995). The marginal exceedence of only the lowest benchmark based on laboratory testing suggests that the current risk to fish from accumulation of mercury appears to be small. It is possible that accumulation of mercury could become detrimental to the fish community in lower Bear Creek. However, this is highly uncertain, given that the source and mechanism for this increase is unknown.

PCB concentrations in fish (Table G.48) do not appear to present a significant risk to fish in Bear Creek. Only one concentration reported to constitute thresholds for toxic effects was exceeded in Bear Creek. The mean and maximum total PCB concentrations in rock bass exceeded the incredibly low threshold value (0.7 mg/kg) for lake trout (at all locations except BCK 12.4. However, the maximum concentration at every site in Bear creek was less than the next lowest threshold value (11.9 mg/kg for the channel catfish). Other threshold values ranged from 14.3 mg/kg to >390 mg/kg. Hence, toxicity from internal concentrations of PCBs in fish from Bear Creek is considered possible but unlikely.

G.2.3.3 Radiation Dose Rates

Current exposures

The concentrations of detected radionuclides were compared with the screening values for small fish. An HQ was calculated for each radionuclide by dividing the UCL95 concentration by the screening value. The screening value is the concentration resulting in a total dose rate of 1 rad/d from the major emissions of the measured parent radionuclide and all short-lived progeny (refer to Sect. G.3.2.2). A total dose rate to small fish at each location was calculated by summing the HQs for all detected radionuclides. Radionuclides present a significant risk to benthic invertebrates if the sum of HQs for a site exceeds 1.0. Table G.9 details the exposure estimates (UCL95), screening values, HQs for individual radionuclides, and the sum of HQs for all radionuclides detected at each location.

Five radionuclides were detected in the technology demonstration sample from NT-1: Tc-99 (1000 pCi/L), U-234 (3.9 pCi/L), U-235 (0.18 pCi/L), U-236 (0.14 pCi/L), and U-238 (8.4 pCi/L). These concentrations were compared to the same benchmarks used for the Reach 1 screening.

Based on these results, radionuclides in BCV surface water appear to present a negligible risk to fish and the characterization of risks for Reach 1 is adequately conservative to account for the downstream concentration gradient in NT-1. That is, the individual and sum of HQs were <1.0 at all locations.

Future exposures

The predicted range of maximum surface water concentrations from Appendix E were compared to the aforementioned screening values for a small fish. The maximum HQ was calculated as the maximum concentration of a radionuclide at a site divided by the screening value for that radionuclide. The sum of the maximum HQs for a site is a conservative estimate of the predicted total dose rate. The predicted individual and sum of maximum HQs were <0.1 at all locations modeled in Appendix E. Based on these results, future risks to fish from radionuclides are expected to be negligible.

G.2.3.4 Ambient Water Toxicity

Water from upper Bear Creek continues to be acutely and chronically toxic to *Ceriodaphnia*. Test results are deemed significant if the difference between the response of the organisms exposed to water from the site and organisms in control or reference water is at least 20% (i.e., biologically significant) or if the likelihood that the difference is due to chance is <5% (i.e., statistically significant). Test results are related to two expressions of exposure, the location of the sample relative to sources and the relationship between the responses and the concentrations of aqueous COPECs in the tested water. *Ceriodaphnia* tests appear to be sensitive indicators of toxicity, whereas fathead minnow tests are not. *Ceriodaphnia* survival and reproduction were often significantly reduced relative to controls. However, fathead minnow survival was rarely reduced by 20% relative to controls (e.g., 2 of 16 tests in Reach 1 and 2 of 21 tests in Reach 2) and growth was nearly always equal to or greater than controls. Given that, this evaluation will focus on the *Ceriodaphnia* tests. The methods and results of these tests are discussed in Sect. D.9. This section analyzes their implications for risks to fish in BCV.

The May 1994 toxicity tests clearly indicated significant acute and chronic toxicity in Reach 1 (BCK 12.36, NT-1, and BCK 11.83) and SS-1 and chronic toxicity in NT-2 (Fig. G.23). Toxicity was not evident at any other tributary or main stream site. The reduced toxicity observed in August 1994 is probably due to the dilution of contaminant concentrations by rainfall and high flows during that sampling period. Although water from Reach 1 was not acutely toxic, water from BCK 12.36 and SS-1 remained chronically toxic (Fig. G.24). Interestingly, water from SS-4, which was not toxic during base flow conditions in May, was acutely and chronically toxic during the high flow conditions in August. This toxicity does not appear to be related to turbidity, given that SS-4 was clear and the surface water sites were turbid.

The pattern of toxicity observed in May of 1994 (Fig. G.23) is representative of the pattern observed in the main stream of Bear Creek since testing was begun in 1984 (Hinzman et al. 1995). Significant toxicity to *Ceriodaphnia* has not occurred below BCK 11.09, and BCK 12.36 has consistently been the most toxic site. However, the magnitude and frequency of effects have decreased since the S-3 Ponds were neutralized and denitrified. Still, this pattern suggests that discharges from the S-3 Ponds continue to be a significant source of toxicity in Bear Creek.

Toxicity in Reach 1 appears to be due to elevated concentrations of metals and calcium. Dissolved metal concentrations were generally higher in Reach 1 than elsewhere in Bear Creek and previous studies have identified nickel in water from BCK 12.36 as a major contributor to *Ceriodaphnia* toxicity (Kszos, Stewart, and Taylor 1992). Also, Stewart et al. (in Hinzman et al. 1995) suggest that the high nitrate concentrations in the S-3 discharges allow calcium to stay in solution at concentrations that are toxic. Calcium is not generally toxic in ambient water because it occurs primarily as calcium carbonate and, under most conditions, calcium carbonate is not soluble enough for calcium to reach toxic concentrations. Based on their evaluation of the nitrate, carbonate, and calcium concentrations in upper Bear Creek, the authors determined that calcium was likely to be present in a bioavailable form at concentrations previously shown to be toxic to daphnids.

This conclusion is supported by the subsequent statistical analyses of the toxicity data for May 19–26, 1994, and chemical data for filtered and unfiltered samples collected May 24, 1994. Linear regression analyses revealed that the percent reduction in *Ceriodaphnia* fecundity relative to controls was significantly positively correlated with dissolved calcium ($\alpha = 0.0004$, $r^2 = 0.81$), but not with any other COPEC. It is interesting to note that the percent reduction in *Ceriodaphnia* survival relative to controls was significantly positively correlated with dissolved manganese ($\alpha = 0.0003$, $r^2 = 0.83$), but not with calcium or any other COPEC.

G.2.3.5 Biological Surveys

The fish community in Bear Creek does not appear to be degraded due to a contaminant effect. The depauperate fish communities observed before 1989, especially at BCK 12.36, have increased in species richness (Fig G.25) and total density (Fig G.26). The fish community in Reach 1 is composed of four species. Only two species, the blacknose dace (*Rhinichthys atratulus*) and creek chub (*Semotilus atromaculatus*) were found before the fall of 1988. Communities observed in 1993 were similar to those observed in the reference headwater streams Gum Hollow Creek and Pinhook Branch. However, the ability to discriminate between Bear Creek sites and reference sites is limited by the considerable variability of fish densities at these locations. The number of species present in Reaches 2 and 3 have fluctuated by one or two species per site, but demonstrated no consistent increasing or decreasing trends. Density at BCK 9.91 was stable from 1988 through spring 1991, increased in fall 1991, and has remained relatively stable and comparable to the reference streams. Species richness was greater at BCK 3.25 than at upstream sites (e.g., BCKs 7.87 and 9.40) because the weir at BCK 4.5 limits upstream migration of some species (Fig. G.25). Density and biomass levels at BCK 3.25 have remained relatively stable and comparable to the reference streams. Densities of all species at BCK 7.87 were lower from the fall of 1989 through the spring of 1991 than during previous sampling periods, apparently due to the gravel and fine sediments that have accumulated at this site (Fig.26). Siltation also is a contributing factor to the changes observed at BCK 9.91.

The Tennessee dace population in Bear Creek does not appear to be degraded due to a contaminant effect (Fig. G.27). Tennessee dace were not observed at BCK 12.36 before 1989. Densities in Reach 1 have increased to levels comparable to reference stream densities, though the year-to-year variability precludes a definitive comparison. Also, the only reference streams with established Tennessee dace populations are Gum Hollow Creek and Pinhook Branch, which were not evaluated before 1993. Tennessee dace densities in Reach 3 at BCK 7.87 decreased by ~90% between the spring of 1989 (0.97 fish/m²) and the fall of 1990 (0.09 fish/m²). However, the density of Tennessee dace was higher in the fall of 1994 than during the previous 6 years (0.92 fish/m²), and no known episodes of contamination occurred that may have caused the observed changes. The habitat quality may have been degraded by silt loading from activities in BCV. Tennessee dace prefer headwater streams and are not expected to inhabit lower Reach 3 (BCK 3.25) and Reach 4 (BCK 0.7).

G.2.3.6 Weight of Evidence for Fish

Current risks

The weight of evidence suggests that water from Bear Creek and tributaries NT-2 through NT-8 does not pose a significant risk to the fish community or the Tennessee dace. Table G.10 summarizes, for each site, the weighing of evidence presented in the following text.

The fish community in Reach 1 does not appear to be significantly degraded relative to reference streams. Species richness and total density of the fish community has increased since 1989 and is comparable to reference communities. Survival and reproduction of *C. dubia* are still drastically reduced relative to controls. Calcium and manganese concentrations were significantly correlated with these responses. Dietary exposures to mercury and PCBs do not appear to be toxic, based on the body burden measurements of these chemicals. Calcium, cadmium, and uranium concentrations are likely to be toxic. Also, nickel is likely to be toxic to sensitive species. Toxicity is possible, but not likely, from barium and copper. Although the toxicity tests and media analyses were positive, a community-level effect was not evident. This suggests that the BCK fish community is less sensitive than the surrogate test organisms to the elevated chemical concentrations present in Bear Creek. This could be due to inherent differences between species and/or acclimation of the Bear Creek community to existing conditions.

The fish communities in Reaches 2, 3, and 4 also do not appear to be degraded by a contaminant effect. Species richness and densities were generally comparable to reference streams. The lower densities observed at some sites (e.g., BCK 11.09 and BCK 7.87) appear to be attributable to poor habitat quality, including low stream flow and siltation from construction activities. The toxicity tests are not indicative of significant current effects, and the chemical analyses suggest that the likelihood of toxicity decreases with increasing distance from Reach 1. Hence, water in these reaches appears to pose less of a risk to fish than does water in Reach 1. The body burden measurements are the only line of evidence that suggests risk increases with increasing distance from Reach 1. Significant toxicity is not expected in Reach 3, given that mercury concentrations are below all benchmarks and PCB concentrations exceeded only one very low screening value. Measured mercury and PCB concentrations in rock bass fillets from Reach 4 (BCK 0.7) suggest that toxicity to sensitive species is possible, but unlikely. However, increasing mercury concentrations suggest that risks may increase in the future. The cause of this increase is unknown, but a similar phenomenon is occurring in EFPC.

Water from tributary NT-2 does not appear to pose a significant risk to fish inhabiting this area. Only two lines of evidence are available: aqueous toxicity tests and aqueous chemical concentrations. *C. dubia* reproduction was reduced by 37% in one of two tests, though survival was 100% in both tests. Calcium concentrations were significantly correlated with this response. Fathead minnows were not significantly affected. Toxicity is likely from calcium and possible, but not likely, from barium. Community surveys were not conducted for the tributaries. However, Reach 1 water was more toxic (i.e., higher intensity and frequency of effects) and more contaminated (i.e., more COPECs at higher concentrations) than NT-2. Given that the fish community in Reach 1 is not at risk, it is highly unlikely that the fish using NT-2 are at risk. Also, the fish in NT-2 are functionally part of the community in Reach 1, because NT-2 is too small to support a distinct fish community.

Water from tributaries NT-3 through NT-8 also do not appear to pose a significant risk to fish inhabiting these area. Only two lines of evidence are available: aqueous toxicity tests and aqueous chemical concentrations. *C. dubia* and fathead minnows were not significantly affected during the two tests conducted using water from these sites, and none of the COPECs occurred at concentrations likely to be toxic.

The Tennessee dace population in Bear Creek does not appear to be degraded due to a contaminant effect, given that the highest densities occur at the most highly contaminated site (BCK 12.36). Lower densities are observed in Reach 2 and upper Reach 3, but may be attributable to poorer habitat quality. As noted above, stream flow is often low or intermittent in upper Reach 2 and lower Reach 1. Also, siltation has been suggested as a causal factor for the degraded fish community and Tennessee dace population at two sites in Reach 2 and upper Reach 3.

Future risks

Current risks to fish are not considered significant primarily as a result of the toxicity and biosurvey data. However, the weight-of-evidence for future risks to fish is based solely on the screening of predicted future aqueous contaminant concentrations. The results of that screening (Table G.8) suggest that exposures are expected to increase, and future risks to the fish community are expected to be significant, in NT-1, NT-2, NT-7, NT-8, and in Bear Creek at BCK 9.47. Significant risks are not expected in Bear Creek above NT-1. Chemical exposures in Bear Creek between BCK 9.47 and NT-1 have the potential to increase in the future and risks to the fish community may become significant, but the uncertainty in this is high because of the lack of model results for this stretch of Bear Creek. Chemical concentrations, and therefore risks to fish, in NT-1 and NT-2 are expected to peak in the next 50 to 350 years. Generally, risks in NT-7 and NT-8 are expected to increase slowly over the next 1000 years. The exception is that risks from cyanide are expected to peak in the next 50 years. The peak time for BCK 9.47 could not be estimated.

G.2.4 UNCERTAINTIES CONCERNING RISKS TO FISH

The following issues constitute the major sources of uncertainty in the risk assessment for the fish community:

- Water samples from most tributaries, Reach 2, and Reach 3 were not collected from the upstream areas and, therefore, may underestimate the risks at these sites.
- Concurrent chemical analyses were available for only one set of aqueous toxicity tests. Hence, some uncertainty is associated with the causes of toxicity. This uncertainty is tempered by the strong relationships between the concentrations of calcium and manganese and the toxicity to *C. dubia*.
- Some uncertainty exists in the ecological relevance of the toxicity tests. The species available for aqueous testing (i.e., *Ceriodaphnia*) may be more sensitive than the indigenous species to the chemicals in BCV. Also, the water may be more toxic to naive test organisms than to equally sensitive organisms that have acclimated to the site conditions.
- Community surveys are not available for the tributaries or Reach 1 above BCK 12.36, and chemical analyses are available for only three sites below BCK 11.97 in Reach 1: BCKs 0.63, 4.55, and 9.4.
- There are considerable uncertainties associated with long-term predictions of surface water chemical concentrations, which are the only evidence available for estimating future risks to fish.

G.3 RISKS TO BENTHIC INVERTEBRATES

This section contains the exposure and effects assessments and characterization of risks to benthic invertebrates in BCV. Benthic invertebrates are primarily exposed to contaminants in sediment, sediment pore water, and overlying surface water. Surface water exposures are more important in erosional areas because chemicals in sediments are primarily associated with fine grains and organic matter, which are eroded from riffles and accumulated in pools. Benthic invertebrates inhabiting depositional areas are generally immersed in the fine sediments. Thus, the primary exposures in depositional areas are to contaminated sediments and sediment pore water. The locations and types of data available for assessing these pathways in Bear Creek are sufficiently different to necessitate evaluating surface water and sediment exposures separately. That is, chemical and toxicity analyses of water were not available at most sediment depositional areas, and community surveys are available only for erosional areas. Other exposure pathways, such as ingestion of contaminated food items, are not explicitly evaluated herein because the necessary exposure and literature toxicity data are not available. However, these exposure pathways are at least partially accounted for by the community surveys and whole sediment toxicity tests.

G.3.1 EROSIONAL AREAS

G.3.1.1 Exposure Assessment

Benthic invertebrates in erosional areas are exposed primarily to contaminants in water. The exposure assessments of current and future aqueous chemical concentrations, current and future aqueous radionuclide concentrations, and aqueous toxicity tests for the fish community (Sect. G.2.1) are also representative of exposure for benthic invertebrates in erosional areas. The screening values for radiation dose rates to a small fish from water are presumed also to be protective of invertebrates exposed primarily to water, given the conservative assumptions used in their derivation.

G.3.1.2 Effects Assessment

The effects assessments of aqueous chemical concentrations, aqueous radionuclide concentrations, and aqueous toxicity tests are presented in Sect. G.2.2.

In addition to the standard laboratory toxicity tests of water from Bear Creek, *in situ* toxicity tests with the snail (*Elimia*) were conducted in 1986 and 1987 in the main stream of Bear Creek. The behavior (i.e., avoidance by moving downstream), morbidity, and mortality of *Elimia* placed in Bear Creek in cages or open trays was evaluated. The severity of effects was greatest in upper Bear Creek near BCK 12.36 and diminished with increasing distance downstream. At the time of the tests, *Elimia* were not observed above BCK 9.4. In July 1994, a cursory survey noted the presence of a *Elimia* as far upstream as BCK 11.83.

Analysis of the benthic invertebrate community survey data provides a direct measure of impacts of human activities on aquatic ecosystems. These data can provide an additional line of evidence relating to potential impacts of DOE operations on Bear Creek. Quantitative sampling of the benthic invertebrate community has been conducted at six to ten locations in Bear Creek since the spring of 1984. Sampling at BCK 0.7 was conducted in the spring and fall of 1992. Methods and the results of benthic community surveys are summarized in Sect. D.9 and detailed in Hinzman et al (1995).

G.3.1.3 Risk Characterization

Chemical and radiological exposures

The characterization of risks based on the screening of current and future aqueous chemical and radionuclide concentrations are presented in Sect. G.2.3.

Ambient water toxicity

The characterization of risks based on the aqueous toxicity tests are presented in Sect. G.2.3.

Biological surveys

The presence of the snail (*Elimia*) at BCK 11.83 in 1994 suggests that the water quality in Bear Creek above BCK 9.4 has improved since 1987. However, the lack of *Elimia* above BCK 11.83 provides additional evidence that the water quality in Reach 1 continues to be degraded relative to other sites. This is consistent with the results of the *Ceriodaphnia* toxicity tests.

The biological surveys reveal that the benthic invertebrate community in Bear Creek continues to be degraded relative to reference streams. The spatial pattern and community composition is suggestive of continued toxic discharges from the S-3 Ponds. That is, the community is severely degraded in Reach 1, moderately degraded in Reach 2, and fully recovered in lower Reach 3 (BCK 3.25) and Reach 4. Considerable improvement has occurred since 1987, especially at BCK 9.91 (Fig. G.28). Total density and abundance have increased steadily throughout this period, the most consistent improvement occurring in Reach 2 and upper Reach 3. Density and abundance in the reference streams also increased during this period, though not as much as in Bear Creek. Hence, some, but not all, of the observed improvements are likely the result of increased stream flow following the 1985–88 drought (Hinzman et al. 1995). Still, the total richness and abundance of benthic invertebrates in Bear Creek is less than in the reference streams. As with the fish community, the degradation of the benthic invertebrate community at BCKs 9.91 and 7.87 is likely to be partly due to the accumulation of fine-grained sediments and the concomitant reduction in habitat quality.

The number and distribution of sensitive species also is indicative of continuing effects of the S-3 Ponds. Cada et al. (in Hinzman et al. 1995) noted that the extremely low density and low number of mayflies species (*Ephemeroptera*) above BCK 3.25 is typically indicative of metals contamination. This is reflected in the continued low *Ephemeroptera*, *Plecoptera*, and *Trichoptera* richness (Fig. G.29). Although *Ephemeroptera*, *Plecoptera*, and *Trichoptera* richness has increased in Bear Creek, this is almost entirely due to increases in stoneflies (*Plecoptera*) and caddisflies (*Trichoptera*), which are less sensitive to metal contamination. Mayflies have never been collected from BCK 12.36 and were rarely collected from BCK 11.83.

Weight of evidence

Current risks

The weight of evidence suggests that water in Reaches 1 and 2, NT-2, SS-1, and SS-4 poses a significant risk to benthic invertebrates from high concentrations of calcium, cadmium, manganese, nickel, and uranium. The distribution of observed effects and toxic concentrations strongly suggests that discharges from the S-3 Ponds continue to be the primary contributor to risks. Table G.11 summarizes, by location, the weighing of evidence presented in the following text.

In Reach 1, the benthic invertebrate community is still severely degraded; survival and reproduction of the sensitive test organism *C. dubia* continues to be drastically reduced; and calcium, cadmium, nickel, and uranium concentrations are likely to be toxic. The convergence of all three lines of evidence provides a high degree of confidence that the observed effects are due to the measured contaminants. That is, mayflies are sensitive to metals and are absent from this reach; previous studies revealed that nickel in Reach 1 water was toxic to a sensitive test organism; and cadmium and uranium occur at toxic concentrations. Also, calcium exceeds the LCV for daphnids, and concentrations of calcium and manganese were significantly positively correlated ($\alpha = 0.05$) with, and explained ~80% of, the observed toxicity to *C. dubia*.

The weight of evidence suggests that Reach 2 water poses a significant risk to the benthic invertebrate community, primarily from high concentrations of cadmium. The benthic invertebrate community in Reach 2 has improved considerably since 1989, but is still moderately degraded relative to reference streams. Total and *Ephemeroptera*, *Plecoptera*, and *Trichoptera* richness and abundance are generally lower than the references. Although water from the farthest upstream site (BCK 11.09) was toxic to *C. dubia* once in 1991, significant effects have not been observed since then, nor have they been observed at other sites in this reach. Therefore, these results are considered not to be representative of current conditions in this reach. The lack of recent toxicity is consistent with the lower concentrations of calcium and manganese, relative to Reach 1. Cadmium concentrations are likely to be toxic, and the density and richness of mayflies is very low. Toxicity also is possible, but not likely, from six other metals: barium, boron, copper, iron, nickel, and uranium. The measured chemical concentrations may underestimate the actual exposure in this reach because the only main stream sampling site was at the lower end of Reach 2.

The weight of evidence suggests that Reach 3 water does not pose a significant risk to the benthic invertebrate community. Although the benthic invertebrate communities just below BCK 9.4 and at BCK 7.87 are generally less rich and abundant than at reference streams, none of the COPECs are likely to be toxic; the water has never been shown to be toxic; and siltation at BCK 7.87 has degraded the habitat. Although the mayfly population here is less rich and abundant than in the reference streams, none of the COPECs are likely to be toxic. Toxicity is possible, but not likely, from copper, iron, nickel, and uranium. Historically, the dilutory effect of water from SS-5 has been associated with higher benthos richness and density, which is supported by the flow-weighted estimates of dissolved metals concentrations at BCK 9.4-SS5. Hence, habitat quality appears to be the primary cause of the observed reductions in community metrics. Also, complete recovery occurs in Reach 3 between BCK 7.87 and BCK 3.25, and Reach 4 is comparable to reference streams.

NT-2 water appears to pose a significant risk from high concentrations of calcium. Surveys were not conducted in this tributary. The toxicity tests and chemical analyses both suggest that calcium is chronically toxic, especially to sensitive species.

Water in NT-3-NT-8 does not appear to present a significant risk. The toxicity tests were negative, and none of the COPECs are likely to be toxic.

SS-1 water appears to pose a significant risk to benthic invertebrates from high concentrations of calcium, cadmium, and nickel. *C. dubia* survival was reduced by 40% in May 1994, and reproduction was reduced by 52% and 45% in May and August of 1994, respectively. Fathead minnow survival was reduced by 30% in May 1994. Calcium, cadmium, and nickel concentrations are likely to be toxic. Toxicity also is possible, but not likely, from barium, copper, iron, nickel, and manganese. This site is too small to support a significant benthic invertebrate community, but probably contributes to the effects observed in main stream Bear Creek.

SS-4 water appears to pose a significant risk to benthic invertebrates, though the cause cannot be clearly identified from the available data. *C. dubia* reproduction was reduced by 29% in August 1994, and fathead minnow survival was reduced by 21% in August 1994. That is, toxicity was observed only during a high-flow event, which suggests that additional sources may be activated or concentrations may increase. At no time were any of the COPECs likely to be toxic and toxicity is possible, but not likely, from the observed concentrations of lithium, barium, nickel, and uranium. This site also is too small to support a significant benthic invertebrate community, but probably contributes to the effects observed in main stream Bear Creek.

Water in SS-5, SS-6, and SS-8 does not appear to present a significant risk. The toxicity tests were negative and none of the COPECs are likely to be toxic.

Future risks

The weight-of-evidence for future risks to benthic invertebrates is based solely on the screening of predicted future aqueous contaminant concentrations. The results of that screening (Table G.8) suggest that exposures are expected to increase, and future risks to the benthic invertebrate community are expected to continue to be significant, in NT-1, NT-2, and Bear Creek at BCK 9.47 (i.e., the lower end of Reach 2). Exposures are expected to increase, and future risks to the benthic invertebrate community are expected to become significant, in NT-7 and NT-8. Significant risks are not expected in NT-3. Risks in Bear Creek above NT-1 due to loading from the S-3 plume are expected to decrease in the future. However, under the no action scenario acceptable exposures are not expected to be attained for 30 to 40 years. That is, calcium and uranium may decrease to acceptable levels in 5 to 10 years, but cadmium is expected to exceed the RBRGO for the next 30 to 40 years. Chemical exposures in Bear Creek between BCK 9.47 and NT-1 cannot be assumed to decrease in the future, given the lack of model results for this stretch of Bear Creek and the predicted increased inputs from NT-1 and NT-2. Chemical concentrations, and therefore risks to benthic invertebrates, in NT-1 and NT-2 are expected to peak in the next 50 to 350 years. Generally, risks in NT-7 and NT-8 are expected to increase slowly over the next 1000 years. The exception is that risks from cyanide are expected to peak in the next 50 years. The peak time for BCK 9.47 could not be estimated.

G.3.2 DEPOSITIONAL AREAS

G.3.2.1 Exposure Assessment

Sediment chemical exposures

Two different expressions of sediment contamination are used—whole sediment concentrations and estimated pore water concentrations. The use of pore water is based on the assumption that chemicals associated with the solid phase are largely unavailable, and, therefore, sediment toxicity can be estimated by measuring or modeling the pore water concentration. This is the approach used by EPA to calculate sediment quality criteria. Whole sediment concentrations do not account for effects of sediment properties on bioavailability. However, they are required by EPA Region IV and may provide a better estimate of risk for highly particle-associated chemicals.

For purposes of screening chemicals, the appropriate estimate of exposure is a concentration that protects the most exposed organisms. The intent of the sediment characterization effort was to sample depositional areas that are likely to accumulate sediment-associated contaminants. Hence, these potential hot spots best represent the maximum exposures received by sediment-associated biota in BCV. The corollary to this is that the distribution of measured concentrations does not represent the full distribution

of exposures received by all sediment-associated biota in BCV. Therefore, risk estimation focuses on each sampled depositional area, and is the evaluation of the single-chemical sample for each area relative to particular effects levels.

Sediment radiation exposures

Exposures to radionuclides are expressed as the dose rate received by the organism. As with radiation exposures in surface water, the total dose rate is the sum of the internal and external dose rates, which are a function of exposure to the radionuclide and the characteristics of the radiation. Radiation exposures to benthic invertebrates immersed in sediments are likely to be driven by external exposures to contaminated sediments. The exception is for alpha-emitters, such as ^{234}U and ^{230}Th . Internal dose rates are based on the concentrations of the radionuclide in the organism, which is a function of bioavailability. Pore water concentrations are assumed to best estimate the bioavailable fraction in sediments, and standard sediment to benthic invertebrate transfer factors are not available. Therefore, the concentration in benthic invertebrates was estimated by using the measured sediment concentrations and the soil-water partition coefficients (K_d) from Baes et al. (1984) to estimate the sediment pore water concentrations. Concentrations in the organism were then estimated based on the biological concentration factors provided in Blaylock et al. (1993). Because the radiation exposure rate is expressed as absorbed dose per unit time (rads/d), the dose rates for each isotope and pathway can be added to determine the total dose rate.

Sediment toxicity test exposures

The sediment toxicity tests include direct exposure to whole sediment (*Hyallela azteca*) and exposure to epibenthic water (*D. magna*). The chemical exposures received by the test organisms are well-known, because toxicity tests and chemical analyses were conducted for each sediment sample (Sect. B.5). It is assumed that the form and bioavailability of chemicals is not altered by sediment collection and handling, so these tests represent exposures in the field.

G.3.2.2 Effects Assessment

Single-chemical sediment toxicity

Because there are no standard screening benchmarks and sediment quality criteria for only a few chemicals, sets of alternative sediment benchmarks were derived for each chemical (Table G.12). Whole sediment concentrations are compared with these alternative benchmarks. The use of multiple benchmarks provides greater assurance of detecting all COPECs. Sediment quality criteria are corrected for site-specific conditions. Sediment benchmarks derived using the equilibrium partitioning method are calculated using location-specific percent organic carbon.

Toxicity profiles are presented in the Supporting Information for chemicals that exceed benchmarks. The toxicity profiles summarize the existing toxicity information for each chemical, including concentrations causing acute lethality and chronic lethal and sublethal effects, and physical-chemical conditions that modify toxicity. Most of the available sediment toxicity data are for marine and estuarine systems. The sediment toxicity profiles primarily address freshwater sediment data, which are not included in the effects range—lows (ER-Ls) and effects range—median (ER-Ms) (Long et al. 1995) or the threshold effect levels (TELs) and probable effects levels (PELs) (MacDonald et al. 1994). An extensive marine data set was presented in MacDonald et al. (1994). Lethal and community level effects from these sources are presented graphically for most COPECs.

Radiological effects

The recommended acceptable dose rate to natural populations of aquatic biota is 1 rad/d (NCRP 1991). Although there are no standard screening benchmarks for radionuclide concentrations in sediments, Blaylock et al. (1993) provide formulas and exposure factors estimating the dose rates to representative aquatic organisms. These formulas were used to calculate the sediment concentration that results in a total dose rate of 1 rad/d to a small invertebrate for each radionuclide detected in the sediment samples from BCV. The exposure factors used in this assessment are from Blaylock et al. (1993) and are presented in Table G.2. The benchmarks include internal and external exposures from the detected isotope and all short-lived daughter products. All major alpha, beta, and gamma emissions for each isotope were included, and the absorbed fraction of each was estimated from the graphs provided in Blaylock et al. (1993). Conservatism was practiced by assuming the representative invertebrate was immersed in the sediments at all times. Internal exposures from radionuclides in sediments were estimated using the soil-water partition coefficients and biological concentration factors (see Sect. G.3.2.1) for the detected parent isotopes.

Ambient sediment toxicity

Because there is no dilution series for the sediment toxicity tests, the appropriate exposure-response relationship is the association between the significant toxic responses and either the concentrations of contaminants in the sediment or the location relative to known sources of contaminants. Responses that are statistically significantly different, or are inhibited by 20% or more relative to reference sediments, are assumed to be indicative of sediments that are toxic to benthic biota. Test responses used in this assessment include reductions in survival of an amphipod (*H. azteca*) in 10-day exposures to whole sediment and reductions in survival and fecundity of another cladoceran (*D. magna*) in 12- to 14-day exposures to water overlying sediment.

G.3.2.3 Risk Characterization

Single-chemical sediment toxicity

Screening against chemical benchmarks

Measured concentrations of inorganic chemicals were compared with the background screening criteria (Sect. D.4). Inorganics that exceeded background and all detected organic chemicals were screened against benchmarks and evaluated as COPECs. An HQ was calculated for each chemical by dividing the measured concentration at each site by the sediment benchmarks (Table G.12). Chemicals that exceeded any benchmark (e.g., HQ > 1) were examined further to determine whether they were credible COPECs (Table G.13). None of the candidate COPECs could be eliminated without a more detailed evaluation of the observed concentrations and the relevant effects data.

The Σ TUs for each sampled depositional area was calculated to show the relative toxicity of sites and the relative contribution of COPECs to that toxicity. This holistic overview provides a context for the detailed discussions of exposure effects that follow. The generic derivation and interpretation of TUs in this assessment is presented in Sect. G.1. The ER-M from Long et al. (1995) was the denominator for most whole sediment COPECs. The SEL_MOE or REG_V_M value was used only if an ER-M was not available. TUs were calculated for each COPEC using the measured concentration at each site. These TUs were summed by sediment sampling site.

To aid interpretation of the figures, the Σ TU for each of four general categories of COPECs are presented in Fig. G.30. The polycyclic aromatic hydrocarbons (PAHs) category is the sum of all detected PAH concentrations in each sample (total PAHs) divided by the ER-M for Total PAHs, rather than the Σ TUs for each individual PAH. The TUs for individual metal and pesticide COPECs are presented in Figs. G.31 and G.32, respectively. TUs for individual PCBs are not depicted because only two PCBs were detected (PCB-1254 and PCB-1260), and the only available ER-M is for total PCBs. The relative magnitude of TUs evince some interesting trends and differences among sites. For example, the most toxic sediment appears to be in NT-3; metals are the primary contributors to toxicity at all sites except NT-8; PAHs are major contributors to toxicity at NT-3 only; PCBs are major contributor at five sites; barium and manganese are important at nearly every site; mercury is a major contributor at two sites; and pesticides are likely to be toxic at only three sites (NT-3, NT-6, and SD 10).

Exposure—effects profiles for sediment exposures

For each COPEC, the observed concentrations in whole sediment are compared with the distribution of concentrations toxic to aquatic biota. The interpretation of the relationship of these distributions is presented in Sect. G.1. Toxicity information is drawn from the toxicity profiles (the Supporting Information). If sufficient toxicity data exist, the empirical distribution functions are presented graphically. There is relatively little standardized sediment test data available. Therefore, the observed concentrations are compared with the ER-L and ER-M from Long et al. (1995) and two effects distributions, community-level effects and lethality (Figs. G.33–G.43). To aid interpretation of the figures, comparisons with the TELs and PELs are discussed in the text, but are not included in the graphs. The effects distributions were derived using the marine and estuarine toxicity data from MacDonald et al. (1994) and freshwater data from Long and Morgan (1991). Although data from studies of saltwater sediments may not seem relevant to freshwater sediments, these data have been recommended by EPA Region IV (1994). Their use may be justified on the basis of the lack of a high-quality data set for freshwater and the apparently small difference in the toxicity of many chemicals between the two media relative to the differences among sites within a medium.

Some level of effect would be expected to rarely occur at concentrations below the ER-L or TEL (i.e., a negligible risk), occasionally occur at concentrations between the ER-L and ER-M or between the TEL and PEL (i.e., a marginal risk), and usually occur at concentrations above the ER-M or PEL (i.e., a significant risk). However, these effects levels are derived from the Biological Effects Database for Sediments, which is an assemblage of data from studies of marine and estuarine systems. The primary study types were spiked sediment bioassays and co-occurrence analysis. These studies evaluated benthic community structure and a wide variety of species (e.g., sandworms, polychaetes, oligochaetes, sea urchins, bivalves, shrimp, flounder, amphipods). Endpoints included taxa richness, diversity, density, mortality, growth, respiration, behavior (e.g., avoidance, emergence, reburial) and suborganismal effects (e.g., mixed-function oxidase, abnormal chromosomes). Hence, the ER-Ls, TELs, ER-Ms, and PELs include many sources of variance as a result of the disparate sources of data and the variability inherent to the toxicity tests. Factors that differ between studies may include the physical characteristics of the sediment (i.e., percent organic matter, texture, pH, pore water hardness, acid-volatile sulfide content, redox conditions), behavior and exposure of the test organisms (i.e., filter feeders, burrowers, epibenthic organisms, ingestion of sediment, respiration of pore water), sensitivity of the test organisms, and the chemical species present. Factors inherent to the test type may include effects of other contaminants in the co-occurrence studies and the bioavailability of contaminants in spiked bioassay tests. Spiked sediment tests may overestimate bioavailability because the chemical forms tested may dissociate more readily than the forms occurring at the site. Also, sorption to solids may bind less of the tested form, or bind it less securely.

The two effects distributions also were derived from the BEDS (MacDonald et al. 1994). Freshwater sediment data from Long and Morgan (1991) were included also and only concentrations associated with effects were used. Measures of community effects included taxa richness and abundance of benthic invertebrates. The lethal effects distributions potentially included mortality data from all study types and tested species. Thus, exceeding the lowest sediment effects concentration, the ER-Ls, or the TEL is not necessarily indicative of toxicity. The rationale and approach for interpreting the relationship of the exposure concentrations and effects distributions are presented in Sect. G.1. In this assessment, risks to benthic invertebrates from COPECs are characterized as significant, marginal, or negligible based on the likelihood of effects and the evaluation of modifying factors. Significant risks are generally indicated if there is a >50% likelihood of toxic effects (i.e., the observed concentration exceeds the 50th percentile of the effects distribution). Marginal risks are generally indicated if there is a >20%, but <50%, likelihood of toxic effects. Negligible risks are generally indicated if the likelihood of toxic effects is <20%. This interpretation is consistent with the approach developed in Long and Morgan (1991), Long et al. (1995), and MacDonald et al. (1994). The final characterization of risks based on single-chemical concentrations will be determined by evaluating the risks suggested by the comparisons to the ER-L, TEL, ER-M, and PEL; the risks suggested by the comparison to the two effects distributions; and the factors that modify toxicity. Factors that may modify the characterization of risk include concordance of effects and exposure concentrations and the relative sensitivities of freshwater and marine species.

Table G.13 summarizes, for each COPEC, which benchmarks were exceeded at each site. Table G.14 details the measured concentration for each site, benchmark values, and the corresponding HQs. Therefore, this section addresses only information that aids in characterizing the risks associated with these COPECs. The metal COPECs are discussed separately and then summarized as a group. PAHs are addressed as a group with additional discussion of the three PAHs with sediment quality criteria. PCBs also are addressed as a group, and all other organic COPECs are addressed separately.

Following is a list of the chemicals (and the number of sites) that were detected above background in BCV sediments, but for which benchmarks are not available: aluminum (6), beryllium (9), calcium (14), cobalt (7), lithium (7), magnesium (5), potassium (2), selenium (3), sodium (1), vanadium (11), 2,4,5-T (6), 2,4-D (1), aldrin (3), nongamma BHCs (4), carbazole (1), di-n-butylphthalate (12), endosulfans (9), and methoxychlor (7). These chemicals were measured in the sediment samples used for toxicity testing. Therefore, the concentrations of these chemicals were qualitatively evaluated to determine whether or not they could have caused the observed toxicity.

The lack of toxicological data precludes the evaluation of these chemicals:

Antimony in sediments appears to present a marginal risk in BCV. Antimony was detected above background in NT-3 (SD04) only, and the observed concentration did not exceed any PELs. There is relatively little sediment toxicity data for antimony, and all of it is from marine and estuarine systems. Long and Morgan (1991) expressed only moderate confidence in the ER-L and ER-M, in part because of the lack of concordance of antimony concentrations with effects in some studies. The concentrations observed in NT-3 are comparable to those associated mixed results in the reported literature.

Arsenic appears to present a marginal risk at ten of the locations in BCV. The measured arsenic concentrations that exceed background in BCV and the sediment effects concentrations are shown in Fig. G.33. The observed levels of arsenic suggest that lethal effects are likely in Reach 1, NT-3, and two sites in Reach 3 and that community effects are likely at all ten sites. However, confidence in the community effects distribution is low because only two studies reporting community effects were found and the threshold level for effects was not consistent across the study sites. All measured concentrations were considerably lower than the generic PELs (i.e., the ER-M and PEL). The ER-L was exceeded at all sites,

but that benchmark probably overestimates the likelihood of effects, as indicated by the low incidence of effects (11%) at concentrations between the ER-L and ER-M in the studies reported by Long et al. (1995).

Barium appears to present a marginal risk in Reaches 1 and 2, NT-2, and NT-6. The only benchmarks for barium are the background values from EPA Region V, which have no toxicological basis and were intended for determining the suitability of dredge material for open water disposal. However, there appears to be a general downstream gradient beginning near the S-3 ponds. Given that elevated barium in the surface water in these areas is considered a significant risk, it is reasonable to presume that risks from barium in sediments are possible.

Cadmium appears to present a significant risk at four sites (SDs 2, 4, 7, and 14), a marginal risk at three sites (SDs 1, 10, and 11), and a negligible risk elsewhere in BCV. The measured cadmium concentrations that exceed background in BCV and the sediment effects concentrations are shown in Fig. G.34. The observed levels of cadmium suggest that lethal effects are likely at two sites in Reach 1, one site in upper Reach 2, and in NT-3 and that community effects are likely at the two sites in Reach 1. Concentrations at the four most contaminated sites are at, or above, the generic PELs (ER-M) and the levels at all of the sites, except SD 15 in Reach 3, exceed the PEL. Furthermore, the effects data are for marine sediments, and freshwater species are reported to be more sensitive to cadmium than marine species.

Chromium appears to present a significant risk in NT-3 and at SD 11 in Reach 3, a marginal risk at SD 7 (Reach 2), and a negligible risk elsewhere in BCV. The measured chromium concentrations that exceed background in BCV and the sediment effects concentrations are shown in Fig. G.35. Community and lethal effects are likely at SD 4 in NT-3 where concentrations exceed the 100th percentile for community effects, the 80th percentile for lethal effects and both of the generic PELs (i.e., the ER-M and PEL). Although the community and generic PELs were not exceeded at SD 11, the measured concentration did exceed the 60th percentile for lethal effects and all but one threshold level from studies with freshwater sediments. Effects at SD 7 are considered possible, rather than unlikely, based on the freshwater effects data and the uncertainties resulting from the lack of chromium speciation in the literature data and BCV sediments. Although levels at six other sites exceed background, they are well below most of the possible effects levels presented in Fig. G.35.

Copper appears to present a significant risk in NT-3 and a negligible risk elsewhere in BCV. The measured copper concentrations that exceed background in BCV and the sediment effects concentrations are shown in Fig. G.36. Community and lethal effects are likely at SD 4 in NT-3 where concentrations meet or exceed the 50th percentiles for community and lethal effects and both of the generic PELs (i.e., the ER-M and PEL). Concentrations at all other sites suggest that risks range from unlikely to possible. Given the ambiguity of the freshwater effects data at comparable concentrations and the apparent lack of concordance with known sources, risks are considered unlikely at these sites.

Iron appears to present a significant risk at SD 14 (Reach 1), NT-3, NT-6, and SD 11 (Reach 3). All other locations were within background. Little data exists for the toxicity of iron in sediments. However, the concentrations that exceed background in BCV also exceed the severe effects level from the Ontario Ministry of the Environment. These levels are based on data from a wide range of geographical areas within Ontario and could potentially eliminate most of the benthic species indigenous to Ontario sediments.

Lead appears to present a significant risk at NT-3, a marginal risk at SD 14 (Reach 1) and SDs 12 and 13 (Reach 3), and a negligible risk at all other locations in BCV. The measured lead concentrations that exceed background in BCV and the sediment effects concentrations are shown in Fig. G.37. None of the measured concentrations exceed the generic PELs or the 50th percentile of the lethal effects data. However, the concentration at NT-3 exceeds the 50th percentile for community effects and meets or exceeds the threshold effects levels for freshwater sediments. Given that freshwater biota may be more sensitive to lead, effects are considered likely in NT-3. However, the levels of lead in sediment at SDs 12, 13, and 14 suggest that community and lethal effects are possible, but not probable.

Manganese appears to present a significant risk at SDs 14 and 2 (Reach 1), NT-2, NT-3, NT-6, SDs 7 and 10 (Reach 2), and SD 11 (Reach 3). All other locations were less than background. Little data exists for the toxicity of manganese in sediments. However, the concentrations that exceed background in BCV also exceed the severe effects level from the Ontario Ministry of the Environment. These levels are based on data from a wide range of geographical areas within Ontario and could potentially eliminate most of the benthic species indigenous to Ontario sediments. Also, the two highest levels are in NT-6 (SD 8) and upper Reach 1 (SD 14), and the concentrations at the other sites appear to show a general downstream gradient.

Mercury appears to present a significant risk at SD 2 (Reach 1) and NT-3. All other locations were less than background. The measured mercury concentrations that exceed background in BCV and the sediment effects concentrations are shown in Fig. G.38. Community and lethal effects are likely at SD 2 and NT-3 where concentrations exceed the 100th percentile for community effects, the 80th percentile for lethal effects and both of the generic PELs (i.e., the ER-M and PEL).

However, the sediment effects distributions may be overly conservative for BCV sediments. That is, there are two general classes of mercury: organic mercury, including methyl mercury, and inorganic mercury, including metallic mercury, mercuric chloride, and mercuric sulfide (EPRI 1987). Methyl mercury is the most toxic of the mercury species (Eisler 1987 and EPRI 1987) and mercuric chloride is the most soluble, and hence most bioavailable, form of inorganic mercury (Barnett and Turner 1995). Speciation of mercury was not performed as part of this investigation and was not reported in the sediment effects data. However, the speciation and bioavailability studies of mercury in EFPC floodplain soils performed as part of the Lower East Fork Poplar Creek RI (DOE 1994C and Barnett and Turner 1995) indicated that the dominant form was mercuric sulfide and that mercuric chloride constituted <1 % of the total mercury. The mercury species present in BCV sediments may be different from those found in Lower East Fork Poplar Creek. However, the proportion of inorganic mercury represented by mercuric chloride increases with increasing chloride ion concentrations, but the proportion of mercuric sulfide changes little over the range of naturally occurring sulfide ion concentrations (EPRI 1987). Nearly all of the sediment effects data are from marine and estuarine systems. Hence, it is likely that the sediment benchmarks and effects distributions represent exposures to more soluble, and thus more toxic, mixtures of inorganic mercury species than the exposures received by benthos in BCV. However, effects were nearly always observed in freshwater studies at the concentrations measured at SD 2 and NT-3 (i.e., 3 and 6.9 mg/kg).

Nickel appears to present a significant risk in NT-3 and at SDs 2 and 14 (Reach 1) and marginal risk at other locations where levels exceed background. The measured nickel concentrations that exceed background in BCV and the sediment effects concentrations are shown in Fig. G.39. The threshold for toxicity is highly uncertain and the standard effects levels likely overestimate risks. That is, the community effects distribution is based on only three points that are clustered together and only 17% of the studies used to derive ER-M indicated biological effects at concentrations greater than the ER-M. Therefore, community and lethal effects are considered likely at SDs 2 and 14 and in NT-3, where

concentrations exceed all of the PELs (i.e., the 50th percentile for community effects, the 50th percentile for lethal effects and both the ER-M and PEL). However, at sites where concentrations exceed more than one possible effects level, but not all PELs, community and lethal effects are considered only possible.

Silver appears to present a significant risk in NT-3 and a negligible risk elsewhere in BCV. The measured silver concentrations that exceed background in BCV and the sediment effects concentrations are shown in Fig. G.40. Concentrations in NT-3 were less than the ER-M, but greater than the PEL and the community and lethal PELs. Effects are considered unlikely at the three other locations where silver exceeds background (SDs 2 and 14 and NT-6). The levels at these sites were less than all PELs and greater than only one possible effects level (i.e., 20th percentile of lethal effects).

Zinc appears to present a significant risk in NT-3, a marginal risk at SDs 1, 2 (Reach 1), and 13 (Reach 3), and a negligible risk elsewhere in BCV. The measured zinc concentrations that exceed background in BCV and the sediment effects concentrations are shown in Fig. G.41. Zinc levels in NT-3 are greater than the probable community and lethal effects levels, the PEL, and the available freshwater effects data. Effects are considered possible at SDs 1, 2, and 13 because the measured concentrations exceed, or are comparable, to at least one possible effect level and the freshwater effects data. Zinc at all other sites is less than the concentrations associated with effects in freshwater sediments.

Summary of Metals

Ten of the thirteen metals (cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc) detected in BCV sediments at concentrations exceeding background present a significant risk to benthic invertebrates at one or more locations. All ten are a significant risk in NT-3. Four metals (copper, lead, silver, and zinc) are a significant risk in NT-3 only. Manganese presents the most widespread risk (i.e., significant at eight sites). Cadmium appears to present the most credible risks, based on the variety of effects levels exceeded and the concordance with likely sources. Three of the thirteen metals (antimony, arsenic, and barium) present only marginal risks in BCV. None of the thirteen metals presented only negligible risks in BCV sediments.

Bis(2-ethylhexyl)phthalate appears to present a negligible risk to benthic invertebrates in BCV. *Bis(2-ethylhexyl)phthalate* was detected at seven locations. However, the generic possible effects level (i.e., the TEL) was exceeded at SD 2 (Reach 1) only and the PEL and adjusted EPA Sediment Quality Criteria [equilibrium partitioning sediment quality benchmarks (EQPSQBs)] were not exceeded at any sites. Hence, significant effects are considered to be unlikely in BCV.

Chlordane appears to present a marginal risk to benthic invertebrates at all nine sites where it was detected. The Σ TU plot for pesticides (Fig. G.32) suggests that the primary sites where chlordane is a potential contributor to toxicity are NT-3 (SD 4), NT-4 (SD 5), and SD 17 (Reach 4). The TUs are based on the ER-M, which does not account for the modifying actions of organic carbon. However, the EQPSQB for chlordane is based on the chronic NAWQC and adjusted for site-specific total organic carbon. These adjusted values were not exceeded at any site. Significant effects are considered possible, but unlikely, given that multiple possible effects levels were exceeded at all sites.

DDT and metabolites appear to present a marginal risk to benthic invertebrates at NT-6 and SD 10 (Reach 2) and a negligible risk elsewhere in BCV. Either 4,4'-DDT or one of the metabolites 4,4'-DDD and 4,4'-DDE were detected in all but four sites. The Σ TU plot for pesticides (Fig. G.32) suggests that these pesticides are not major contributors to toxicity at any site. The TUs are based on the ER-M or PEL, which do not account for the modifying actions of organic carbon. However, EQPSQBs adjusted for site specific total organic carbon are available for 4,4'-DDT and 4,4'-DDD. These values were not

exceeded. 4,4'-DDE was the most widely detected of these three compounds. An EQPSQB is not available, but the PELs (i.e., ER-M and PEL) were not exceeded at any sites. Significant effects are considered possible, but unlikely, at NT-6 and SD 10 because one or more of these compounds exceeds a possible effects level (i.e., ER-L or TEL). Effects are not expected elsewhere in BCV.

Dieldrin appears to present a marginal risk at NT-3 (SD 4) and NT-6 (SD 8), which are the only locations where it was detected. The Σ TU plot for pesticides (Fig. G.32) suggests that dieldrin is a significant contributor to toxicity at NT-6. The TUs are based on the ER-M, which does not account for the modifying actions of organic carbon. However, the EPASQC adjusted for site-specific total organic carbon was not exceeded at either site. Thus, significant effects are considered possible, but unlikely, given that multiple possible effects levels were exceeded at both sites and generic PELs were exceeded at NT-6.

Endrin (total) appears to present a significant risk at SD 1 (Reach 1) and SD 10 (Reach 2), and a marginal risk at the other 13 sites where it was detected. The Σ TU plot for pesticides (Fig. G.32) suggests that endrin is not a major contributor to toxicity at any site. As with the other pesticides, the TUs are based on the ER-M, which does not account for the modifying actions of organic carbon. However, adjusted EPASQC were exceeded at SDs 1 and 10 because of the low total organic carbon content at these locations. These adjusted values were not exceeded at any site. Significant effects are considered possible, but unlikely at the remaining 13 sites, given that multiple possible effects levels were exceeded.

PAHs appear to present a significant risk to benthic invertebrates in NT-3 (SD 04) and a negligible to marginal risk at all other sites in BCV where they were detected. Screening results for all detected PAHs with benchmarks are summarized in Table G.13 and detailed in Table G.14. The concentrations of all detected PAHs were added together for each sample and compared with the Total PAH screening values (Table G.14). The evaluation of total PAHs was, in general, consistent and representative of the results for the individual PAHs. That is, PAHs were detected sporadically throughout BCV and possible effects levels were exceeded at several sites, but NT-3 was the only site at which effects are considered likely. The Total PAH levels in BCV and the sediment effects concentrations for Total PAHs are shown in Fig. G.42. Total PAH levels at all sites exceed the 100th percentile for community effects. However, the community effects distribution is based on only four points, which are clustered together and are an order of magnitude lower than the other effects thresholds. Hence, the threshold for community effects is highly uncertain. At eight of the nine sites where PAHs were detected, the Total PAH levels exceeded all three generic possible effects levels (i.e., the TEL, ER-L and REG IV), but not the 20th percentile for lethal effects. Significant effects are considered possible, but unlikely, at these sites. Significant effects are considered likely at NT-3, where all PELs are exceeded. Sediment Quality Criteria (EPASQC_A) are available for three of the detected PAHs: acenaphthalene, fluoranthene, and phenanthrene. Only phenanthrene at NT-3 exceeds the adjusted criterion. Eight of the PAHs with benchmarks occur at levels that exceed the ER-M and/or PEL at NT-3: anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, fluoranthene, phenanthrene, and pyrene.

Total PCBs appear to present a significant risk at three sites (NT-3, SD 10, and SD 11) and a marginal risk at the 11 other sites where PCBs were detected. Screening results for PCB-1254 and PCB-1260 are summarized in Table G.13 and detailed in Table G.14. The community and lethal effects data are available for Total PCBs only. The Total PCB levels in BCV and the sediment effects concentrations are shown in Fig. G.43. Total PCB levels at all sites exceed the 50th percentile for community effects. The generic PELs and the 50th percentile for lethal effects are exceeded at SDs 4, 8, 9, 10, and 11. However, the toxicity data are highly uncertain. Freshwater data indicate little or no concordance between toxicity and PCB concentrations, and there is a low (51%) incidence of biological

effects at concentrations greater than the ER-M ("probable-effects range") reported by Long et al. (1995). Also, MacDonald et al. (1994) expressed a low degree of confidence in the TEL and PEL. The data used to derive the effects distributions were from the same database used to derive the TEL and PEL. Furthermore, the Total PCB values do not account for the modifying effects of organic carbon. PCB-1260 did not exceed the adjusted EQPSQBs at any site and it was the only PCB detected at NT-6 and NT-8. PCB-1254 did exceed the adjusted EQPSQBs at NT-3, SD 10 (Reach 2) and SD 11 (Reach 3). Therefore, significant effects from PCBs are considered to be likely at NT-3, SD 10, and SD 11. Significant effects are considered to be possible, but unlikely, at all other sites, given the EQPSQB results and the uncertainties associated with the Total PCB data.

Sediment radiation exposures

The concentrations of detected radionuclides were compared with the screening values for small invertebrates immersed in sediments. An HQ was calculated for each radionuclide by dividing the measured concentration by the screening value. The screening value is the concentration resulting in a total dose rate of 1 rad/d from the major emissions of the measured parent radionuclide and all short-lived progeny (refer to Sect. G.3.2.2). A total dose rate to small invertebrates at each site was calculated by summing the HQs for all detected radionuclides. Radionuclides present a significant risk to benthic invertebrates if the sum of HQs for a site exceeds 1.0. Table G.15 details the detected concentrations, screening values, HQs for individual radionuclides, and the sum of HQs for all radionuclides detected at each site.

Based on these results, radionuclides in BCV sediments appear to present a negligible risk to benthic invertebrates. That is, the individual and sum of HQs were considerably <1.0 at all locations.

Ambient sediment toxicity

There was relatively little indication of sediment toxicity in any of the tests and no clear spatial trends. Test results are deemed significant if (1) at least a 20% difference exists between the response of the organisms exposed to sediment from BCV and the organisms exposed to control or reference sediment or control water, or (2) the likelihood that the difference is due to chance is <5%. Test results are related to two expressions of exposure, the location of the sample relative to sources and the relationship between the test responses and the concentrations of sediment COPECs in the tested sediments. The methods and results of the sediment tests are discussed in detail in the *Chronic Sediment Toxicity Test Report: BCVSD1* by A. M. Gonzalez, which is in the Supporting Information. The following section analyzes their implications for risks to benthic macroinvertebrates in BCV sediments.

Reductions in survival of *H. azteca* relative to reference and control sediments were biologically (> 20%) and statistically ($\alpha = 0.05$) significant at site SD 17 only. Survival of *H. azteca* in sediment from SD17 was reduced by 37% and 38% relative to survival in reference and control sediments, respectively. Reductions in survival of *H. azteca* were neither biologically nor statistically significant in sediments from any other site. In fact, survival in sediment from ten sites was nominally higher than survival in control sediments. These limited reductions in survival of *H. azteca* preclude a rigorous statistical evaluation of the effects of COPECs and sediment properties. That is, percent reduction in survival relative to control sediment was greater than 20 percent for only one site, zero for ten sites, and less than five percent for most other sites. However, the sediment toxicity laboratory did not identify any anomalous physico-chemical properties of the sediment from SD17 that would account for the observed effects (refer to Supporting Information, "Sediment Toxicity Report").

Reductions in survival of *D. magna* relative to reference sediments were biologically significant at four sites (i.e., 33% at NT-2, 30% at NT-6, 22% at SD 13, and 44% at SD 17) and statistically significant at SD 17 ($\alpha = 0.05$). The sediment toxicity testing laboratory suspected that high levels of fine particulates in the tested sediment may have contributed to the reduced survival of *D. magna*. This was based on previous tests of overlying water with *D. magna*, in which particulates in the water biased the test results, and on the behavior of the organisms during the BCV tests. However, reductions in survival of *D. magna* were not significantly ($\alpha = 0.05$) positively correlated with the physical properties of the sediment (i.e., percent clay, percent silt, percent moisture, and percent total organic carbon). The concentrations of individual sediment COPECs and the toxicity-normalized concentrations (Σ TUs) of metals, PAHs, PCBs, and pesticides also were not significantly ($\alpha = 0.05$) positively correlated with reductions in survival of *D. magna*. Hence, if survival of *D. magna* exposed to BCV sediments was adversely affected by the physical properties of the sediment or the concentrations of sediment COPECs, the relationship could not be discerned with the available data.

D. magna reproduction is not considered to be a reliable indicator of chemical toxicity in tests of BCV sediments. Reproduction of *D. magna* was significantly reduced relative to control water in tests of all sites. Percent reductions relative to the reference sediment were significant in tests of all but four sites (SDs 2, 8, 11, and 17). However, the sediment toxicity laboratory believes that these reductions were caused primarily by fine sediment particles, which are known to interfere with feeding and reduce the growth and reproduction of *D. magna* (refer to Supporting Information, "Sediment Toxicity Report"). The toxicity laboratory observed that no obvious spatial pattern to the toxicity existed, but that an apparent relationship to the qualitative sediment descriptions existed. This is supported by the subsequent statistical analyses of the toxicity data and the sediment physical and chemical data.

Stepwise multiple linear regression analyses were performed using the general linear model procedure in SAS®. All of the measured physical properties of the tested sediment data (e.g., percent clay, percent moisture, percent total organic carbon) were included as explanatory variables for the percent reduction in *D. magna* relative to control water. The best-fit model was the four-variable model in which the percentages of clay, silt, moisture, and total organic carbon were included. The complete model was statistically significant ($P = 0.012$) and explained 48% (adjusted $r^2 = 0.481$) of the variance in the dependent variable. All four physical variables contributed significantly ($P \leq 0.05$) to the model.

The sediment COPEC data were added to the physical model to determine if *D. magna* reproduction was adversely affected by these chemicals. For each chemical variable, a forward and stepwise multiple linear regression analysis of the physical plus chemical data was performed. All COPECs that were detected in at least eight samples were evaluated, as were the toxicity-normalized concentrations (Σ TUs) of metals, PAHs, PCBs, and pesticides. None of the chemical variables contributed significantly ($P \leq 0.05$) to the model.

In summary, these toxicity tests suggest that sediment from four sites (NT-2, NT-6, SD 13, and SD 17) are potentially lethal to sediment-associated biota. The evidence for this is strongest for SD 17. Significant effects at the other three sites are possible, but the tests were not statistically different from references tests, and the toxicity laboratory has since determined that *D. magna* may not be an appropriate test organism for whole sediment samples. Also, the COPECs do not appear to be significant contributors to the observed toxicity to *D. magna*. The impaired reproduction of *D. magna* is not considered to be a reliable indicator of the toxicity of BCV sediments. This is based on the conclusion by the toxicity laboratory that tests with *D. magna* are biased by the presence of fine-grained particulates and the results of the statistical analyses of the physical and chemical data.

Weight of evidence

The weight of evidence suggests that sediment from 3 of the 18 sites poses a significant risk to benthic invertebrates inhabiting those sites. Toxicity at two sites appears to be from high concentrations of one COPEC (manganese) and potentially two chemicals for which toxicological data are not available (selenium and 2,4,5-trichlorophenoxyacetic acid [2,4,5-T]). The toxic agent at the third site, SD 17 in Reach 4, could not be identified from the available information. Table G.16 summarizes, for each site, the weighing of evidence presented in the following text.

The 18 sampled sites fall into six categories, based on the toxicity tests, chemical analyses, and weight of evidence. For one site, SD 18 in ET-4, significant risks are not indicated because none of the COPECs are likely to be toxic and the sediment was not tested for toxicity.

Six sites (NT-4, NT-8, and three sites in Reach 3) do not pose a significant risk, given that significant toxicity was not observed and none of the COPECs are likely to be toxic.

Although one or more of the COPECs are likely to be toxic at seven other sites (NT-3, three from Reach 1, three from Reach 2, and one from Reach 3), significant risks are not indicated because the toxicity tests were negative. That is, the measured chemical concentrations were tested and shown to be not toxic.

Significant risks are not indicated at SD 13 in Reach 3 because the toxicity tests were too ambiguous to interpret and none of the COPECs are likely to be toxic. *D. magna* survival was reduced by 22%, but this was not statistically different from reference sediments; this organism may not be reliable for tests of whole sediment; and *H. azteca* survival was not reduced by 20% or more, relative to references. Hence, these tests alone do not provide convincing evidence of significant risks. Although none of the COPECs are likely to be toxic, other chemicals, for which benchmarks are not available, could be causing the mortality of *D. magna*. However, all such chemicals detected at this site are present at higher concentrations at other sites where toxicity was not evident. Given that, the chemical analyses suggest that the reduced survival of *D. magna* exposed to this sediment is not due to chemical toxicity.

The toxicity tests of NT-2 and NT-6 sediment also were too ambiguous to interpret. However, unlike SD 13, the chemical analyses for these two sites suggest that the reduced survival of *D. magna* is likely the result of chemical toxicity. That is, the toxicological information suggests that the concentrations of iron and manganese measured at NT-6 are likely to be toxic. This is supported by the fact that this sample had the highest manganese concentration of all the tested sediment samples. However, iron is considered not to be toxic at this site, because the concentrations were higher at other sites where toxicity was not evident. Benchmarks and appropriate toxicological data are not available for selenium and 2,4,5-T. This sample had the highest selenium concentration of all tested samples. Only sediment from SD 3 in NT-2 had higher concentrations of 2,4,5-T and the toxicity tests also were ambiguous for that site. Therefore, selenium and 2,4,5-T must be considered potentially toxic at NT-6. For NT-2, the toxicological information suggests that manganese is likely to be toxic. However, manganese concentrations were higher at other sites where toxicity was not evident. As noted above, the sediment from this site had the highest 2,4,5-T concentration of all the tested sediment samples. Therefore, 2,4,5-T must be considered potentially toxic at this site.

Significant risks are indicated at SD 17 in Reach 4, even though the toxic agent could not be identified in this evaluation. The toxicity tests were unambiguously positive. Not only was *D. magna* survival reduced by 38%, but *H. azteca* survival also was reduced by 44%, which was statistically significantly different from the reference sediments. However, none of the COPECs occur at

concentrations that are likely to be toxic. A benchmark was not available for aldrin, and the measured concentrations were higher here than at other sites. The acute NAWQC for aldrin (EPA 1980) and the final acute/chronic ratio for dieldrin (the metabolite of aldrin) were used to estimate a chronic NAWQC for aldrin. This estimated water quality value (0.0000024 mg/L), the log Kow for aldrin (6.5), and the percent organic carbon measured at this site (0.86%) were used to estimate a sediment quality benchmark (0.051 mg/kg) following the procedures outlined in Hull and Suter (1994). At 0.00021 mg/kg, the aldrin concentration at SD 17 is considerably less than the estimated chronically toxic sediment concentration. All chemicals detected at this site for which toxicological data were not available are present at higher concentrations at other sites where toxicity was not evident. It is somewhat disconcerting that the most toxic sediment was from the site farthest downstream from the source areas and that it was one of the least contaminated samples tested. However, if the toxicity tests for this site are considered reliable, and they are, then risks to benthic invertebrates inhabiting the sediment at SD 17 must be considered significant. Because the toxic agent could not be identified, sources other than the operations in upper Bear Creek cannot be ruled out.

Although the benthic invertebrates inhabiting these three sites are at risk, it is unlikely that the benthic invertebrate community as a whole is degraded. SD 17 is only one of six sampled depositional areas in lower Bear Creek (Reaches 3 and 4) and the other five are not a significant risk to benthics. Although mapping of the sediment depositional areas in Bear Creek was not conducted, this one site does not appear to constitute 20% of the soft sediments in lower Bear Creek. All sediments in NT-2 and NT-6 should be considered toxic, because the selected sediment sites were identified as potential hot spots. Hence, the communities that inhabit soft sediments in NT-2 and NT-6 are considered at risk. Because these tributaries are small relative to the adjoining areas of Bear Creek, the sediments in NT-2 and NT-6 probably do not constitute an ecologically significant portion of the available soft-sediment habitat in these areas.

G.3.3 UNCERTAINTIES CONCERNING RISKS TO BENTHIC INVERTEBRATES

The following issues constitute the major sources of uncertainty in the risk assessment for the benthic invertebrate community:

- The cumulative effects of multiple contaminants and exposure pathways cannot be adequately evaluated at this time. Water and sediment exposures had to be evaluated separately, and dietary exposures could not be evaluated benthic invertebrates.
- There is some uncertainty in the ecological relevance of the toxicity tests. The species available for sediment testing may be less sensitive than the indigenous species to the chemicals in BCV. The species available for aqueous testing (i.e., *Ceriodaphnia*) may be more sensitive than the indigenous species. Also, the sediment and water may be more toxic to naive test organisms than to equally sensitive organisms that have acclimated to the site conditions.
- Water samples from most tributaries, Reach 2, and Reach 3 were not collected from the upstream areas and, therefore, may underestimate the risks at these sites.
- Concurrent chemical analyses were available only for one set of aqueous toxicity tests. Hence, some uncertainty is associated with the causes of toxicity. This uncertainty is tempered by the strong relationships between the concentrations of calcium and manganese and the toxicity to *C. dubia*.
- There is a high degree of uncertainty associated with the sediment effects data because sediments are highly heterogeneous and complex. There are few standardized sediment toxicity tests and most

of the available data are from marine and estuarine systems. The endpoints used to define the ER-L and ER-M range from community-level responses to suborganismal effects. These sources of variance are discussed in more detail in Sect. G.3.2.3.

- The lack of biosurvey data for benthic invertebrates in depositional areas also adds uncertainty.
- There is a general need for reliable and standard sublethal whole sediment tests. That is, the *D. magna* test is reliable for pore water tests, but appears to be questionable for use with whole sediments. Also, the only standard test that uses whole sediment is an acute lethality test.

G.4 RISKS TO SOIL INVERTEBRATES

G.4.1 FLOODPLAIN AREAS

Six soil samples were collected from 13 transects perpendicular to Bear Creek. For each transect, two samples were collected in the creek berms on either side of Bear Creek, and two others were in the backmarsh if the floodplain was wide enough on both sides of the creek [Sect. B.5.3.1 of Appendix B (Vol. 2 of the BCV RI Report)]. Although sample depth intervals included 0–4 in., 4–16 in., and 16–32 in., only the two more shallow depths are used for the assessment of toxicity to soil invertebrates.

G.4.1.1 Exposure Assessment for Soil Invertebrates

Earthworms absorb a wide variety of inorganic and organic soil contaminants both through feeding in soil and litter and dermal exposure to soil and soil pore water through burrowing. It is assumed that these organisms represent highly exposed soil invertebrates. It is not possible or necessary to distinguish and quantify the exposure to earthworms by way of the feeding and dermal routes. Another possible route for which we have no data is exposure to volatile organic compounds in the soil air. Exposure through this pathway is assumed to be negligible.

The bioavailability of the contaminants in soil and decomposing plant litter are controlled by soil, litter, and analyte characteristics; however, current knowledge is not sufficient to allow the prediction of bioavailability based on several soil variables. An exception is the association of extremes in pH and metal availability (van Gestel 1992).

It is assumed that the earthworms spend their entire life span in soil with contaminant levels represented by a weighted average of concentrations in the 0–4-in. and 4–16-in. fractions of the soils sampled for analyses. However, geophagus organisms (those taking in large amounts of soil during feeding on well-decomposed organic material) and those living on or near the surface may be exposed to different quantities of organic chemicals than worms feeding on litter pulled down into burrows in the subsoil (Curl et al. 1987). Moreover, few earthworms are found in waterlogged soils. Because this assessment seeks to identify hot spots and because some soil invertebrates are not found throughout the top 16 in. of soil, the maximum contaminant concentrations from either depth sample were screened against toxicity benchmarks, as described in G.4.1.2. These concentrations are used to assess potential negative impacts of contaminated soils on earthworm populations.

G.4.1.2 Effects Assessment for Soil Invertebrates

Single-chemical soil toxicity

Contaminant concentrations in soils were compared with toxicological benchmarks for earthworms in order to screen out chemicals that do not constitute a hazard to soil invertebrates and therefore do not require detailed risk characterization. References used for the derivation of benchmarks were reports of toxicity tests of individual chemicals in laboratory, greenhouse, or field settings. Only experiments in which earthworms were exposed to soil (natural or artificial mixture of natural components), soil/litter microcosms, or manure were considered. Twenty percent reduction in growth, reproduction, or activity was used as the threshold for significant effects to be consistent with other screening benchmarks for ecological risk assessment and because the Federal Facilities Agreement parties adopted this level of effects for ecological endpoints (Suter et al. 1995).

Derivation of benchmarks

The method used for deriving soil benchmarks (Will and Suter 1995a) is based on the National Oceanographic and Atmospheric Administration's method for deriving the ER-L (Long and Morgan 1991) that has been recommended as a sediment screening benchmark by EPA Region IV. The ER-L is the tenth percentile of the distribution of various toxic effects thresholds for various organisms in sediments. As with the ER-Ls, statistical fitting was not used because sufficient data seldom existed and because these benchmarks are to be used as screening values and do not require the consistency and precision of regulatory criteria. Screening benchmarks for toxic effects of contaminants present in BCV floodplain soils are presented in Table G.17.

Of the 10 inorganic elements detected at concentrations above their background criteria in the floodplain, benchmarks are not available for beryllium, cyanide, lithium, or thallium. Benchmarks were not available for any of the 3 herbicides, 18 pesticides, 2 PCBs, and 12 semivolatile organic compounds detected in the floodplain (Sect. D.9.2.3).

Ecotoxicological profiles

Toxicity profiles are presented for COPECs (i.e., chemicals occurring in soil at maximum concentrations exceeding benchmarks and background for toxicity to plants) in the Supporting Information.

Ambient soil toxicity

A report entitled *Toxicity Test Results, Bear Creek Valley Floodplain Soil*, by Stewart et al., included in the Supporting Information, describes in detail the methods, results, and conclusions of the toxicity tests. The following text is a summary of the report.

Materials and methods

Eisenia foetida were chosen to represent soil invertebrates because of (1) the recommendation of EPA, (2) the ease in culturing these earthworms, (3) sensitivity to toxicants, and (4) rapid growth. References for the rationale for species choice appear in Supporting Information (Stewart et al. 1995). Survival, growth (including cocoon mass), and reproduction were tested using a procedure described in Gibbs et al. (1995) with modifications in the number of replicates, worms per replicate, container, and test period (Supporting Information).

A single 3.8-L, 0–16-in. depth sample was taken from each location, including 11 transects, 3 reference sites, and 1 artificial soil. Analysis of variance (ANOVA) was used to determine whether growth and/or survival differed significantly ($p < 0.05$) among sites. If so, Duncan's multiple range test identified which sites were different, compared with the reference sites.

Results

Complete tables of results appear in Stewart et al. 1995 (Supporting Information). Earthworm survival was between 80% and 100% for all treatments and reference sites. Survival was lowest at one of the reference sites (G00111).

The mean growth of earthworms for the reference sites ($N = 3$), the artificial soil ($N = 1$), and the nonreference sites ($N = 16$) was 14.76, 81.29, and 82.39 mg/pair/21 d, respectively. Four of the five

lowest mean growth values were obtained in reference and artificial control soils. Based on determinations from ANOVA tests, most of the differences in growth among site types were explained by low growth in the three reference sites. The lowest growth rate obtained from a nonreference soil was from TS092, in Transect 9.

The number of cocoons per earthworm ranged from 0 to 27, with no discernible pattern associated with the type of sample. A positive correlation was found, however, between the number of cocoons and mean growth of earthworms; the correlation (R) was 0.44 ($\rho = 0.052$ for $N = 20$).

Conclusion

According to Stewart et al. (Supporting Information), only one nonreference site, Transect 1, Site 2, may have shown toxicity to *E. foetida*. At that site earthworm growth was only ~29% of the mean value for earthworm growth at the "best" sites.

Growth and reproduction of earthworms at the three reference sites were low, compared with the contaminated sites. The reference sites, which were at a distance from the floodplain and somewhat upland, were probably not representative of floodplain soils.

G.4.1.3 Risk Characterization for Soil Invertebrates

The evidence concerning risks to soil invertebrates consists of soil toxicity test data and analyses of chemicals in soil. These lines of evidence are summarized in the following text. The goal of this assessment was to locate hot spots of chemical contamination in the floodplain, rather than to offer a complete picture of the nature and extent of contamination.

Single-chemical soil toxicity

COPECs for soil invertebrates in the BCV floodplain were identified by comparing maximum concentrations in soil at each location (from the 0–4-in. - or 4–16-in. depth samples for six locations per transect to (1) background soil values and (2) available benchmarks for toxicity to soil invertebrates (Will and Suter 1995a). Maximum detected concentrations in soil are used for screening purposes because earthworms and other soil invertebrates are relatively immobile and can therefore be exposed to the maximum concentration during the course of their lifetimes (Suter et al. 1995). If both background and benchmark criteria were exceeded, the contaminant was identified as a COPEC. HQs were calculated by dividing the maximum concentration in soil by the toxicity benchmark concentration. Benchmarks, maximum concentrations of analytes at each transect sample location exceeding background for which benchmarks are available, and HQs for the contaminants are given in Table G.17. The only COPEC for soil invertebrates was mercury, with the maximum soil concentration found to exceed to 0.1 ppm benchmark concentration at several sites.

Mercury

Samples in transects 1, 2, 3, 4, 6, 7, 8, and 13 exceeded benchmarks for toxicity to worms in surface soil (Table G.17). The maximum concentrations were usually in the top 4 in. of soil. The distribution of mercury in floodplain soils at the 0–4-in. and 4–16-in. soil depths is depicted in Fig. D.114. The maximum HQs for the transects were 70 (TS012), 20 (TS023), 30 (TS034), 4 (TS042), 7 (TS064), 10 (TS071), 4 (TS086), and 4 (TS 13). Apparent hot spots with HQs >10 also included TS033, with a value of 20. Mercury is the only chemical of those for which benchmarks for toxicity to plants and worms are available that the latter concentration is lower than the former.

The range of mercury concentrations reported in unpolluted soils of the eastern United States is <0.01 to 3.4 ppm (Shacklette and Boerngen 1984). The highest average mercury concentration in any floodplain location is 3.035 mg/kg, for TS012, which is in this range.

A toxicity profile for the effects of mercury on earthworms is included in the Supporting Information. The 0.1 mg/kg benchmark for mercury was derived from a study of *Octochaetus pattoni* exposed to mercuric chloride, one of the more toxic forms of mercury (Abbasi and Soni 1983). At 0.5 mg/kg Hg, survival and cocoon reproduction were reduced 65% and 40%. A safety factor of 5 was applied to the LOEC (Will and Suter 1995a).

The strength of the literature toxicity line of evidence is in its ability to relate the concentration of a single contaminant in soil to its effect. Ideally, the bioavailability of mercury in BCV floodplain soils should be comparable to that of the chemical in laboratory toxicity tests in other soils. Moreover, in the specific case of mercury, chemical speciation must match that of toxicity tests. Here, the fractions of mercuric chloride, methyl mercury, mercuric sulfide, and so forth, were not determined.

Ambient soil toxicity

The toxicity tests give no evidence for adverse effects of soils at Bear Creek floodplain sites on earthworms. According to Stewart et al. (Supporting Information), only one nonreference site, Transect 9, site 2, may have shown toxicity to *E. foetida*. At that site, earthworm growth was only ~29% of the mean value for earthworm growth at the “best” sites. However, a moderate level of reproduction was associated with this site, and exposure to toxins, including mercury, for which soil invertebrate benchmarks were available, were not exceeded at this site (Table G.17).

Weight of evidence for soil invertebrates

A summary of the weight of evidence for risk to soil invertebrates posed by floodplain soils in BCV is given in Table G.18. Only one COPEC, mercury, was identified, that was found above the earthworm toxicity benchmark at several isolated locations in the BCV floodplain. The weight of evidence for all transects was that soil invertebrates are not negatively impacted by contaminants in the BCV floodplain. The high concentrations of mercury were determined not to be entirely bioavailable to earthworms, based on toxicity tests.

G.4.2 SOURCE AREAS

The four source areas evaluated for potential risk to ecological receptors were the S-3 Ponds area, BYBY, the combined SL and OLF, and the BG. Analytical results were aggregated by area for evaluation of exposure of soil invertebrates to contaminants at each source area.

Surface soil samples were taken during two sampling programs. One set was used to identify potential locations for biota sampling and toxicity testing. These samples were taken to a depth of 30 cm (12 in.) and were analyzed for inorganics, PCBs, and isotopes of uranium. An additional set of samples was taken from soil borings as part of the site characterization. These samples were composites of 120-cm (48-in.) depth intervals, beginning at the soil surface. Soil aggregates used for evaluation of potential risk to ecological receptors comprise all soil samples taken at each source area that began at the soil surface. Summary statistics for surface soil aggregates are given in Tables G.19–G.22.

Separate assessments were carried out for the Creekside and Bear Creek Road Debris Burial areas. Analytical results for soil in these areas are presented along with the single-chemical toxicity screening in Sect. G.4.2.3.

G.4.2.1 Exposure Assessment for Soil Invertebrates

The mechanisms by which earthworms are exposed to soil contaminants are discussed in Sect. G.4.1.1. Current exposures were evaluated using data from surface soil samples at the source areas (Tables G.19–G.22). Because the range of movement of individual earthworms is small, the maximum concentrations of contaminants in each soil data aggregate were used to assess the potential maximum negative impacts of contaminated soil on earthworm populations.

Future exposures were evaluated by assuming that the maximum potential future exposures would be to inventoried wastes. Combined data for S-3 Pond sludges were used to compute source term concentrations at the S-3 Ponds (Table A.3), and waste inventory data for the BG area were used to compute source term concentrations in the BG wastes (Table A.14). For the purposes of this assessment, contaminants at the BG waste inventory sites were considered to be in soil. A single contaminant concentration was determined at each site, either because concentrations were computed from analytical sampling data (S-3 Ponds sludges) or from historic inventory information (BG waste inventory). These data were used to evaluate potential future risks at the S-3 Ponds and BG areas for earthworms exposed in the wastes. For future risks at the capped sites, it is assumed that the cap is no longer present and the contaminants are freely accessible to earthworms.

G.4.2.2 Effects Assessment for Soil Invertebrates

Published information on the toxicity of individual chemicals to earthworms in controlled tests, as well as the results of site-specific ambient soil toxicity tests, were used to evaluate potential adverse effects to earthworm populations in the source areas.

Single-chemical soil toxicity

Toxicity benchmarks, as presented in Will and Suter (1995a), are discussed in Sect. G.4.1.2. The single-chemical toxicities of arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, and 26 organic chemicals (Will and Suter 1995a) were evaluated where those contaminants appeared above background in source area soil aggregates.

Ambient soil toxicity

Ambient soil toxicity testing was done on soil from floodplain transects only (Sect. G.4.1.2). Information from those tests, described in Sects. G.4.1.2. and the Supporting Information, was used to evaluate potential toxicity of source area contaminants to earthworms.

G.4.2.3 Risk characterization for soil invertebrates

The data used to evaluate risks to soil invertebrates at the source areas consists of soil toxicity test data from the floodplain soils and analyses of chemicals in source area soils. Chemical concentrations in source area soils and results of ambient toxicity testing of floodplain soils are used to interpret the potential negative impacts of source area soils. The goal of this assessment is to identify source areas that present hazards to biota rather than to give a detailed picture of the nature and extent of risks to soil invertebrates.

Single-chemical soil toxicity

COPECs for soil invertebrates at the Bear Creek source areas were identified by comparing the maximum concentrations of contaminants detected above background in each soil aggregate with available benchmarks for toxicity to soil invertebrates (Will and Suter 1995a). Maximum soil concentrations at each source area were used for comparison with benchmarks because earthworms are relatively immobile and may be exposed for their lifetime to contaminants at a single location. If both the background concentration and the toxicity benchmark were exceeded, the contaminant was identified as a COPEC. HQs were calculated by dividing each maximum concentration above background by the toxicity benchmark concentration. Benchmarks, maximum concentrations of contaminants in each soil aggregate for which benchmarks are available, and HQs are presented in Table G.23.

At the S-3 Ponds, the maximum concentrations of copper and mercury exceeded both background and the toxicity benchmark. The maximum concentration of copper exceeded background by <50% and gave an HQ of 1.02. The maximum mercury HQ was 829, and the HQ of the mean mercury concentration was 148.

At the BYBY, cadmium, chromium, copper, lead, mercury, nickel, and zinc exceeded both background and the toxicity benchmark. The mean concentration of chromium was within background, and the mean concentrations of cadmium and lead were below their toxicity benchmarks.

In the SL/OLF aggregate, copper, mercury, and zinc exceeded both background and the toxicity benchmark. The mean concentrations of copper and zinc were below their toxicity benchmarks, and the mean concentration of zinc was within background.

In the BG aggregate, chromium, mercury, and nickel exceeded both background and the toxicity benchmark. The maximum chromium concentration exceeded background by ~5%. The HQ for this concentration was 210; however, the background concentration is >200 times the toxicity benchmark. The mean mercury concentration exceeds the toxicity benchmark by 10% and is within background. The maximum mercury concentration at BG exceeds background by <50%. The maximum nickel concentration exceeds the toxicity benchmark by 3%, and the mean concentration is within background.

The results of single-chemical soil screening at the Creekside and Bear Creek Road Site Debris Burial areas are presented in Table G.23. At the Creekside Debris Burial area, the concentrations of chromium, copper, and mercury in the soil sample exceeded both background and the toxicity benchmark. The HQ of mercury was 330 and the HQ of copper was 26.8. Chromium exceeded the benchmark by only 4%.

At the Bear Creek Road Debris Burial area, chromium, copper, mercury, and zinc exceeded both background and the toxicity benchmark, with HQs of 195, 33, 54, and 4.4, respectively.

The results of single-chemical soil screening for potential future exposures of earthworms to S-3 Ponds sludges and the BG waste inventory are presented in Table G.23. In the S-3 Ponds sludges, chromium, copper, mercury, and nickel exceeded both background and their toxicity benchmarks. Chromium exceeded the benchmark by >100-fold, mercury by ~20-fold, and copper and nickel by <3-fold.

In the Burial Ground waste inventory, lead and mercury exceeded both background and their toxicity benchmarks. Exceedances for mercury ranged from 20 to 170 times the benchmark and were

seen in the Walk-in Pit (WIP) 1 (North) and WIPs 2 and 3 (South) inventory listings. Lead had an HQ of 1.03 in WIP 1 (North).

Ambient soil toxicity

Ambient soil toxicity testing was not done using samples from the source areas. However, the results of toxicity testing on floodplain soil samples were evaluated to interpret potential toxic effects of source area soils. If floodplain soil samples that were not toxic to earthworms contained concentrations of SRCs that were above single-chemical toxicity benchmarks, the toxicity tests could be interpreted as showing that site-specific toxicity of those SRCs is lower than in the single-chemical toxicity tests. COPECs identified for the source areas were cadmium, chromium, copper, lead, mercury, nickel, and zinc. Of these, only mercury appeared above benchmark values in soil samples tested for toxicity. The maximum mercury concentration reported in floodplain soil samples that showed no toxicity was 7.3 mg/kg, or 73 times the mercury benchmark. Therefore, ambient toxicity testing on floodplain soil samples can be used in the weight of evidence to interpret the results of single chemical toxicity screening for mercury only.

Weight of evidence for soil invertebrates

A summary of the weight of evidence findings is presented in Table G.24. The weight of evidence evaluation is used to interpret the results of soil contaminant screening in light of ambient soil toxicity tests. Most COPECs could not be excluded as contaminants of concern (COCs) because the maximum concentrations were higher than those used in ambient soil toxicity testing. No COCs were identified for the BG aggregate. At the S-3 Ponds area, mercury was identified as the sole COC. However, much of the S-3 Ponds area is paved or graveled, providing little attractive habitat for earthworms. Mercury was the only COC with an HQ >5 at the SL/OLF area, but the presence of copper and zinc at concentrations above toxicity benchmarks indicates potential toxicity to soil invertebrates at these sites. Multiple COCs with an HQ >100 were identified at the BYBY area, indicating that significant risk to soil invertebrates is likely at the BYBY area. Mercury and chromium are identified as COCs at the Creekside Burial area, and chromium, copper, mercury, and zinc are identified as COCs at the Bear Creek Road Debris Burial area.

COPECs in the S-3 Ponds sludges are chromium, copper, mercury, and nickel. The copper and nickel HQs are ≤ 2.75 , suggesting that these COPECs would contribute less to future risks to earthworms at this site than chromium and mercury, especially considering the mixing of sludges with soil that would be expected if the site's cap were to be lost and habitat for earthworms were restored. The concentrations of chromium and mercury are significantly above both background and toxicity benchmarks. Therefore, chromium, copper, mercury, and nickel are retained as COCs for potential future exposure of earthworms to the S-3 Ponds sludges.

COPECs in the BG waste inventory are lead and mercury. The lead HQ at WIP 1 (North) is 1.03, suggesting that lead exposure would not contribute significantly to risks to earthworms at this site, especially considering the mixing of wastes with soil that would be expected if the site's cap were to be lost and habitat for earthworms were restored. However, mercury is significantly above background and toxicity benchmarks in WIP 1 (North) and WIPs 2 and 3 (South). High levels of uranium and PCBs are also present, but there are no toxicity benchmarks for these SRCs. Therefore, mercury is retained as a COC for potential future earthworm exposure in the BG waste inventory.

G.4.3 UNCERTAINTIES CONCERNING RISKS TO SOIL INVERTEBRATES

The following factors create uncertainty in assessing the risk posed by the potential COCs in soils:

- **'Bioavailability' of elements.** The extraction methods used may remove from the soil quantities of elements and compounds greater than those that are extracted from soil as they pass through the gut of the earthworm or those that are adsorbed dermally.
- **Variable response to contaminants.** Various earthworm and other soil invertebrate species and earthworm growth stages tolerate contaminants to different degrees. The literature from which benchmarks were derived is not necessarily based on experiments using earthworm species known to be representative of those occurring in the soils of BCV.
- **Exposure to multiple contaminants.** Toxicity benchmark concentrations are derived from experiments in which earthworms are exposed to single contaminants. Typical soils of the BCV expose earthworms to multiple contaminants that may not be adequately assessed on the basis of literature-derived benchmarks.
- **Lack of benchmarks for some metals and most organic compounds.** Little research has been conducted on the toxic effects of the organic compounds, other than pesticides. Thus, it is not possible to assess the risk to earthworm populations posed by many of the analytes found in the soils.
- **Adequacy of reference soils.** Reference soils were generally more "toxic" than nonreference soils. These upland sites were apparently inappropriate matches for the contaminated sites in particle size and chemistry.
- **Soil depth and toxicity.** The calculated weighted average of the top 16 in. of soil may have been somewhat inaccurate if the 0–4 and 4–16-in. samples were of different densities.
- **Chemical speciation.** Earthworm toxicity benchmarks for metals are often derived from studies with a single species of a contaminant. In this assessment, knowledge of the form of mercury would decrease the uncertainty associated with this assessment.

G.5 RISKS TO PLANTS

G.5.1 FLOODPLAIN AREAS

The major part of the following assessment is an evaluation of current risks using data for soil, springs, and groundwater. Because groundwater plumes may change in concentration, area, and locations of contact with surface soil, predicted future groundwater concentrations are also evaluated for potential risks to plants.

G.5.1.1 Exposure Assessment for Plants

Vegetation growing in the Bear Creek floodplain is exposed to contaminants in soil and potentially in shallow groundwater seeps. Trees and herbaceous plants are both present in the Bear Creek floodplain, unlike the source areas, and risks are considered using current concentrations of contaminants in soil and current and predicted future concentrations in groundwater. Deep-rooted trees and shallow-rooted grasses may be exposed to different concentrations of contaminants, depending on the location of the source.

Soil exposures

Soil was collected from 6 stations at each of 13 transects perpendicular to Bear Creek. For each transect, two samples were collected in the creek berms on either side of Bear Creek, and two others were in the backmarsh if the floodplain was wide enough on both sides of the creek (Sect. B.5.3.1). Although sample depth intervals included 0–4 in., 4–16 in., and 16–32 in., only the two more shallow depths are used for the assessment of toxicity to terrestrial plants.

Concentrations of analytes in the soil derived from double acid-extractions (nitric and hydrochloric) generally represent the total potential reservoir of contaminants, not the concentrations to which the plants are exposed at any one time. Some metals are more readily available for uptake by plants than others, depending on the solubility and species of the compound, interactions with soil constituents (organic matter and clay) and with other contaminants, and mechanisms for bioaccumulation in particular plant species. Organic contaminants may interact strongly with soil organic matter and therefore be of limited availability for plant uptake.

Contaminants have vertical distributions in soil that reflect interactions between the soil and the contaminant, controlled by the chemical and physical characteristics of the soil and the quantity and chemical characteristics of the contaminant. The exposure of plant roots to a contaminant in the soil will depend on these abiotic factors and the growth characteristics of individual plants, such as rooting depth and density. In the absence of data on root distribution, it is assumed that the plants are rooted within the zone from which the soil was sampled for analysis (i.e., the top 16 in.). An average concentration of contaminants in the top 16 in. was created through a weighted average of measured concentrations in the top 4 in. and those from the next 12 in. of soil depth. Samples of the top 4 in. of soil alone reflect the exposure of more shallow rooting plants. Plants are assumed to rely on one or both of these zones for their immediate water and nutrient requirements.

There are two other routes of exposure that we cannot address because of a lack of data. These are exposure to volatile organic compounds in the air above and in the soil, and contaminants in dust

particles deposited on above-ground plant parts. These routes are assumed to contribute negligibly to plant exposure in the Bear Creek floodplain.

The toxicity of contaminants in the soils to lettuce seedlings was evaluated by (1) measuring the proportion of germinating seeds in 7 days and (2) measuring above-ground plant growth after 21 d in soils of the Bear Creek floodplain. A detailed discussion of the application and results of these tests are presented in the Supporting Information.

Potentially exposed threatened or endangered species in Bear Creek Valley soils include pink lady's slipper, Canada lily, ginseng, tubercled rein-orchid, and purple fringeless orchid (Awl et al. 1996).

Current Soil solution exposures

Plants growing in wetland seep areas are exposed to contaminants in the water. Wetlands along the Bear Creek tributaries have been mapped by Rosensteel and Trettin (1993) according to the U. S. Army Corps of Engineers criteria for wetlands delineation (USACOE 1987). Wetlands in Bear Creek tributary bottoms include land along North Tributary 1 (NT1), NT2, NT5, NT6, NT8, NT9, NT10, NT11, and NT12. Most of the wetlands are smaller than 0.4 ha, with those in upstream reaches below 0.1 ha. In almost all wetlands, plant species include some of the following: red maple, sweetgum, ironwood, green ash, and microstegium. Four species found in wetlands in the Bear Creek watershed that are classified as Threatened or Endangered by the Tennessee Department of Environment and Conservation are: tubercled rein orchid, purple fringeless orchid, fen orchid, and Canada lily (Rosensteel and Trettin 1993). Of the Bear Creek Valley wetlands, only the palustrine forested wetlands in the downstream Bear Creek floodplain and the palustrine emergent/scrub-shrub/forested wetland complex along East Tributary 3 (downstream of NT15) are registered Tennessee Natural Areas and habitat for rare plant species (Rosensteel and Trettin 1993).

In the BCV floodplain eight springs were identified south of the creek. Of these, five were sampled for contaminants: SS1 (South Spring 1), SS4, SS5, SS6, and SS8. (Soil water in wetlands at a distance from tributaries were not sampled.) It is assumed that the roots of plants near the springs may be exposed to seeps of similar concentrations and to contaminants in shallow groundwater, as described in the following text. Although the discharge in many of these seeps is seasonal and heightened during rainfall events, we make the conservative assumption that plants growing at these locations may be exposed to contaminants in the water throughout the year. We also assume that the entire root systems of plants growing in seep areas are exposed to contaminants in springs or groundwater, and that this type of exposure is the only significant source of contaminants for the plants. On the other hand, it cannot be assumed that the plant community in the entire region above a groundwater plume is exposed to contaminants below to the degree that terrestrial plants are exposed to the soil.

The division of floodplain groundwater exposures in this section from those associated with source OUs (Sect. G.5.2.1) is somewhat artificial, compared with the division of soils. The floodplain is defined by its soils; groundwater plumes may underly the BYBY or the OLF as well as the floodplain, so the assessments of the two areas are somewhat overlapping. For the floodplain, we evaluate contaminants from two shallow wells in the NT-1 catchment (GW-345 and GW-537) and one deeper well in the NT-2 catchment (GW-526). These wells are associated with the nitrate plume with dimensions depicted in Fig. D.6 and described in the following text. Although called a nitrate plume, various inorganic contaminants were measured in it.

The "interpreted" shallow nitrate plume extends ~4,000 ft upstream (with respect to Bear Creek) of the confluence of NT1 with Bear Creek, 400 ft downstream of the NT2 confluence with Bear Creek (on the north side of BC) with an arm of the plume extending 2,000 ft downstream on the south side of Bear Creek. The plume extends 200–300 ft on the south side and 600 to 800 ft on the north side of the creek.

A second shallow portion of what is probably the same nitrate plume below the floodplain extends from 400 ft upstream (with respect to Bear Creek) of where NT6 joins Bear Creek to 700 ft downstream of where NT7 joins the creek. Only the portion of the plume between NT6 and NT8 is north of Bear Creek.

Groundwater plumes and the extent of contamination may change substantially in the future. The methods for predicting future groundwater concentrations, including current conditions, contaminant fluxes, and a conceptual fate and transport model, are described in Sect. E.4. For purposes of the floodplain assessment, predicted future groundwater concentrations near Bear Creek are used.

Total recoverable and filtered concentrations of inorganic and organic contaminants were measured in springs south of Bear Creek. Concentrations of dissolved contaminants were measured in groundwater wells but not in background samples. All available filtered and unfiltered data for which background inorganic contaminant concentrations were available were used for the screening. Concentrations of contaminants in unfiltered water were assumed to be a conservative representation of exposure.

Future soil solution exposures

Future exposures are based on the range of predicted maximum groundwater concentrations presented in Appendix E. These concentrations were derived using source terms for the S-3 Ponds, the Bone Yard/Burn Yard, and the Bear Creek Burial Grounds; groundwater transport models; and surface water dilution ratios. These are assumed to be dissolved phase concentrations. Also presented in Appendix E are the predicted time ranges for the peak concentrations in years from the start of waste operations at each site.

Ground water concentrations due to contaminant loading from the following sources were predicted for six locations: NT-1 and NT-2 due to the S-3 plume, NT-3 due to the BYBY, NT-7 due to BG A, NT-8 due to BG C-west and the walk-in pits, and BCK 9.47 due to all modeled sources. A concentration range for NT-8 from all sources was estimated by summing the contributions from both modeled sources (i.e., BG C-west and the walk-in pits). This is conservative, given that the peak contributions from these sources probably will not occur at the same time.

G.5.1.2 Effects Assessment for Plants

Contaminant concentrations in soils, springs, and groundwater were compared with toxicological benchmarks in order to screen out chemicals that do not constitute a hazard to plants and therefore do not require detailed risk characterization. Tests conducted in natural soils were assumed to be representative of the exposure of plants to contaminants measured in floodplain soils, with the possibility that chemicals freshly added to soils in literature toxicity tests and rigorous chemical extractions from ambient media toxicity tests may be more bioavailable than contaminants in BCV soils. Tests conducted in nutrient and mineral solutions are the best available representation of exposures of plants to contaminants in the vicinity of seeps and springs.

Single-chemical soil toxicity

Derivation of benchmarks

The phytotoxicity benchmarks were derived by the same method used for soil invertebrates (Sect. G.4.1.2); that is, by rank ordering the EC₂₀ values and then picking a number that approximated the tenth percentile (Will and Suter 1995b). Screening benchmarks for phytotoxic effects of contaminants present in floodplain soils are presented in Table G.25.

Of the 10 inorganic elements detected at concentrations above their background criteria in the floodplain (Sect. D.9.2.1, Table D.98 and D.99), a benchmark is not available for cyanide. Benchmarks were not available for any of the 3 herbicides, 18 pesticides or 2 PCBs, detected in the floodplain (Sect. D.9.2.3). Only 1 of the 12 semivolatile organic compounds, di-*n*-butyl phthalate, had a benchmark associated with it.

Ecotoxicological profiles

Toxicity profiles are presented for COPECs (i.e., chemicals occurring in soil at maximum concentrations exceeding benchmarks and background for toxicity to plants) in Supporting Information. If a chemical is of concern in one medium (soil or water) and not in the other, the toxicity profile addresses toxicity only in that medium.

Single-chemical soil solution toxicity

The benchmarks for plants in solution were derived by the same method used for soil invertebrates (Sect. G.4.1.2); that is, by rank ordering the EC₂₀ values and then picking a number that approximated the tenth percentile (Will and Suter 1995b). Screening benchmarks for phytotoxic effects of contaminants present in unfiltered and filtered water of springs in the floodplain are presented in Tables G.26 and G.27, respectively.

Ambient soil toxicity

The report entitled *Toxicity Test Results, Bear Creek Valley Floodplain Soil*, by Stewart et al., included in the Supporting Information, describes in detail the methods, results, and conclusions of the toxicity tests. The following text is a summary of the report. No toxicity tests in groundwater or springs were performed.

Materials and methods. *Latuca sativa* (buttercrunch lettuce) was chosen to represent plants because of (1) the high and rapid germination rate, (2) the commercial availability, (3) the uniform growth pattern, and (4) the recommendation of EPA. The rationale for species choice, including the original plan to use *Arabidopsis thaliana*, are described in more detail in the report *Toxicity Test Results, Bear Creek Valley Floodplain Soil* (Stewart et al., the Supporting Information). Proportion of germination and above-ground growth were tested using a procedure described in Greene et al. (1988).

A single 3.8-L, 0–16-in. depth sample was taken from each location, including 11 transects, 3 reference sites, and 1 artificial soil. ANOVA was used to determine whether growth and/or survival differed significantly ($p < 0.05$) among sites. If so, Duncan's multiple range test identified which sites were different, compared with the reference sites.

Results. Complete tables of results appear in Stewart et al. (the Supporting Information). The proportion of germinating lettuce ranged from 0.26 to 0.84 for the reference and nonreference sites; the highest germination rate was at one of the reference sites. The mean proportion of seeds that germinated at the reference and nonreference sites was 0.773 and 0.637, respectively. "Site" explained a large part of the variation in lettuce germination ($R^2 = 0.372$, $p < 0.0025$).

The mean growth of lettuce for the reference sites ($N = 3$), the artificial soil ($N = 1$), and the nonreference sites ($N = 16$) were 0.89 mg/replicate, 1.57 mg/replicate, and 2.96 mg/replicate, respectively. The three lowest mean growth values were obtained in reference soils. Mean growth in the three worst nonreference sites were 1.35 mg/replicate (TS042), 1.54 (TS041), and 2.08 (TS034). According to Duncan's procedure, growth in floodplain soil from the nonreference sites was greater than in floodplain soil from the reference sites or control soil. An ANOVA of floodplain soil concentrations just from the nonreference sites found differences among the sites ($R^2 = 0.656$, $p < 0.0001$).

Conclusions. According to Stewart et al. (Supporting Information), soil from three nonreference sites, TS042, TS041, and TS034 may show phytotoxicity. The level of growth among these samples is 31% to 48% as great as the mean growth of lettuce in soil from the three "best" sites.

Growth of lettuce was low at the three reference sites, compared with the contaminated sites. The reference sites, which were at a distance from the floodplain and somewhat upland, were probably not physically or chemically representative of floodplain soils.

Vegetation survey

Qualitative observations of exposed plant communities may provide evidence about the effects of contaminants. A walkthrough survey of several sites in the BCV was undertaken in November 1995. Vegetation was assessed for "the presence of groupings of dead trees or shrubs, patches of groundcover vegetation, twig or bud die-back, and atypical growth form" (Rosensteel 1995, Supporting Information). The evaluation of leaf stress and premature mortality were not included because most of the plants had begun senescence or were entering dormancy. Sites chosen for their location above shallow groundwater contaminant plumes and reference sites are described in the vegetation assessment report in the Supporting Information. They include: the mainstem of Bear Creek in the West End Management Zone, NT1 downstream of Bear Creek Rd, NT2 at and downstream of Haul Road, NT3 in the BYBY, NT7 between Haul Road and Bear Creek Road, NT8 from the BG fence to Bear Creek and the West Branch of NT8 upstream of Haul Road, SS2, SS3, SS4, and SS5. Three reference areas outside of the groundwater plume, NT1 upstream of Bear Creek Road, NT2 upstream of Haul Road, and NT3 upstream of Haul Road were surveyed also.

Small areas of dead, dying, and atypical growth forms of vegetation, usually trees, were observed at several of the plume area sites in the floodplain and reference sites in November 1995. Those that were not explained by causes other than contamination (refer to Sect. G.5.1.3) are as follows:

- NT1, upstream of Bear Creek Road (outside of the groundwater plume area): several dead trees, including red maples and green ash;
- NT2, southeast side, downstream of Haul Road: recently dead honeysuckle and several dead trees, including tulip poplar and misshapen ash; and
- NT8, wetland: several dead trees and stumps.

These areas were resurveyed in June 1996 by B. Rosensteel (Supporting Information). Although the dead trees at NT1 remained, other stressed or dead vegetation was not observed. In transects 1, 2 and 3, no

unhealthy plants were seen. There was no evidence of the dead honeysuckle that was observed near NT2 in November. No additional dead trees were observed at NT2, and the dead tulip poplars may be attributable to a disease of this species that has been present in the area for years and was observed to cause holes and curling of leaves. Vegetation in NT8 was not surveyed in June.

G.5.1.3 Risk Characterization for the Plant Community

The evidence concerning risks to plants consists of soil toxicity test data; analyses of chemicals in soil, seeps, and groundwater; and a vegetation survey. These lines of evidence are summarized in the following text. The goal of this assessment is to locate hot spots of chemical contamination in the floodplain, rather than to offer a complete picture of the nature and extent of contamination.

Single-chemical soil and solution toxicity

COPECs for terrestrial plants in the BCV floodplain were identified by comparing maximum detected site concentrations (from the 0–4-in. or 4–16-in. depth samples) in each transect sample to (1) background soil values and (2) available benchmarks for toxicity to terrestrial plants (Will and Suter 1995b). The screening of maximum concentrations against benchmarks is intended to protect plants that spend their entire lives in a single, highly contaminated location. If both background and benchmark criteria were exceeded, the contaminant was identified as a COPEC. HQs were calculated by dividing the maximum concentration in soil by the toxicity benchmark concentration. Contaminants with HQs of <1 at a site were not identified as COPECs. Benchmarks for plants growing in soils, maximum concentrations of analytes at each transect sample location exceeding background and for which benchmarks are available, and HQs for the contaminants are given in Table G.25.

COPECs for plants exposed to groundwater and springs were identified by a similar comparison of contaminant concentrations with background and toxicity benchmarks. Contaminants detected in whole or filtered water in seeps were screened against benchmarks. Chemicals that exceeded any benchmark were evaluated further for bioavailability and potential sources to determine if they were credible COPECs. Filtered concentrations of contaminants in groundwater could not be compared with background concentrations, but when available, they were used to further evaluate potential COPECs. Predicted future concentrations in groundwater were also compared with plant solution benchmarks.

Toxicological profiles for COPECs and references associated with toxic effects are presented in the Supporting Information.

Plants exposed to soil

Locations of transects are depicted in the summary of risks to plants map (Sect. G.8). High transect numbers signify downstream locations.

Transect 1 (TS01). The maximum detected concentrations of cadmium, lithium, mercury, and selenium at TS012 (transect 1, station 2) were 3, 20, 20, and 3 times the benchmarks (i.e., concentrations causing toxic effects when added to surface soil). Lead only marginally exceeded the phytotoxicity benchmark (HQ of 1 if appropriate significant figures were used). The maximum detected concentration of selenium at TS016 was 2 times the benchmark, and that of mercury was slightly above the benchmark. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS011, TS013, TS014, and TS015.

Since cadmium, lithium, mercury, and selenium exceed benchmarks at several sites in TS01 and in other transects, these contaminants are discussed in this section.

TS02. The maximum detected concentrations of mercury, selenium, and thallium at TS023 were 5, 3, and 2 times benchmarks, respectively. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS021, TS022, TS024, TS025, and TS026.

Risks from thallium cannot be confidently estimated; Will and Suter (1995b) have little confidence in the 0.3 mg/kg benchmark for thallium because it is based on a single secondary reference, Kabata-Pendias and Pendias (1984).

TS03. The maximum detected concentrations of cadmium, lithium, mercury, nickel, and selenium at TS033 were 4, 20, 8, 2, and 10 times benchmarks, respectively. The maximum detected concentrations of cadmium, mercury, nickel and selenium at TS034 were 4, 8, 2, and 2 times benchmarks, respectively. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS031, TS032, TS035, and TS036. The contamination was highest at the two stations closest to the creek.

TS04. The maximum detected concentration of selenium at TS041 was 3 times the benchmark for the contaminant. The maximum detected concentrations of lithium, mercury, and selenium at TS042 were 30, 1, and 3 times benchmarks, respectively. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS041, TS043, TS044, TS045, and TS046.

TS05. The maximum detected concentration of selenium at TS051 was two times the benchmark for the contaminant. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS052, TS053, TS054, TS055, and TS056.

TS06. The maximum detected concentration of mercury at TS063 was 2 times the benchmark for the contaminant. The maximum detected concentration of mercury at TS064 was two times the benchmark for the contaminant. Selenium was slightly above the benchmark for the contaminant at TS064. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS061, TS062, TS065, and TS066.

TS07. The maximum detected concentrations of mercury and selenium at TS071 were 3 and 2 times the benchmark for the contaminant, respectively. The maximum concentration of cadmium at TS071 was slightly above the benchmark concentration. The maximum detected concentration of mercury at TS073 was 2 times the benchmark concentration. The maximum concentration of selenium was slightly above the benchmark for the contaminant at TS073. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS072, TS074, TS075, and TS076.

TS08. The maximum detected concentration of selenium at TS086 was 2 times the benchmark for the contaminant. Mercury was found at a concentration that slightly exceeded the benchmark. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS081, TS082, TS083, TS084, and TS085.

TS10. The maximum detected concentration of selenium at TS103 was slightly above the benchmark for the contaminant. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS101, TS102, TS104, TS105, and TS106.

TS13. The maximum concentration of selenium at TS132 was 2 times the benchmark for the contaminant. Mercury was at a concentration that slightly exceeded the benchmark. No contaminant concentrations exceeded both background and benchmark toxic concentrations at TS131, TS102, TS104, TS105, and TS106.

TS09, TS11, TS12. Data were not available for these transects.

Cadmium. Several stations (TS012, TS033, TS034, and TS071) had maximum detected concentrations of cadmium between 3 (the benchmark concentration) and 11 mg/kg. According to Will and Suter (1995b), "approximately 40% of the concentrations responsible for greater than 20% reductions in plant growth parameters fall between 1 and 10 ppm cadmium added to soil." A map of maximum detected cadmium concentrations at the 0–4-in. depth range and the 4–16-in. depth range along the floodplain is presented in Fig. D.112. The two apparent sources of the chemical are the S-3 area and the burial grounds, with detected concentrations at the transects (TS04 through TS09) downstream from TS03 and the burial grounds.

Lithium. A few stations (TS012, TS033, and TS042) had maximum detected concentrations of lithium between 33 and 55 mg/kg—20 to 30 times the benchmark concentration of 2 mg/kg. The benchmark was derived from few studies; the 2 mg/kg concentration was associated with an undefined phytotoxic effect on sweet orange seedlings (Aldrich et al. 1951). The highest detected concentration of lithium, 55.2 mg/kg (TS042), is well within the range for uncontaminated soils in the eastern United States (<5 to 140 mg/kg; Shacklette and Boerngen 1984). A map of maximum detected lithium concentrations at the 0–4-in. depth range and the 4–16-in. depth range along the floodplain is presented in Fig. D.113. Apparent sources of the chemical are the burial grounds and the S-3 area; no lithium was detected downstream of TS04.

Mercury. Mercury was detected at concentrations above background and the phytotoxicity benchmarks at transects 1 through 8, except for TS05, and 13. The maximum concentrations that exceeded benchmarks at a station ranged from 0.4 mg/kg to 7 mg/kg. The toxicity of mercury is dependent on the form of the chemical. Will and Suter (1995b) have little confidence in the 0.3 mg/kg benchmark because it is based on a single secondary reference, Kabata-Pendias and Pendias (1984). A map of maximum detected mercury concentrations at the 0–4-in. depth range and the 4–16-in. depth range along the floodplain is presented in Fig. D.114. Apparent sources of the chemical are the burial grounds, the S-3 area, and perhaps the sanitary landfill, with downstream mercury probably being deposited from the creek.

Selenium. Selenium was detected above background and phytotoxicity benchmarks at transects 1 through 8, TS10, and TS13 (i. e., all transects sampled). The maximum concentrations that exceeded benchmarks were remarkably constant, ranging from 1.4 mg/kg to 3.2 mg/kg. Samples taken downstream of TS08 were somewhat lower in concentration than most of the others. The consistent concentration is evident from Fig. D.115, a map of maximum detected selenium concentrations at the 0–4-in. depth range and the 4–16-in. depth range along the floodplain. Background is 1.2 mg/kg. The 1 mg/kg benchmark was taken from a study of sorgrass in loamy sand and sandy soil. The maximum detected concentrations of selenium were within the range of concentrations of the element in uncontaminated soils of the eastern United States, <0.1 to 3.9 mg/kg (Shacklette and Boerngen 1984).

Plants exposed to groundwater seeps

South springs. A comparison of contaminant concentrations from unfiltered and filtered spring samples to screening benchmarks for toxicity to plants in solution appear in Tables G.26 and G.27,

respectively. Contaminants for which HQs were greater than one (i.e., for which the maximum detected concentration exceeded the benchmark) are discussed in this section.

SS1. The maximum concentration of aluminum in unfiltered samples was 20 times the plant solution benchmark for the contaminant. Lead was present at a concentration slightly above the benchmark.

Aluminum concentrations did not exceed the background concentration in filtered samples. The background concentration of aluminum in filtered samples (3.1 mg/L) was higher than the background concentration in unfiltered samples. Only 1 of 12 samples had a detected concentration of lead. We have eliminated lead as a COPEC because of its marginal exceedence of the phytotoxicity benchmark in unfiltered samples (HQ of 1 if appropriate significant figures are used) and its nonexceedence of the phytotoxicity benchmark in filtered samples.

SS4. The maximum concentration of aluminum in unfiltered samples was 10 times the plant solution benchmark for the contaminant.

Aluminum concentrations did not exceed the background concentration in filtered samples.

SS5. The maximum concentration of arsenic in filtered samples was 60 times the plant solution benchmark for the contaminant. No contaminants in unfiltered samples were measured at concentrations above plant solution benchmarks.

The background concentration of arsenic in filtered water was 0.05 mg/L, only slightly lower than the 0.059 mg/L maximum detected concentration at SS5. Only 2 of 14 samples had detected concentrations of arsenic; the mean was 0.0052 mg/L.

SS6. The maximum concentration of aluminum in unfiltered samples was 20 times the plant solution benchmark for the contaminant.

Aluminum concentrations did not exceed the background concentration in filtered samples.

SS8. The maximum concentration of arsenic in filtered samples was 50 times the plant solution benchmark for the contaminant. Copper was measured at a concentration in filtered samples that slightly exceeded the plant solution toxicity benchmark. No contaminants in unfiltered samples were measured at concentrations above plant solution benchmarks.

The background concentration of arsenic in filtered water was 0.05 mg/L, only slightly lower than the 0.059 mg/L maximum detected concentration at SS5. Only 2 of 14 samples had detected concentrations of arsenic; the mean was 0.0047 mg/L. Only 2 of 25 samples had detected concentrations of copper; the mean was 0.0049 mg/L. The maximum detected concentration of copper, 0.7 mg/kg, only slightly exceeded the 0.67 mg/kg background value for filtered water.

SS2, SS3, and SS7. Concentrations of contaminants in these springs were not available.

Current groundwater

A comparison of maximum detected, above-background concentrations of contaminants in three groundwater wells and phytotoxicity benchmarks is found in Table G.28.

GW 345. The maximum concentration of copper in unfiltered samples was two times the benchmark for toxicity to plants in solution.

Copper in filtered samples from GW 345 did not exceed the benchmark ($HQ = 1$). Nonetheless, we have not eliminated copper as a COPEC because it is found at GW 526 (the deeper well at the same location) at a concentration above the phytotoxicity benchmark both in unfiltered and filtered samples. The maximum detected concentration of copper (0.083 ppm) is in the range of the concentrations that affected rye grass (Wong and Bradshaw 1982), maize (Stiborova et al. 1986), and chrysanthemum (Patel et al. 1976) growth. Dissolved copper sulfate was used.

GW 526. The maximum concentration of copper in unfiltered samples was nine times the benchmark for toxicity to plants in solution. Zinc was present at a concentration slightly above the benchmark.

The maximum concentration of copper in filtered samples was two times the phytotoxicity benchmark. Effects observed at the 0.46 ppm maximum detected concentration include those detailed above. We have not found studies that show effects on trees at this concentration.

We have eliminated zinc as a COPEC because of its marginal exceedence of the phytotoxicity benchmark in unfiltered samples (HQ of 1 if appropriate significant figures are used) and its nonexceedence of the phytotoxicity benchmark in filtered samples.

GW 537. No contaminants in unfiltered samples were measured at concentrations above plant solution benchmarks.

GW 345 and GW 526 are representative of groundwater flowing under much of the floodplain; thus, the negligible risks to plants estimated from benchmark comparisons, particularly for copper, are valid for most plants that are not near particular springs or in riparian areas. Additional contaminant data from piezometers near NT-1 were obtained from a technical demonstration project intended to locate areas of high contamination. Locations of the piezometers are depicted in Fig. D.38. These data represent a maximum exposure scenario for riparian plants along NT-1, with samples taken at depths less than 2 m. A comparison of maximum detected contaminant concentrations from two wells with benchmarks for toxicity to plants is presented in Table G.29. The concentrations were compared to the lowest background upper tolerance limits among the limits for groundwater clusters 1, 2, and 3, presented in Table D.10. None of the background concentrations were higher than the maximum well concentration. Hazard quotients for aluminum (500), cadmium (8), chromium (2), cobalt (10), manganese (30), nickel (7), thallium (7), and titanium (7) are greater than 1. Hazard quotients would be expected to be significantly less for filtered concentrations of chemicals in groundwater, which are more realistic estimates of exposure to plants.

Future groundwater

Risks to plants from predicted future concentrations of contaminants in groundwater are presented in this section. No attempt is made to distinguish between groundwater associated with the floodplain and that below the source areas. Maximum predicted concentrations of contaminants were lower than plant solution benchmarks for 1,1,1-trichloroethane, 1,1,2-trichloroethane, lithium, selenium, uranium. Benchmarks were not available for 1,1,2,2-tetrachloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,2-dichloroethene, antimony, barium, strontium, benzene, bis(2-ethylhexyl) phthalate, carbon tetrachloride, chloroform, cyanide, methylene chloride, nitrate, PCBs, trichloroethene, vinyl chloride.

Plant solution benchmarks that are predicted to be exceeded at any time in the future are depicted in Figures G.44 through G.49. Exceedences are predicted for arsenic [Fig. G.44 (A)], beryllium [Fig. G.44 (B)], boron [Fig. G.45 (A)], cadmium [Fig. G.45 (B)], chromium [Fig. G.46 (A)], copper [Fig. G.46 (B)], lead [Fig. G.47 (A)], manganese [Fig. G.47 (B)], mercury [Fig. G.48 (A)], nickel [Fig. G.48 (B)], and tetrachloroethene (Fig. G.49).

Locations where predicted future groundwater concentrations exceed phytotoxicity benchmarks are presented in Table G.30. All of the concentrations predicted at in the vicinity of Bear Creek are decreasing with time. Similarly, the concentration of manganese at NT-1 is gradually decreasing. Concentrations of contaminants at NT-3 and NT-8 (CW) are at steady state. Predicted peak times are not available for NT-8 from C-west because seep concentrations and surface water dilution factors were used rather than modelling. Thus, risks to plants from contaminants at NT-3 and NT-8 (CW) are not expected to increase in the future.

- Of the contaminants estimated to exceed benchmarks in the future, concentrations of cadmium, mercury, and nickel are expected to get worse at NT-1 for the next 60 to 160 years. Similarly, manganese and contamination from shallow groundwater near NT-2 will probably get worse for the next 160 years. Contaminants at NT-7 and the walk-in pits at NT-8 are predicted to increase gradually (20 to 30%) over the next 1000 years. Thus, risks to plants from contaminants at the following locations are expected to increase in the future:
- NT-1: cadmium, mercury, nickel
- NT-2: manganese
- NT-7: beryllium, boron, copper, lead, manganese, nickel, tetrachloroethene
- NT-8: arsenic, beryllium, boron, chromium, copper, lead, manganese

Ambient soil toxicity

According to Stewart et al. (Supporting Information), three nonreference sites—TS042, TS041, and TS034—may show phytotoxicity. The level of growth among these samples is 31% to 48% as great as the mean growth of lettuce in soil from the three “best” sites.

Lettuce has not previously been used for toxicity tests on the ORR. The rankings of growth responses of earthworms and lettuce at different sites were similar, suggesting that lettuce toxicity test outcomes were rather reliable (Stewart et al., Supporting Information). Multiple linear regressions where % clay, % sand, % silt, pH and total organic matter were independent variables and lettuce growth at 10 stations was the dependent variable were not significant ($p = 0.10$). Because the toxicity tests were performed at uniform moisture contents, percent moisture was not considered as a variable. Multiple linear regressions with cadmium, mercury, and selenium as independent variables and growth as the dependent variable were not significant ($p = 0.10$). The variables were tested in all combinations, though when cadmium was a variable, the sample size was five because of the large number of sites where cadmium was not detected. Regressions with lead and lithium as variables were not performed because of the small sample size.

The apparent inappropriateness of the reference sites means that 20% decreases in growth compared with reference sites could not be identified.

Vegetation survey

Apparent negative impacts on plants from B. Rosensteel's November 1995 report (Supporting Information) are only included in the risk characterization if they were not easily attributable to causes other than contamination. The bases for this decision were Rosensteel's suggestions in the November 1995 report and an additional survey and analysis undertaken in June 1996 (Supporting Information). Impacts that may possibly be attributed to contaminants are noted in Sect. 5.1.2.4 and in the weight of evidence tables for plants in soil (Table G.31) and groundwater (Table G.32). Rosensteel writes, "In some locations, plant death and stress could be attributable to alterations in surface hydrology [because of beaver dams, for example], the pine bark beetle, competition from kudzu, or natural plant succession, such as when the tree canopy closes over a shade-intolerant species." Explanations for deaths of trees include bottomland siltation and physical damage to trees from construction in the West End Management Zone. Also, in the June 1996 report Rosensteel pointed to a disease that has afflicted tulip poplar for years (Supporting Information).

Weight of evidence for the plant community

Plants exposed to soil

Risks to plants from exposure to soils in the BCV floodplain vary from transect to transect and station to station. Toxicity tests are intended to measure the bioavailability of contaminants better than rigorously extracted concentrations. Soil from two transects, TS03 and TS04, were associated with apparently low growth of lettuce. These results must be qualified by the lack of appropriate reference sites. Vegetation surveys added to the weight of evidence in the case of TS04, though the weight placed on this type of evidence was not high. The evaluation of risks at TS01 is problematic, because of the similarity of contaminants and concentrations found at TS03 and TS04 and the lack of apparent toxicity to lettuce plants at TS01. Given the lack of toxicity to lettuce and the vegetation survey that found few dead plants, all with explanations other than the presence of contaminants, there were determined to be no significant contaminant-related risks at TS01.

Our evaluation is that the plant community is significantly impacted by exposure to contaminants in soils at TS033, TS034, TS041, and TS042. TS033 and TS034 are the closest stations on either side of the creek in transect 3. TS041 and TS042 are on the north side of Bear Creek along NT8. Thus, risks from soils are observed only at two contained locations: along the floodplain near transect 3 and along NT8 on the north side of the creek. No distinction can be made between impacts to threatened and endangered and other plant species.

Plants exposed to groundwater

Risks to plants from exposure to shallow groundwater are probably negligible. Unfortunately, ambient toxicity tests are not available for groundwater exposure. Contaminants that exceed phytotoxicity benchmarks in unfiltered samples often do not in filtered samples. In other cases, either unfiltered or filtered samples do not exceed background. Contaminants that exceed benchmarks are often detected in only one or two samples. Although surveys of vegetation have found isolated dead trees and honeysuckle, it is impossible to apportion causes among contaminants in soil, those in soil water, and other possible causes. The groundwater wells GW 345, GW 526, and GW 537 approximately represent groundwater in catchments NT1 and NT2. However, since they measure contaminants in the large nitrate plume whose boundaries are defined in G.5.1.1, the conclusion of low- to no-adverse impacts from contaminants in the wells may be extrapolated, with some caution, to the boundaries of the plume.

Future risks to plants from groundwater

If estimated future ground water concentrations are accurate, risks to plants from groundwater near NT1 and NT2 from the S-3 source area may be substantial in the next 60 to 160 years. Risks to plants at NT7 and NT8 will increase gradually during the next 1000 years. Risks from groundwater in the vicinity of Bear Creek are predicted to decrease, and those at NT-3 are predicted to remain the same as current risks.

G.5.2 SOURCE AREAS

The four source areas evaluated for potential risk to ecological receptors were the S-3 Ponds area, BYBY, the SL/OLF, and BG. Analytical results were aggregated by area for evaluation of exposure of terrestrial plants to contaminants at each source area.

Surface soil samples were taken during two sampling programs. One set was taken to a depth of 30 cm (12 in.) and were analyzed for inorganics, PCBs, and isotopes of uranium. An additional set of samples was taken from soil borings. These samples were composites of 120-cm (48-in.) depth intervals, beginning at the soil surface. Soil aggregates used for evaluation of potential risk to ecological receptors comprise all soil samples taken at each source area that began at the soil surface. Summary statistics for surface soil aggregates are given in Tables G.19–G.22.

G.5.2.1 Exposure Assessment for Plants

Plants may be exposed to contaminants in soil by root uptake or by direct foliar contact. This assessment focuses on root uptake. For most areas, plants are exposed to contaminants associated with soil particles. These exposures are evaluated in the following subsections as soil exposures. In some cases, shallow groundwater may carry contaminants that have not equilibrated with soil, so that soil pore water exposure may be greater than exposure to soil alone. These exposures are evaluated in the following subsections as soil solution exposures.

Soil exposures

The mechanisms by which plants are exposed to soil contaminants are discussed in Sect. G.5.1.1. Because plants are immobile, some plants are exposed to the maximum concentrations of contaminants in each soil data aggregate. Therefore, maximum concentrations in each source area soil aggregate were used to assess the potential negative impacts of contaminated soil on terrestrial plants in the source areas.

Current exposures were evaluated using data from surface soil samples at the source areas (Tables G.19–G.22). Separate assessments were carried out for the Creekside and Bear Creek Road Debris Burial Areas. Analytical results for soil in these areas are presented along with the single-chemical toxicity screening in text that follows.

Future exposures were evaluated by assuming that the maximum potential future exposures would be to inventoried wastes. Combined data for S-3 Pond sludges were used to compute source term concentrations at the S-3 Ponds (Table A.3), and waste inventory data for the BG area were used to compute source term concentrations in the BG wastes (Table A.14). For the purposes of this assessment, contaminants at the BG waste inventory sites were considered to be in soil. A single contaminant concentration was determined at each site, either because concentrations were computed from analytical sampling data (S-3 Ponds sludges) or from historic inventory information (BG waste inventory). These data were used to evaluate potential future risks at the S-3 Ponds and BG areas for plants growing in the

wastes. For future risks at the capped sites, it is assumed that the cap is no longer present and the contaminants are freely accessible to plants.

Soil solution exposures

Current solutions exposures were evaluated by using the concentrations of contaminants in selected shallow groundwater wells. Wells near tributaries NT1, NT2, NT3, NT4, NT6, NT7, and NT8 were evaluated to determine potential impacts of shallow groundwater upwelling into the tributaries. One well in the BG area that was not near a tributary was evaluated for potential impacts where tributaries should not exert an immediate local influence on the movement of a shallow contaminant plume. The wells chosen for evaluation and their depths and well cluster numbers are presented in Table G.33. The maximum observed concentration above background in filtered and unfiltered samples from each well grouping was used in the evaluation.

G.5.2.2 Effects Assessment for Plants

Published information on the toxicity of individual chemicals to terrestrial plants in controlled tests, as well as the results of site-specific ambient soil toxicity tests, were used to evaluate potential adverse effects to terrestrial plants in the source areas.

Single-chemical soil toxicity

Toxicity testing of chemicals administered to plants growing in soil is discussed in Sect. G.5.1.2. Toxicity benchmarks for exposure of plants growing in soil, as presented in Will and Suter (1995b), are available for 27 inorganic analytes and 12 organic analytes. The single-chemical toxicities of these analytes, where they occur above background in source area soils, were evaluated.

Single-chemical soil solution toxicity

Toxicity benchmarks for plants exposed in solution, as presented in Will and Suter (1995b), are discussed in Sect. G.5.1.2. Toxicity benchmarks for solutions were used to evaluate potential adverse effects of soil contaminants in shallow groundwater at the source areas to terrestrial plants exposed to those contaminants in soil pore water. Toxicity benchmarks for exposure of plants in solution are available for 30 inorganic analytes and 16 organic analytes. The single-chemical toxicities of these analytes, where they occur above background in selected shallow groundwater wells, were evaluated.

Ambient soil toxicity

Ambient soil toxicity testing was done on soil from floodplain transects only (Sect. G.4.1.2). Information from those tests, described in Sects. G.5.1.2 and Supporting Information, was used to evaluate potential toxicity of source area contaminants to terrestrial plants exposed to contaminants in soil.

Vegetation survey

Two vegetation surveys were carried out to identify possible adverse impacts of BCV soil contaminants on terrestrial vegetation (Rosensteel 1995,1996; Supporting Information). Each survey consisted of a walkover of several BCV sites that had been identified as potentially exposed to contaminants in soil or in shallow groundwater. The purpose of the surveys was to identify areas where

there was obvious negative impact to plants that could be attributed to soil or shallow groundwater contaminants. A quantitative evaluation of plant populations and communities was not made as part of either survey.

G.5.2.3 Risk Characterization for the Plant Community

The data used to evaluate risks to terrestrial plants at the source areas consists of soil toxicity-test data for the floodplain soils and analyses of chemicals in source area soils and shallow groundwater. Chemical concentrations in source area soils and groundwater and results of ambient toxicity testing of floodplain soils and the plant community survey are used to assess the potential negative impacts of source area soils on plants. The goal of this assessment is to identify source areas that present hazards to plants rather than to give a detailed picture of the nature and extent of risks to terrestrial plants.

Single-chemical soil toxicity

COPECs for terrestrial plants in soil at the Bear Creek source areas were identified by comparing the maximum concentrations of contaminants detected above background in each soil aggregate with available benchmarks for toxicity to plants growing in soil (Will and Suter 1995b). Maximum soil concentrations at each source area were used for comparison with benchmarks because plants are immobile and are exposed for their lifetime to contaminants at a single location. This approach provides a conservative screening for potential risk to terrestrial plants. If both the background concentration and the toxicity benchmark were exceeded, the contaminant was identified as a COPEC. HQs were calculated by dividing each maximum concentration above background by the toxicity benchmark concentration. Benchmarks, maximum concentrations of contaminants in each soil aggregate for which benchmarks are available, and HQs are presented in Table G.34.

Toxicity benchmarks for several contaminants are below the ORR background concentrations. Analytes for which toxicity benchmarks are below background are aluminum, arsenic, chromium, cobalt, lithium manganese, mercury, molybdenum, nickel, selenium, silver, vanadium, and zinc. Background is more than four times the toxicity benchmark for aluminum, chromium, lithium, manganese, molybdenum, and vanadium. This implies that the contaminants measured in soil may not be as biologically available or as toxic as those administered in controlled toxicity tests.

At the S-3 Ponds, the maximum concentrations of arsenic, mercury, nickel, silver, vanadium, and zinc exceeded both background and the toxicity benchmark. HQs for arsenic, nickel, silver, and zinc were <10. Vanadium had a maximum HQ of 46, and at the maximum observed concentration of mercury, the HQ was 278. The mean concentrations of mercury, vanadium, and zinc were also above toxicity benchmarks.

At the BYBY, aluminum, antimony, arsenic, barium, cadmium, chromium, copper, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, tin, vanadium, and zinc exceeded both background and the toxicity benchmark. HQs for aluminum, antimony, chromium, mercury, nickel, and selenium were >100. The mean concentrations of arsenic, chromium, cobalt, lithium, manganese, molybdenum, and vanadium were within background. The mean concentrations of cobalt, lead, and tin were below their toxicity benchmarks.

In the SL/OLF aggregate, aluminum, arsenic, cadmium, cobalt, copper, lithium, manganese, mercury, nickel, silver, vanadium, and zinc exceeded both background and the toxicity benchmark. HQs for aluminum and mercury were >100. The mean concentrations of aluminum, arsenic, cobalt,

manganese, nickel, and vanadium were within background. The mean concentrations of arsenic, cadmium, and copper were below their toxicity benchmarks.

In the BG aggregate, aluminum, arsenic, chromium, lithium, manganese, mercury, nickel, selenium, silver, vanadium, and zinc exceeded both background and the toxicity benchmark. The HQ for aluminum was >100. The mean concentrations of aluminum, arsenic, chromium, lithium, manganese, mercury, nickel, selenium, silver, vanadium, and zinc were within background. The maximum chromium concentration exceeded background by ~5%. The maximum HQ for chromium was 84; however, the background concentration is >80 times the toxicity benchmark. The maximum mercury concentration at BG exceeds background by <50%. The mean concentrations of arsenic, mercury, nickel, and selenium were below their toxicity benchmarks.

The results of single-chemical soil screening at the Creekside and Bear Creek Road Site Debris Burial areas are presented in Table G.35. In the Creekside Debris Burial area soil sample, chromium, mercury, selenium, silver, and zinc exceeded both background and their toxicity benchmarks. In the Bear Creek Road Debris Burial area soil sample, barium, cadmium, copper, lead, mercury, nickel, selenium, silver, and zinc exceeded both background and their toxicity benchmarks.

The results of single-chemical soil screening for potential future exposures to S-3 Ponds sludges and the Burial Ground waste inventory are presented in Table G.35. In the S-3 Ponds sludges, boron, cadmium, chromium, lithium, mercury, molybdenum, nickel, and uranium exceeded both background and their toxicity benchmarks. Chromium, lithium, and uranium exceeded their benchmarks by >100-fold, boron by ~75-fold, and mercury, molybdenum, and nickel by <20-fold. Cadmium was <2-fold above the benchmark.

In the BG waste inventory, beryllium, lead, lithium, mercury, and uranium exceeded both background and their toxicity benchmarks. Exceedances for uranium ranged from 122 to 60,000 times the benchmark and were seen in every inventory listing except Walk-in Pit (WIP)1 (North). Beryllium and lithium exceeded benchmarks by >100-fold in BG C-East and BG C-West, while beryllium had an HQ of only 2.6 in WIP 1 (North). Lead and mercury exceeded benchmarks by >10-fold and >50-fold, respectively in WIP 1 (North).

Single-chemical soil solution toxicity

The results of single-chemical soil solution screening in the source areas are presented in Table G.36.

In wells near NT1 and NT2 only copper was found to be above background and toxicity benchmarks, with an HQ <2. Therefore, shallow groundwater contaminants that may originate from the S-3 Ponds are not likely to pose unacceptable risks to plants.

In the NT3 area, aluminum, arsenic, and lead had concentrations above background and their toxicity benchmarks. The HQ for aluminum was 15.5. Aluminum, arsenic, and lead are COPECs in shallow groundwater contaminants that may originate in the BYBY.

In the NT4 area, aluminum, chromium, cobalt, iron, lead, and manganese had concentrations above background and their toxicity benchmarks. HQs ranged from 1.5 (for cobalt) to 215 (for aluminum). These contaminants are retained as COPECs in shallow groundwater contaminants that may originate in the SL/OLF.

In the NT6 area, aluminum, chromium, and lead had concentrations above background and their toxicity benchmarks. HQs ranged from 1.2 (for chromium) to 16 (for aluminum). These contaminants are retained as COPECs in shallow groundwater contaminants that may originate in the BG area and expose plants near NT6.

In the NT7 area lead had concentrations above background and their toxicity benchmarks. The maximum HQ for lead was 26.5. Lead is retained as the sole COPEC in shallow groundwater contaminants that may originate in the BG area and expose plants near NT7.

In the NT8 area, aluminum, copper, iron, and lead had concentrations above background and their toxicity benchmarks. HQs ranged from 3.3 (for iron) to 132 (for copper). These contaminants are retained as COPECs in shallow groundwater contaminants that may originate in the BG area and expose plants near NT8.

In the BG area away from the tributaries, none of the contaminants were above background and a toxicity benchmark.

Risks to plants from predicted future concentrations of contaminants in groundwater are presented in Section G.5.1.3.

Ambient soil toxicity

Ambient soil toxicity studies were done on soil samples from the floodplain transects rather than on source area soils. For most contaminants, the concentrations in floodplain soils were below the maximum values at the source areas. Therefore, ambient soil toxicity test results do not provide useful information to interpret the results of single-chemical soil toxicity screening.

Vegetation survey

The first vegetation survey (Rosensteel 1995, supporting data) did not identify any areas where damage to vegetation could be attributed to contaminants from the source areas. Most visible damage appears to have resulted from overgrowth of vines or from construction that has caused flooding of tributary floodplain areas.

Locations potentially impacted by SRCs in the source areas were surveyed (Rosensteel 1996 supporting data). These areas consisted of a vegetated area south of the S-3 Ponds, the area surrounding the lower portion of NT-2, portions of the BYBY, portions of the BCBG, and the Roadside Debris Burial area. No dead or obviously stressed vegetation was reported in any of these areas, except that in a seep on the north edge of the HCDA there were a number of black willows that had died back and were sending out new vegetation. Therefore, it appears that in that seep, intermittent exposure to SRCs may be toxic to vegetation, but in the rest of BYBY and in the other source areas there is no evidence of toxicity from exposure to SRCs.

Weight of evidence for plants

A summary of the weight of evidence findings for soil exposures is presented in Table G.37. The weight of evidence evaluation is used to interpret the results of soil contaminant screening in light of ambient soil toxicity tests and the vegetation survey. Because the maximum concentrations of contaminants in source area soils were higher than those used in ambient soil toxicity testing, the ambient testing results could not be used to exclude COPECs as COCs. Although the vegetation survey was

designed to detect obvious toxicity to plant communities in areas where potential contaminant exposure is high, the survey did not include all parts of the source areas, and effects of the maximum concentrations of contaminants may not have been evaluated by the survey. Therefore, the negative results of the vegetation survey cannot be used reliably to exclude COPECs as COCs where the survey was not done.

COPECs in the S-3 Ponds soils are arsenic, mercury, nickel, silver, vanadium, and zinc. The maximum arsenic concentration exceeded background by <5%, suggesting that exposure to arsenic at the site does not contribute significantly to risks to plants. The maximum concentrations of all other contaminants are significantly above both background and toxicity benchmarks. However, the vegetation surveys found no evidence of dead or stressed vegetation in the area. Therefore, there is no evidence that SRCs in soil pose a risk to plant populations at the S-3Ponds.

COPECs in the BYBY soils are aluminum, antimony, arsenic, barium, cadmium, chromium, copper, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, tin, vanadium, and zinc. Aluminum is a major component of clay soils and is probably not biologically available at the concentrations indicated by analytical results. Therefore, aluminum is not retained as a COC. The maximum concentrations of all other contaminants are significantly above both background and toxicity benchmarks. However, the vegetation surveys found no evidence of dead or stressed vegetation in the area. Therefore, there is no evidence that SRCs in soil pose a risk to plant populations at the BYBY.

COPECs in the SL1/OLF soils are aluminum, arsenic, cadmium, cobalt, copper, lithium, manganese, mercury, nickel, silver, vanadium, and zinc. Aluminum is not retained as a COC. The maximum concentrations of all other contaminants are significantly above both background and toxicity benchmarks. However, the vegetation surveys found no evidence of dead or stressed vegetation in the area. Therefore, there is no evidence that SRCs in soil pose a risk to plant populations at SL1/OLF.

COPECs in the BCBG area soils are aluminum, arsenic, chromium, lithium, manganese, mercury, nickel, selenium, silver, vanadium, and zinc. Aluminum is not retained as a COC. The maximum mercury concentration is <50% above background and the HQ is 1.6, suggesting that mercury exposure does not contribute significantly to risks to plants at the BG area. The maximum concentrations of all other contaminants are significantly above both background and toxicity benchmarks. However, the vegetation surveys found no evidence of dead or stressed vegetation in the area. Therefore, there is no evidence that SRCs in soil pose a risk to plant populations at the BCBG area.

COPECs in the Creekside Debris Burial area soils are chromium, mercury, selenium, silver, and zinc. The concentrations of all these contaminants are significantly above both background and toxicity benchmarks. However, the vegetation surveys found no evidence of dead or stressed vegetation in the area. Therefore, there is no evidence that SRCs in soil pose a risk to plant populations at the Creekside Debris Burial area.

COPECs in the Bear Creek Road Debris Burial area soils are barium, cadmium, copper, lead, mercury, nickel, selenium, silver, and zinc. The lead HQ is 1.03, suggesting that LEAD exposure does not contribute significantly to risks to plants at this burial area. The concentrations of all other contaminants are significantly above both background and toxicity benchmarks. However, concentrations of COPECs in this debris are not higher than at sites where no adverse impact to plant populations was observed. Therefore it is unlikely that SRCs in soil at this site pose a risk to plant populations.

COPECS in the S-3 Ponds sludges are boron, cadmium, chromium, lithium, mercury, molybdenum, nickel, and uranium. The cadmium HQ is 1.63, suggesting that cadmium exposure would not contribute significantly to future risks to plants at this site, especially considering the mixing of sludges with soil that would be expected if the site's cap were to be lost and habitat for plants were restored. The concentrations of all other contaminants are significantly above both background and toxicity benchmarks. Therefore, boron, chromium, lithium, mercury, molybdenum, nickel, and uranium are retained as COCs for potential future exposure of plants in the S-3 Ponds sludges.

COPECS in the Burial Grounds waste inventory are beryllium, lithium, lead, mercury, and uranium. The beryllium HQ at WIP 1 (North) is 2.6, suggesting that beryllium exposure would not contribute significantly to risks to plants at this site, especially considering the mixing of wastes with soil that would be expected if the site's cap were to be lost and habitat for plants were restored. However, beryllium is significantly above background and toxicity benchmarks in BG C-East and BG C-West. The concentrations of all other contaminants are significantly above both background and toxicity benchmarks in multiple locations. Therefore, beryllium, lithium, lead, mercury, and uranium are retained as COCs for potential future exposure of plants in the BG waste inventory.

A summary of the weight of evidence findings for soil solution exposures is presented in Table G.38. Because the vegetation survey was intended to evaluate the results of potential exposures of plants to contaminants in shallow groundwater, the results of the survey can be used in the weight of evidence evaluation to interpret the results of soil contaminant screening.

Copper was the single COPEC for shallow groundwater at the S-3 Ponds area. However, the HQ was 1.6, and the vegetation surveys provided no evidence of adverse impact to plant populations from SRCs in the vicinity of NT-1 and NT-2. Therefore, there is no evidence that SRCs in shallow groundwater pose a risk to plant populations in the S-3 Ponds area.

COPECs in shallow groundwater in the BYBY near NT-3 were aluminum, arsenic, and lead. No ambient toxicity testing of soil solutions was done. The vegetation surveys provided no evidence of adverse impact to plant populations from SRCs in the vicinity of NT-3, but there were indications of possible toxicity in a seep at the north edge of the HCDA. Therefore, it is possible that there is intermittent toxicity to plant populations at the seep, but it is unlikely that shallow groundwater near NT-3 poses a risk to plant populations at the BYBY.

There were no analytes above background in shallow groundwater in the SL 1/OLF near NT-4. Therefore, there is no evidence that SRCs in shallow groundwater pose a risk to plant communities in the SL 1/OLF area near NT-4.

COPECs in shallow groundwater in the BCBG near NT-6 were aluminum, chromium, and lead. No ambient toxicity testing of soil solutions was done, nor was a vegetation survey done at this location. The concentration of aluminum was nearly the same as at NT-3, and the concentrations of aluminum and lead were less than at NT-8, where no evidence of dead or stressed vegetation was found in the vegetation survey. Therefore, it is possible but unlikely that COPECs in shallow groundwater pose a risk to plants should their roots contact the shallow groundwater near NT-6.

Lead was the single COPEC for shallow groundwater near NT-7 at the BCBG. However, concentration of lead was lower than near NT-8, where the vegetation surveys provided no evidence of adverse impact to plant populations from SRCs. Therefore, it is possible but unlikely that SRCs in shallow groundwater pose a risk to plant populations near NT-7 in the BCBG.

COPECs in shallow groundwater in the BCBG near NT-8 were aluminum, copper, iron, and lead. No ambient toxicity testing of soil solutions was done. However, the vegetation surveys provided no evidence of adverse impact to plant populations from SRCs in the vicinity of NT-8. Therefore, there is no evidence that SRCs in shallow groundwater pose a risk to plant populations near NT-8 in the BCBG.

There were no SRCs above both background and a toxicity benchmark in a shallow groundwater aggregate at the BCBG, and the vegetation surveys provided no evidence of adverse impact to plant populations from SRCs in the BCBG. Therefore, although there may be some risk to plants near NT-6, there is no evidence that SRCs in shallow groundwater pose a risk to plant populations at the BCBG in general.

G.5.3 UNCERTAINTIES CONCERNING RISKS TO PLANTS

The following factors create uncertainty in assessing the risk posed by the contaminants of potential concern in the BCV soils, seeps, and underlying groundwater plume:

- **Bioavailability of elements in soil.** The extraction methods used may remove from the soil quantities of chemicals greater than are available to plants. The double-acid extraction removes the exchangeable fraction of metals, thereby giving a concentration that reflects the total potential pool of contaminants, not that to which the plant is exposed at any one time. Under field conditions these contaminants will be in the soil solution and available for uptake in concentrations reflecting a dynamic equilibrium between the solid and liquid phase. Therefore, it is difficult to assess the types of interactions between contaminants and between contaminants and plant roots that may occur under field conditions at the site from the reported soil metal concentrations. This is confounded by the concentration- and species-dependent synergistic and antagonistic interactions between metals during uptake by roots and inside plants.
- **Bioavailability of elements in groundwater and springs.** Concentrations of contaminants in whole, unfiltered groundwater are probably higher than the concentrations bioavailable to plants. In unfiltered water samples (i.e., containing soil and organic particles), acidification will bring into solution metals strongly bound to this particulate matter. No background contaminant concentrations were available for comparison with filtered well data. Differences between maximum contaminant concentrations in filtered and unfiltered groundwater indicates that the bioavailability of chemicals in the two samples is probably quite different.
- **Variable response to toxicants.** Various plant species and plant growth stages tolerate contaminants to different extents. The literature from which benchmarks were derived is not based on experiments using plants found in ecosystems representative of BCV. It is difficult to extrapolate from largely agricultural crops in early growth stages used in most of the published literature to trees and the varied ground vegetation found in BCV.
- **Multiple-contaminant exposure.** Because of our lack of understanding of the complex interactions between contaminants, benchmark levels are necessarily derived from experiments in which plants are exposed to single contaminants. Typical soils of BCV expose plants to multiple contaminants that may not be adequately assessed on the basis of literature-derived benchmarks.
- **Lack of benchmarks for some metals and most organic compounds.** Little research has been conducted on the phytotoxic effects of the organic compounds. Thus, it is not possible to assess the risk to plant growth posed by some of the analytes found in the BCV soils.

- **Adequacy of reference soils.** Reference soils were generally more "toxic" than nonreference soils. These upland sites were apparently inappropriate matches for the contaminated sites in particle size and chemistry. Nutrient differences may have interfered with observed toxic effects in contaminated soil.
- **Representativeness of groundwater wells.** Several shallow groundwater wells at sites upland from the floodplain were used to assess risks to plants in the floodplain. A comparison of risks with plants in various regions of the floodplain was impossible, given the lack of knowledge of the variability in plume depth and contaminant concentration across the floodplain.
- **Chemical speciation.** The analytical techniques did not differentiate among species of chemicals, such as mercury, present in the soil that have variable toxicity to plants.
- **Adequacy of vegetation survey.** The vegetation survey was performed in November; thus, a large portion of vegetation was dormant. Also, the survey was qualitative and unstructured, such that plant community diversity and the presence of specific species were not ascertained.

G.6 RISKS TO WILDLIFE FROM CHEMICALS

Risks from organic and inorganic chemical contaminants were estimated for small mammals, piscivores, and wide-ranging species in BC OU 1 and within the BCV watershed as a whole. Because they are highly mobile and may travel throughout the watershed, risks to piscivores and wide-ranging species were evaluated at a watershed level only. Due to their more limited spatial requirements, risks to small mammals were evaluated both within BC OU 1 and BCV. Risks to T&E species that may occur within the BCV watershed (e.g., northern pine snake, cooper's and sharp-shinned hawks) were estimated based upon risks to the most closely related surrogate species.

G.6.1 EXPOSURE ASSESSMENT

Wildlife may be exposed to contaminants through ingestion of food, soil, and water. In this assessment, exposure through ingestion of food and soil was estimated using exposure models (described in the following text). Exposure through ingestion of water was not modeled; water exposure was assessed by comparing unfiltered water concentrations with water benchmarks for wildlife (refer to Sect. G.6.3). Contaminant exposure through ingestion was estimated for small mammals (short-tailed shrew and white-footed mice), wide-ranging species (white-tailed deer, red-tailed hawk, and red fox) and piscivores (mink and belted kingfisher). Exposure estimates were calculated for using soil and terrestrial biota data (small mammals, earthworms, and herbaceous, canopy, and browse vegetation) from 15 locations within the Bear Creek watershed (4 within BC OU 1 and 13 within the Bear Creek floodplain) and fish data from 5 locations in Bear Creek.

G.6.1.1 Oral Ingestion Exposure Model

Oral exposure to contaminants experienced by wildlife may come from multiple sources. They may consume contaminated food (either plant or animal), drink contaminated water, or ingest soil or sediment. Soil or sediment ingestion may be incidental while foraging or grooming or purposeful to meet nutrient needs. The total oral exposure experienced by an individual is the sum of the exposures attributable to each source and may be described as:

$$E_{total} \approx E_{food} + E_{water} + E_{soil}, \quad (1)$$

Where

- E_{total} = total exposure from all pathways,
- E_{food} = exposure from food consumption,
- E_{water} = exposure from water consumption,
- E_{soil} = exposure from soil consumption.

Because exposure from water is being addressed separately (refer to Sect. G.6.3), Eq. 2 may be modified to read as follows:

$$E_{total} \approx E_{food} + E_{soil}. \quad (2)$$

For exposure estimates to be useful in the assessment of risk to wildlife, they must be expressed in terms of a body weight-normalized daily dose or mg contaminant per kg body weight per day (mg/kg/d).

Exposure estimates expressed in this manner may then be compared with toxicological benchmarks for wildlife, such as those derived by Opresko, Sample, and Suter (1995), or to doses reported in the toxicological literature. Estimation of the daily contaminant dose an individual may receive from a particular medium for a particular contaminant may be calculated using the following equation:

$$E_j = \sum_{i=1}^m p_{ik} \left(\frac{IR_i \times C_{ijk}}{BW} \right), \quad (3)$$

where

- E_j = total exposure to contaminant (j) (mg/kg/d),
- m = total number of ingested media (e.g., food or soil),
- IR_i = consumption rate for medium (I) (kg/d or L/d),
- p_{ik} = proportion of type (k) of medium (I) consumed (unitless),
- C_{ij} = concentration of contaminant (j) in type (k) of medium (I) (mg/kg or mg/L),
- BW = body weight of endpoint species (kg).

Exposure estimates were calculated for all contaminants detected in soil or biota from the Bear Creek watershed. Because wildlife are mobile, their exposure is best represented by the mean contaminant concentration in media. To be conservative, the UCL95 is used in exposure estimates. These data were used in the initial exposure estimates. Exposure estimates for contaminants that may potentially present a risk to wildlife (based upon comparisons to NOAELs and LOAELs) were recalculated using Monte Carlo simulations. (Note: because the purpose of the initial exposure estimate is to be conservative and to identify COPECs, the UCL95 was used regardless of whether or not the value exceeded the maximum observed value. Overestimates of exposure that may occur at the screening level are addressed through the use of Monte Carlo simulation.)

G.6.1.2 Fillet-to-Whole Fish Ratios

Fish data from Bear Creek consisted of analyses of both whole body concentrations in stonerollers and concentrations in rock bass and redbreast sunfish fillets. Because piscivores consume whole fish (not fillets) and fillet concentrations do not accurately represent whole body concentrations, contaminant-specific fillet-to-whole fish ratios reported in Sample, Baron, and Jackson (1995) were used to estimate the whole-body contaminant concentration in fish for which only fillet analyses were performed.

G.6.1.3 Soil Biota Uptake Factors

Contaminant concentrations were not available for all biota types at all locations within the watershed. To estimate contaminant concentrations in biota, uptake factors were developed from the biota data collected for this assessment. Uptake factors were derived by dividing the contaminant concentration in the biota by the soil concentration in the 0–16-in. depth range at the same location. Summary statistics for the biota uptake factors are presented in Table G.39. Contaminant concentrations in media at locations where these data were not collected were estimated by multiplying the biota type-specific uptake factor by the soil concentration in the 0–16-in. depth range.

G.6.1.4 Contaminant Concentrations in Media

Contaminant concentrations in soil and biota are needed to estimate exposure. Summary statistics (including UCL95s) for contaminants detected in soil and biota from Bear Creek are presented in Tables G.40–G.48.

G.6.1.5 Exposure Modeling Using Point Estimates

Initial estimates of exposure of piscivorous wildlife to contaminants were performed for each sampling point using point estimates of parameters in the exposure model (Eq. 3). Measured biota contaminant concentrations were used for all locations for which these data were available. Contaminant concentrations in biota at locations where data were not collected were estimated by multiplying the medium-specific uptake factor by the soil concentration in the 0–16-in. depth range. Soil exposure was estimated using soil concentration data in the 0–4-in. depth range. Species-specific parameters necessary to estimate exposure using Eq. 1 are listed in Tables G.49–G.55.

To estimate contaminant exposure experienced by short-tailed shrew, the following assumptions were made:

- Body weight = 0.015 kg.
- Food consumption = 0.009 kg/d (fresh wt).
- Soil consumption = 0.00117 kg/d (dry wt).
- Diet consists 100% of earthworms or soil invertebrates.
- Contaminant concentration in earthworms is representative of that in other invertebrate prey.

To estimate contaminant exposure experienced by white-footed mouse, the following assumptions were made:

- Body weight = 0.022 kg.
- Food consumption = 0.0034 kg/d (fresh wt).
- Soil consumption = 0.000068 kg/d (dry wt).
- Diet consists 50% of earthworms or soil invertebrates and 50% of herbaceous plant material.
- Contaminant concentration in earthworms is representative of that in other invertebrate prey.

To estimate contaminant exposure experienced by white-tailed deer, the following assumptions were made:

- Body weight = 56.5 kg.
- Food consumption = 1.74 kg/d (fresh wt).
- Soil consumption = 0.0348 kg/d (dry wt).
- Diet consists 33% of browse plants, 33% canopy plants, and 33% herbaceous plant material.

To estimate contaminant exposure experienced by red fox, the following assumptions were made:

- Body weight = 4.5 kg.
- Food consumption = 0.45 kg/d (fresh wt).
- Soil consumption = 0.0126 kg/d (dry wt).
- Diet consists 80.8% of small mammals and birds, 10.4% browse plant material, and 8.8% earthworms or other invertebrates.

- Contaminant concentration in small mammals is representative of that in other vertebrate prey.
- Contaminant concentration in earthworms is representative of that in other invertebrate prey.

To estimate contaminant exposure experienced by red-tailed hawk, the following assumptions were made:

- Body weight = 1.126 kg.
- Food consumption = 0.109 kg/d (fresh wt).
- Soil consumption = 0 kg/d (dry wt).
- Diet consists 100% of small mammals and other vertebrates.
- Contaminant concentration in small mammals is representative of that in other vertebrate prey.

To estimate contaminant exposure experienced by mink, the following assumptions were made:

- Body weight = 1 kg.
- Food consumption = 0.137 kg/d (fresh wt).
- Diet consists 54.6% of fish or other aquatic prey and 45.4% small mammals.
- Contaminant concentration in fish is representative of that in other aquatic prey.

To estimate contaminant exposure experienced by kingfisher, the following assumptions were made:

- Body weight = 0.148 kg.
- Food consumption = 0.075 kg/d (fresh wt).
- Diet consists 100% of fish.

Using Eq. 3 and the assumptions and data described in the previous text, point estimates of exposure to contaminants were estimated for each endpoint (Tables G.56–G.62). Exposure estimates for all analytes detected in samples at the background location are also presented in Tables G.56–G.62.

G.6.1.6 Exposure Modeling Using Monte Carlo Simulations

Employing point estimates for the input parameters in the exposure model does not take into account the variation and uncertainty associated with the parameters and therefore may over- or underestimate the contaminant exposure that endpoints may receive. In addition, calculating the model using point estimates produces a point estimate of exposure. This estimate provides no information concerning the distribution of exposures or the likelihood that individuals within the watershed will actually experience potentially hazardous exposures. To incorporate the variation in exposure parameters and to provide a better estimate of the potential exposure experienced by wildlife in the BCV, the exposure model was recalculated using Monte Carlo simulations.

Monte Carlo simulation is a resampling technique frequently used in uncertainty analysis in risk assessment (Hammonds, Hoffman, and Bartell 1994). In practice, distributions are assigned to input parameters in a model and the model is recalculated many times to produce a distribution of output parameters (e.g., estimates of contaminant exposure). Each time the model is recalculated, a value is selected from within the distribution assigned for each input parameter. As a result, a distribution of exposure estimates is produced that reflects the variability of the input parameters.

For small mammals (short-tailed shrews and white-footed mice), Monte Carlo simulations were performed on the mean exposure (mean of all sampling locations) for the BC OU 1 and for the entire BCV. For the other endpoints, Monte Carlo simulations were performed for the entire BCV. The percentiles of the resulting exposure distributions represent the likelihood that individuals within the modeled area will experience a given exposure level. For small mammals, deer, fox, hawks, and exposure of mink to contaminants in small mammals, it was also assumed that each sampling location contributed equally to the overall mean exposure (i.e., individuals within each watershed do not preferentially forage at any one location within the watershed). While this assumption is not likely to be ecologically correct (foraging effort and, therefore, exposure is likely to be biased toward locations with the most abundant food), data were not available to estimate the preferential use at each sampling location.

It was assumed that mink and kingfisher would forage preferentially at locations with the greatest biomass of fish. Therefore, exposure of mink and kingfisher to contaminants in fish were weighted by the mean biomass of fish observed at the sampling locations in spring and fall of 1993 (Table G.63).

Simulations were performed for each contaminant where comparison of point estimates of exposure to LOAELs produced HQs ≥ 1 for at least one location (LOAELs are presented in Sect. G.6.2.; screening of exposure estimates against LOAELs is presented in Sect. G.6.3.).

Distributions were used for the following parameters in the exposure model: contaminant concentrations in soil and biota, and soil-biota uptake factors. All distributions were assumed to be normal. Because these wildlife are mobile, the contaminant concentration they are exposed to on a daily basis is best represented by the average concentration instead of the entire distribution. The standard error of the mean was used to describe variation in the average contaminant concentration. Means and standard errors for contaminants in soil and biota, and for the soil uptake factors are presented in Tables G.39–G.48.

Monte Carlo simulations were performed using the @Risk software. Samples from each distribution were selected using Latin hypercube sampling. The number of iterations, or recalculations, of each exposure simulation was determined by the convergence criteria set in the software. Under these criteria, iterations are performed until the between-iteration percent change in the percentiles, mean, and standard deviation are below 1.5% (i.e., the percentile, mean, and standard deviation for the latest iteration is <1.5% different than the those from the previous iteration). Using this convergence criteria, from 600 to 2500 model iterations were performed for each exposure estimate. Monte Carlo estimates of contaminant exposures are presented in Table G.64.

G.6.2 CHEMICAL EFFECTS ASSESSMENT FOR WILDLIFE

G.6.2.1 Single-Chemical Toxicity Data

Single-chemical toxicity data consist of NOAELs and LOAELs of toxicity studies reported in the literature.

In cases where a NOAEL for a specific chemical was not available, but a LOAEL had been determined experimentally or where the NOAEL was from a subchronic study, the chronic NOAEL was estimated. EPA (1993d) suggests the use of uncertainty factors of 1 to 10 for subchronic to chronic NOAEL and LOAEL to NOAEL estimation. Because no data were available to suggest the use of lower values, uncertainty factors of 10 were used in all instances in which they were required.

Smaller animals have higher metabolic rates and are usually more resistant to toxic chemicals because of more rapid rates of detoxification. In mammals, it has been shown that metabolism is best expressed in terms of body weight (bw) raised to the 3/4 power ($bw^{3/4}$) (EPA 1995). If the dose (d) itself has been calculated in terms of unit body weight (i.e., mg/kg), then the metabolic rate-based dose (D) equates to

$$D = \frac{d \times bw}{bw^{3/4}} = d \times bw^{1/4}. \quad (4)$$

Mineau (1996) reports that the mean allometric scaling factor for chemical toxicity to birds is 1.15 and may range as high as 1.55. Because the allometric scaling factors for the majority of the chemicals evaluated were not significantly different from 1, 1 was used as the best estimate of the allometric scaling factor for birds. If the dose (d) itself has been calculated in terms of unit body weight (i.e., mg/kg), then the dose per unit body surface area (D) equates to

$$D = \frac{d \times bw}{bw^1} = d \times bw^0. \quad (5)$$

The assumption is that the effective dose per body surface area for species "a" and "b" would be equivalent. Therefore, knowing the body weights of two species and the dose (d_b) producing a given effect in species "b," the dose (d_a) producing the same effect in species "a" can be determined. Using this approach, if a NOAEL were available for a mammalian test species ($NOAEL_t$), the equivalent NOAEL for a mammalian wildlife species ($NOAEL_w$) was calculated by using the adjustment factor for differences in body size:

$$NOAEL_w = NOAEL_t \left(\frac{bw_t}{bw_w} \right)^{1/4}. \quad (6)$$

For birds, if a NOAEL were available for an avian test species ($NOAEL_t$), the equivalent NOAEL for an avian wildlife species ($NOAEL_w$) would be calculated by using the adjustment factor for differences in body size:

$$NOAEL_w = NOAEL_t \left(\frac{bw_t}{bw_w} \right)^0 = NOAEL_t (1) = NOAEL_t. \quad (7)$$

This methodology for toxicity extrapolation is equivalent to that the EPA uses in its carcinogenicity assessments and Reportable Quantity documents for adjusting from animal data to an equivalent human dose.

To evaluate the potential risk that contaminants in water may present, water benchmarks were derived. Water benchmarks represent the concentration of a contaminant in water (C_w , in mg/L) that would result in a dose equivalent to a $NOAEL_w$ or $LOAEL_w$ and may be calculated from the daily water consumption rate (W, in L/d) and the average body weight (bw_w) for the species:

$$C_w = \frac{NOAEL_w \times bw_w}{W}. \quad (8)$$

Water consumption rates for all endpoint species are listed in Tables G.49–G.55.

NOAELs and LOAELs and water benchmarks were derived for all seven endpoints. Experimental information used to estimate mammalian benchmarks and NOAELs and LOAELs for mammalian endpoints are presented in Tables G.65 and G.66. NOAELs and LOAELs for avian endpoints are listed in Table G.67. Water benchmark values for all endpoints are listed in Table G.68. Ecotoxicological profiles of the effects of antimony, cadmium, chromium, mercury, molybdenum, PCBs, selenium, and vanadium are presented in Supporting Information.

G.6.2.2 Biological Surveys

Mink survey

Stevens (1995) investigated bioaccumulation of mercury in mink on the ORR in 1993 through 1995. The methods used in the mink survey, while indicating that mink are present on the Reservation, cannot be used to estimate abundance or density of mink on the ORR. Four male mink were live-trapped over the course of 6,073 trap nights (trap night = 1 trap set for 24 h). One juvenile was captured along EFPC, two adults were captured along Bear Creek, and one adult was captured along White Oak Creek. Captured mink were fitted with an intraperitoneal radio transmitter (to monitor movements and home range) and released. Before release, samples of hair were collected and metals analysis was done. An additional eight road kill mink (five male and three female) were collected from the ORR and surrounding areas of Roane and Anderson counties. While one road kill sample (a male) was collected on a bridge over Bear Creek and was assumed to be a resident of Bear Creek, all others were collected off the ORR and were used as references.

Results of metals analysis are presented here.

Metal concentrations in hair of mink from the ORR and from off-site reference samples^a

Site	N	Hg	Se	As	Cd	Pb
EFPC	1	104	0.69	ND ^b	ND	0.33
Bear Creek	3	10.97±3.42	1.88±1.41	0.15±0.09	0.04±0.02	0.97±1.28
White Oak Creek	1	8.8	1	ND	ND	0.37
Off site	7	5.15±3.43	1.11±0.25	0.22±0.31	0.04±0.02	0.7±0.31

^a Mean ± standard deviation mg/kg dry wt.

^b ND = Not Detected.

Radiotelemetry data on home ranges and movements were obtained for three mink—one each from the EFPC, Bear Creek, and White Oak Creek watersheds. Mean (± standard deviation) home range for these three individuals was found to be 7.5±3 km of stream. The entire home range of the EFPC mink was in a highly urbanized area; it included all of upper East Fork inside the Y-12 Plant and all areas of East Fork upstream of the Oak Ridge Turnpike-Illinois Avenue intersection. The home range of the White Oak Creek mink included all of White Oak Creek from the headwater tributaries to the Clinch River, including the ORNL facility. This individual was observed to use dens within the ORNL facility and moved through the facility on several occasions.

G.6.3 CHARACTERIZATION OF CHEMICAL RISKS TO WILDLIFE

Risk characterization integrates the results of the exposure assessment (Sect. G.6.1) and effects assessment (Sect. G.6.2) to estimate risks (the likelihood of effects given the exposure) based on each line of evidence, and then applies a weight of evidence inference logic to determine the best estimate of risk to each assessment endpoint. In an ideal risk assessment, three lines of evidence exist: literature-derived single-chemical toxicity data (which indicate the toxic effects of the concentrations measured in site media), biological surveys of the affected system (these indicate the actual state of the receiving environment), and toxicity tests with ambient media (these indicate the toxic effects of the concentrations measured in site media). With the exception of the biosurvey data for mink (Sect. G.6.2.2), only one line of evidence was available to assess risk to wildlife in the BCV—that is single-chemical toxicity data.

Procedurally, the risk characterization is performed for each assessment endpoint by (1) screening all measured contaminants against toxicological benchmarks and background concentrations (if available), (2) estimating the effects of the contaminants retained by the screening analysis, (3) estimating the toxicity of the ambient media based on the media toxicity test results, (4) estimating the effects of exposure on the endpoint biota based on the results of the biological survey data, (5) logically integrating the lines of evidence to characterize risks to the endpoint, and (6) listing and discussing the uncertainties in the assessment. A detailed discussion of methods and the approach to risk characterization on the ORR is presented in Suter et al. (1995).

G.6.3.1 Single-Chemical Toxicity Data

Exposure estimates generated by the exposure model (refer to Sect. G.6.1.1) produced by both point estimates of parameter values and Monte Carlo simulation represent exposure at the individual level. The exposure estimates using point estimates of parameter values at each individual sampling point are used to identify COPECs and locations that contribute significantly to risk. In contrast, the BCV-level and BC OU 1-level exposure distributions generated by Monte Carlo simulation represent the likelihood that an individual within the area for which exposure is modeled will experience a particular exposure.

Two types of single-chemical toxicity data are available with which to evaluate wildlife contaminant exposure: NOAELs and LOAELs. NOAELs are used to screen exposure estimates generated from point-estimates of exposure parameters; if the estimate is >NOAEL, adverse effects are possible and additional evaluation is necessary. LOAELs are compared with the exposure distribution generated by the Monte Carlo simulation. If the LOAEL is lower than the 80th percentile of the exposure distribution, there is a >20% likelihood that individuals within the modeled location are experiencing contaminant exposures that are likely to produce adverse effects. By combining measured or literature-derived population density data with the likelihood or probability of exceeding the LOAEL, the magnitude of population-level impacts may be estimated.

Screening point estimates of exposure: food and soil

To determine if the contaminant exposures experienced by wildlife in BC OU 1 and throughout the BCV are potentially hazardous, the dietary contaminant exposure estimates (generated using point estimates of parameter values; Tables G.56–G.62) were compared with estimated NOAELs and LOAELs for these species (Tables G.66 and G.67). To quantify the magnitude of hazard, an HQ was calculated where $HQ = \text{exposure}/\text{NOAEL or LOAEL}$. HQs >1 indicate that individuals may be experiencing exposures that are in excess of NOAELs or LOAELs. While exceeding the NOAEL suggests that adverse effects are possible, exceeding the LOAEL suggests that adverse effects are likely. HQs for all endpoints are presented along with the point estimates of exposure in Tables G.56–G.62.

Exposure of shrews (Table G.56), mice (Table G.57), deer (Table G.58), and fox (Table G.59) to aluminum exceeded both NOAELs and LOAELs at all locations, including the background. Comparison of background exposure to aluminum with that estimated for shrews, mice, deer, and fox in BCV indicates that aluminum exposure at background is greater than that in BCV for most locations. BCV aluminum exposures at locations where background exposure was exceeded ranged from 1.05 to 4.5 times greater than background. It is highly unlikely that the aluminum exposures estimated within BC OU 1 and within BCV are toxic and present a hazard to wildlife. This is for several reasons. Aluminum is a common and abundant structural element in soil whose most common forms are unlikely to be bioavailable and therefore toxic; most BCV exposures to aluminum were less than that observed at background; and exposures that exceeded background did not dramatically exceed background.

The spatial distribution of contamination and potential risks to wildlife in BCV are illustrated in Figs. G.50–G.56. These figures display the sum of the LOAEL-based HQs (e.g., Σ TUs) for those contaminants where at least one LOAEL-based HQ >1 was obtained. Sampling locations were arranged in order from upstream to downstream. Aluminum has been excluded. For almost all endpoint species, risks are highest near the headwaters of Bear Creek, near BC OU 1, and decline with increasing distance from BC OU 1. The greatest risks are consistently associated with both the Creek side and Bear Creek Roadside debris burial areas. The spatial patterns of contaminant risk were comparable for many of the endpoint species.

Antimony, cadmium, chromium, copper, mercury, and PCBs account for the majority of risk to short-tailed shrews (Fig. G.50); additional contaminants that present risks include arsenic, barium, lead, molybdenum, nickel, selenium, and zinc (Fig. G.50). Risk peaks were observed at the S-3 ponds (mercury), the Creekside Debris area (mercury and chromium), the Roadside Debris area (cadmium, chromium, copper, and mercury), the BYBY (antimony and mercury), the OLF (mercury), TS03 (molybdenum, chromium, and selenium), the BCBG (PCBs and chromium), TS04 (molybdenum, chromium, and arsenic), TS07 (molybdenum and chromium), and TS10 (PCBs) (Fig. G.50).

The primary contaminants presenting risks to white-footed mice were mercury (at S-3 Ponds, Creek side debris area, and OLF), copper (at the Roadside debris area), molybdenum (at TS03), PCBs (at TS10), and chromium (at TS03 and TS07) (Fig. G.51). Only three contaminants, antimony (BYBY), copper (at the Roadside debris area), and mercury (S-3 Ponds, Creek side area, and BYBY) significantly contributed to risk to white-tailed deer (Fig. G.52). Mercury (S-3 Ponds, TS01, Creek side and Roadside areas, BYBY, and OLF), antimony (BYBY), copper (at Roadside area, OLF, BCBG, and TS04), and PCBs (BCBG and TS04) present significant risks to red fox (Fig. G.53). Three contaminants, mercury (S-3 Ponds, Creek side and Roadside areas, and OLF), copper and zinc (Roadside area) presented a risk to red-tailed hawks (Fig. G.54). Among mink, the primary risks were from mercury in fish at BCK 0.6 (Fig. G.55a) and mercury (S-3 Pond, Creek side and Roadside areas, and OLF), copper (at the Roadside area, OLF and TS04), in small mammals (Fig. G.55b).

PCBs and mercury at BCK 0.6 and 4.5 present the greatest risk to belted kingfisher (Fig. G.56). The pattern of risk observed for kingfisher is likely to be an artifact of the data. Data from BCK 0.6 and 4.5 consisted exclusively of sunfish (rock bass and redbreast), while data from BCK 3.3, 9.4, and 12.4 were exclusively stonerollers. The differences in body burdens are likely related to food habits of the fish and species-specific PCB and mercury uptake kinetics and not to a particular contaminant source.

Screening point estimates of exposure: surface water

To evaluate the potential risk that contaminants in surface water present to wildlife, the UCL95s for concentrations in unfiltered water were compared with NOAEL and LOAEL water benchmarks for all

species. HQs (water concentration/benchmark value) were calculated for all species. Comparisons with NOAEL and LOAEL benchmarks are presented in Tables G.69 and G.70, respectively.

Only one contaminant (aluminum) at two locations (BCK 9.4 and NT6) exceeded the NOAEL benchmark (Table G.69). At BCK 9.4, the NOAEL benchmark was exceeded for mice, mink, fox, and deer. At NT6 the NOAEL benchmark was exceeded for deer only. No other NOAEL (Table G.69) or LOAEL (Table G.70) benchmarks were exceeded. Most HQs ranged from 10^{-2} to 10^{-3} or greater, indicating minimal contribution of surface water to wildlife risks in BCV.

Screening Monte Carlo simulation estimates of exposure

To incorporate the variation present in the parameters employed in the exposure model, Monte Carlo simulations were performed for the exposure estimates of each species to analytes where at least one LOAEL-based HQ >1 was observed. For small mammals (shrews and mice), simulations were performed for BC OU 1 and for the BCV (including BC OU 1). For all other endpoints, simulations were performed only at the BCV level. For comparison, simulations of exposure at the reference location were performed for all endpoints and contaminants where LOAEL HQs >1 were observed. The mean, standard deviation, and 80th percentile of the simulated exposures are presented in Table G.64.

By superimposing NOAEL and LOAEL values on the exposure distributions generated from the Monte Carlo simulation, the likelihood of an individual experiencing potentially hazardous exposures can be estimated and the magnitude of risk may be determined. Interpretation of the comparison of exposure distributions to NOAELs and LOAELs is described here:

Comparison	Meaning	Risk-based interpretation
NOAEL >80th percentile of exposure distribution	<20% of exposures >NOAEL	Individual- and population-level adverse effects are highly unlikely.
NOAEL <80th percentile <LOAEL	>20% of exposures >NOAEL, but less than 20% of exposures >LOAEL	Individuals experiencing exposures at the high end of the distribution may experience adverse effects, but those effects are unlikely to significantly contribute to effects on the ORR population.
LOAEL <80th percentile of exposure distribution	More than 20% of exposures >LOAEL	Effects on some individuals are likely and they may contribute significantly to effects on the ORR population.

To evaluate the likelihood and magnitude of population-level effects on wildlife, literature-derived population density data (expressed as number of individuals/ ha or km of stream) were combined with hectares of suitable habitat (within the watershed or BC OU 1) to estimate the number of individuals of each endpoint species expected to be present in the watershed. For the terrestrial species (shrew, mice, deer, fox, and hawk) habitat preferences follow those reported in the Preliminary Reservation-wide Ecological Risk Assessment (Sample, Baron, and Jackson 1995). These habitat preferences were compared with the habitat types identified in BCV and BC OU 1 in Washington-Allen, Ashwood, and Christensen (1995). Because streams are the preferred habitats for mink and kingfisher, the length of

Bear Creek was assumed to represent suitable habitat. The estimated abundance of wildlife endpoint species is reported in Table G.71.

The number of individuals within BCV or BC OU 1 likely to experience exposures >LOAELs can be estimated using cumulative binomial probability functions (Dowdy and Wearden 1983). Binomial probability functions are estimated using the following equation:

$$b(y; n; p) = \binom{n}{y} p^y (1-p)^{n-y}, \quad (9)$$

where

- y = the number (or percent) of individuals experiencing exposures >LOAEL,
- n = total number (or percent) of individuals within the watershed,
- p = probability of experiencing an exposure in excess of the LOAEL,
- b(y; n; p) = probability of y individuals out of a total of n, experiencing an exposure, >LOAEL, given the probability of exceeding the LOAEL = p.

By solving Eq. 9 for y = 0 to y = n, a cumulative binomial probability distribution may be generated that can be used to estimate the number of individuals within BCV or BC OU 1 that are likely to experience adverse effects.

Binomial probability distributions were generated only for contaminant-endpoint combinations where the percent of the exposure distribution exceeding the LOAEL was 15% to 85% (these values are reported in Table G.64). If the percent of the exposure distribution exceeding the LOAEL was <15%, it was assumed that no individuals within the area of interest were experiencing adverse effects. Conversely, if the percent of the exposure distribution exceeding the LOAEL was >85%, it was assumed that all individuals within the area of interest were experiencing adverse effects. Exposure estimates for 9 contaminant-endpoint combinations met the 15% to 85% exceedance criterion: antimony exposure to shrews in BC OU 1 and in the BCV, copper exposure to shrews, fox, and mink in the BCV, vanadium exposure to shrews in the BC OU 1, mercury exposure to mice in BC OU 1 and mink in the BCV, and PCB exposure to shrews in the BCV. Figures G.57–G.6.73 graphically display the cumulative binomial probability distributions for each contaminant-endpoint combination. The total numbers of individuals for each endpoint species estimated to be experiencing adverse effects within BCV and BC OU 1 are summarized in Table G.72.

Based on the Monte Carlo analysis, comparison to background exposure estimates, and binomial distribution analysis, the following conclusions may be made:

- Because <20% of the population is estimated to be experiencing exposures >LOAEL, the following contaminants for which exposure was modeled do not present significant risks:

Analyte	Location	Endpoints
Antimony	BCV	Deer, fox
Arsenic	BCV and BC OU 1	Shrews
Barium	BCV and BC OU 1	Shrews
Cadmium	BCV and BC OU 1	Shrews, mice
Chromium	BCV and BC OU 1	Shrews, mice
Copper	BC OU 1	Shrews
Copper	BCV and BC OU 1	Mice, deer, hawk
Lead	BCV and BC OU 1	Shrews
Mercury	BCV	Mice, deer, hawk
Molybdenum	BC OU 1	Shrews, mice
Molybdenum	BCV	Mice
Nickel	BCV and BC OU 1	Shrews
PCBs	BCV and BC OU 1	Mice, fox, mink, kingfisher
Vanadium	BCV	Shrew
Zinc	BCV and BC OU 1	Shrew and hawk

- Because exposure of shrews molybdenum and selenium at the background location exceeded that for both BCV and BC OU 1 (Table G.64), molybdenum and selenium do not present significant risks to shrews in the BCV or in BC OU 1.
- Because >20% of the population is estimated to be experiencing exposures >LOAEL, and the on-site exposures (e.g., BCV or BC OU 1) exceeded background, the following contaminants for which exposure was modeled present significant risks:

Analyte	Location	Endpoints
Antimony	BCV and BC OU 1	Shrews
Copper	BCV	Shrews, fox, mink
Mercury	BCV and BC OU 1	Shrews, fox, mink, kingfisher
Mercury	BC OU 1	Mice
PCBs	BCV and BC OU 1	Shrews
Vanadium	BC OU 1	Shrews

G.6.3.2 Effects of Retained Contaminants

Antimony

The mammalian NOAELs and LOAELs for antimony were derived from a study of mice fed antimony potassium tartrate in water through their life span (Schroeder et al. 1968b). Consumption of 1.25 mg/kg/d antimony significantly reduced longevity. Only one dose level was tested. The study was considered to represent a chronic exposure; therefore, a subchronic-chronic correction factor was not employed. A NOAEL was estimated using a LOAEL-LOAEL correction factor of 0.1. The 0.125 mg/kg/d exposure was considered to be a chronic NOAEL; the 1.25 mg/kg/d exposure was considered to be a chronic LOAEL. Based on the results of Schroeder et al. (1968b), shrews and fox experiencing exposure $\geq$ LOAEL are likely to display reduced longevity.

Copper

The mammalian NOAELs and LOAELs for copper were derived from a study of mink fed 25, 50, 100, or 200 ppm supplemental copper (as copper sulfate) for 357 days (Aulerich et al. 1982). Consumption of 50, 100, and 200 ppm supplemental Cu increased the percentage mortality of mink kits. Kit survivorship among the 25 ppm supplemental Cu group was actually greater than the controls. Because this study was approximately one year in duration and considered exposure during reproduction, the 25 ppm supplemental Cu (85.5 ppm total Cu) dose was considered to be a chronic NOAEL, and the 50 ppm supplemental Cu (110.5 ppm total Cu) dose was considered to be a chronic LOAEL. Based on the results of Aulerich et al. (1982), individual shrews, fox, or mink experiencing exposure $\geq$ LOAEL are likely to display impaired reproduction.

Mercury

For the purposes of this assessment, it is assumed that 100% of the mercury to which wildlife are exposed consists of methyl mercury.

Both the avian NOAEL and LOAEL are based upon a study of mallard ducks fed methyl mercury for three generations (Heinz 1979). The study was considered to represent a chronic exposure, and a subchronic-chronic correction factor was not employed. The only dose level administered, 0.064 mg/kg/d, caused hens to lay fewer eggs, lay more eggs outside of the nest box, and produce fewer ducklings. This dose level was considered to be an LOAEL. Because an experimental NOAEL was not established, the NOAEL was estimated using LOAEL-NOAEL correction factor of 0.1. Based on the results of Heinz (1979), kingfisher experiencing exposure $\geq$ LOAEL are likely to display impaired reproduction.

The fox and mink NOAELs and LOAELs for mercury were derived from a study of mink fed methyl mercury for 93 d (Wobeser, Nielsen, and Schiefer 1976). While consumption of 0.247 mg/kg/d methyl mercury resulted in significant mortality, weight loss, and behavioral impairment, no effects were observed at the 0.15 mg/kg/d exposure level. The 0.15 mg/kg/d exposure was considered to be an NOAEL, and the 0.247 mg/kg/d exposure was considered to be an LOAEL. Because the study was subchronic in duration (<1 year), a subchronic-chronic correction factor was applied (NOAEL = 0.015, LOAEL = 0.025). Based on the results of Wobeser, Nielsen, and Schiefer (1976), shrews, mice, and fox experiencing exposure $\geq$ LOAEL are likely to display increased mortality, weight loss, and behavioral impairment.

PCBs

The mammalian NOAEL and LOAEL for PCBs was derived from a study of mink fed Aroclor 1254 for 4.5 months (Aulerich and Ringer 1977). While consumption of 0.69 mg/kg/d Aroclor 1254 reduced kit survivorship, no effects were observed at the 0.14 mg/kg/d exposure level. The 0.14 mg/kg/d exposure was considered to be a chronic NOAEL; the 0.69 mg/kg/d exposure was considered to be a chronic LOAEL. Based on the results of Aulerich and Ringer (1977), shrews and fox experiencing exposure $\geq$ LOAEL are likely to display reduced survivorship of young.

Vanadium

The mammalian NOAEL and LOAEL are based on a study in which rats were fed sodium metavanadate for 60 d before gestation, through gestation, delivery and lactation (Domingo et al. 1986). This study represents chronic exposures since it took place during reproduction. Significant effects on reproduction, including increased number dead young/litter and reduction in size and weight of offspring were observed at the lowest dose administered, 5 mg/kg/d. Therefore, this dose was considered the chronic LOAEL. To estimate the chronic NOAEL, the chronic LOAEL was multiplied by a LOAEL-NOAEL uncertainty factor of 0.1. Based on the results of Domingo et al. (1986), short-tailed shrews experiencing exposures $\geq$ the LOAEL may display a reduction in reproductive success.

G.6.3.3 Biological Surveys: Mink Survey

Results of the mink survey (refer to Sect. G.6.2.2) indicate that mink are present on the ORR and within the BCV, have large home ranges, and do not avoid the industrial facilities on the ORR. The methods employed in the study do not allow numbers or density of mink to be determined. While mercury levels in hair of mink were statistically significantly greater in the BCV than in reference samples, no statistically significant differences were observed for arsenic, cadmium, lead, or selenium.

G.6.3.4 Weight of Evidence*Short-tailed shrews*

One line of evidence, literature toxicity data, was available to evaluate potential risk to short-tailed shrews in BC OU 1 and within the BCV. Point estimates of exposure indicated that 20 contaminants exceeded NOAELs and 15 also exceeded LOAELs (aluminum, antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, PCBs, selenium, vanadium and zinc; refer to Table G.56). Monte Carlo simulation of exposure and comparison of these estimates with NOAELs and LOAELs (Table G.64), and calculation of binomial probability distributions (Table G.72) suggest that antimony, mercury, PCBs, and vanadium present significant risks to the shrew population in BC OU 1, and antimony, copper, mercury, and PCBs present a significant risks to the BCV shrew population.

White-footed mice

One line of evidence, literature toxicity data, was available to evaluate potential risk to white-footed mice in BC OU 1 and within the BCV. Point estimates of exposure indicated that 13 contaminants exceeded NOAELs and 7 also exceeded LOAELs (aluminum, cadmium, chromium, copper, mercury, molybdenum, and PCBs; refer to Table G.57). Monte Carlo simulation of exposure and comparison of these estimates with NOAELs and LOAELs (Table G.64), and calculation of binomial probability distributions (Table G.72) suggest that mercury presents a significant risk to the mouse population in BC OU 1. No contaminant presented a significant risk to the BCV mouse population.

White-tailed deer

One line of evidence, literature toxicity data, was available to evaluate potential risk to white-tailed deer within the BCV. Point estimates of exposure indicated that 11 contaminants exceeded NOAELs and 4 also exceeded LOAELs (aluminum, antimony, copper, and mercury; refer to Table G.58). Monte Carlo simulation of exposure and comparison of these estimates with NOAELs and LOAELs (Table G.64), suggests that no contaminant presents a significant risk to the white-tailed deer population within the BCV. The weight of evidence suggests that white-tailed deer are not at risk from contaminants in the BCV.

Red fox

One line of evidence, literature toxicity data, was available to evaluate potential risk to red fox within the BCV. Point estimates of exposure indicated that 15 contaminants exceeded NOAELs with 5 also exceeding LOAELs (aluminum, antimony, copper, mercury, and PCBs; Table G.59). Monte Carlo simulation of exposure and comparison of these estimates to NOAELs and LOAELs (Table G.64), and calculation of binomial probability distributions (Table G.72) suggest that copper and mercury present significant risks to the BCV fox population.

Red-tailed hawk

One line of evidence, literature toxicity data, was available to evaluate potential risk to red-tailed hawk within the BCV. Point estimates of exposure indicated that seven contaminants exceeded NOAELs and that three, copper, mercury, and zinc also exceeded LOAELs (Table G.60). Monte Carlo simulation of exposure and comparison of these estimates with NOAELs and LOAELs (Table G.64), suggests that mercury does not present a significant risk to the hawk population within the BCV. The weight of evidence suggests that hawks are not at risk from contaminants in the BCV.

Mink

Two lines of evidence, biological survey data and literature toxicity data, were available to evaluate potential risks to mink within the BCV. The biological survey data indicate that mink are present within the BCV, but due to the sampling methods employed, estimates of the abundance of the mink population cannot be made from these data. Residue analysis indicates that mink in the BCV have significantly higher concentrations of mercury in hair than do mink from off-site, suggesting elevated exposure to mercury.

Point estimates of exposure indicated that four contaminants exceeded NOAELs and LOAELs (aluminum, copper, mercury, and PCBs; Table G.61). Monte Carlo simulation of exposure and comparison of these estimates with NOAELs and LOAELs (Table G.64), suggests that copper and mercury presents a significant risks to the mink population within the BCV. The weight of evidence suggests that mink are at risk from contaminants in the BCV.

Belted kingfisher

One line of evidence, literature toxicity data, was available to evaluate potential risk to belted kingfisher within the BCV. Point estimates of exposure indicated that three contaminants (mercury, PCBs, and zinc) exceeded NOAELs and that two also exceeded LOAELs (mercury and PCBs; refer to Table G.56). Point estimates of exposure at background indicated that all estimates were <LOAELs. (Table G.57). Monte Carlo simulation of exposure and comparison of these estimates with NOAELs and

LOAELs (Table G.64), suggests that mercury may present a significant risk to the kingfisher population within the BCV.

Threatened or Endangered Species

Three T&E species may potentially occur in the BCV, northern pine snakes, cooper's and sharp-shinned hawks. In the problem formulation (Section G.1.3.1) it was stated that estimation of risks to red-tailed hawks would adequately serve to protect cooper's and sharp-shinned hawks. As stated previously, risks were not estimated for individual red-tailed hawks from any contaminant. Therefore, the weight of evidence indicates that no risks are expected for individual cooper's and sharp-shinned hawks that may reside within the BCV.

Because toxicological data to evaluate risks to reptiles are not available, it was assumed that assessment of risk for other predators or scavengers would serve to protect northern pine snakes (Sect. G.1.3.1). Because reptiles are phylogenetically more closely related to birds than mammals and the diet of red-tailed hawks is more similar to that of pine snakes (both consume predominantly small mammals) than either mink (fish and small mammals) or fox (birds, small mammals, invertebrates, and fruit), the red-tailed hawk was selected as the most appropriate surrogate to estimate risks to northern pine snakes. Because risks were not estimated for individual red-tailed hawks from any contaminant in the BCV, the weight of evidence indicates that no risks are expected for individual northern pine snakes that may reside within the BCV.

G.6.4 UNCERTAINTIES CONCERNING RISKS TO WILDLIFE

G.6.4.1 Bioavailability of Contaminants

Bioavailability of contaminants was assumed to be comparable between soil and biota collected from the BCV and the diets used in the literature toxicity tests. Because bioavailability may not be comparable, exposure estimates based upon the contaminant concentrations may either under- or overestimate the actual contaminant exposure experienced.

G.6.4.2 Extrapolation from Published Toxicity Data

While published toxicity studies are available for mink, no published data for the other endpoints exist. To estimate toxicity of contaminants at the site, it was necessary to extrapolate from studies performed on test species (i.e., mallard ducks, ring-necked pheasant, and rats). While it was assumed that toxicity could be estimated as a function of body size, the accuracy of the estimate is not known. For example, hawks or kingfisher may be more or less sensitive to contaminants than ducks or pheasants, due to factors other than metabolic rate.

Additional extrapolation uncertainty exists for those contaminants for which data consisted of only LOAELs or tests were subchronic in duration. For either case, an uncertainty factor of 10 was employed to estimate NOAELs or chronic data. The uncertainty factor of 10 may either over- or underestimate the actual LOAEL-NOAEL or subchronic-chronic relationship.

Toxicity of PCBs to piscivorous wildlife was evaluated using toxicity data from studies on Aroclor 1254. Because toxicity of PCB congeners can vary dramatically, the applicability of data for Aroclor 1254 is unknown.

G.6.4.3 Variable Food Consumption

While food consumption by piscivorous wildlife was assumed to be similar to that reported for the same or related species in other locations, the validity of this assumption cannot be determined. Food consumption by wildlife on the ORR may be greater or less than that reported in the literature, resulting in either an increase or decrease in contaminant exposure.

G.6.4.4 Single-Contaminant Tests vs. Exposure to Multiple Contaminants in the Field

While piscivores on the ORR are exposed to multiple contaminants concurrently, published toxicological values only consider effects experienced by exposures to single contaminants. Because some contaminants to which wildlife are exposed can interact antagonistically, single-contaminant studies may overestimate their toxic potential. Similarly, for those contaminants that interact additively or synergistically, single-contaminant studies may underestimate their toxic potential.

G.6.4.5 Inorganic Forms or Species Present in the Environment

Toxicity of metal species varies dramatically depending upon the valence state or form (organic or inorganic) of the metal. For example, arsenic (III) and methyl mercury are more toxic than arsenic (V) and inorganic mercury, respectively. The available data on the contaminant concentrations in media do not report which species or form of contaminant was observed. Because benchmarks used for comparison represented the more toxic species/forms of the metals (particularly for arsenic and mercury), if the less toxic species/form of the metal was actually present in media from the BCV, potential toxicity at the sites may be overestimated.

G.6.4.6 Contaminant Concentrations in Unanalyzed Food Types

Contaminant data or uptake factors were not available for all food types consumed by the endpoint species. It was assumed that the contaminant concentration in or uptake factors for food types for which we had data were representative of that for those without data. Due to the different life histories among food types, contaminant burdens are likely to differ from the measured data. Therefore, assuming comparability among food types may either over- or underestimate exposure.

G.6.4.7 Monte Carlo Simulation

To perform Monte Carlo simulations, distributions must be assigned to parameters. Because wildlife are mobile, the mean of the contaminant concentration is likely to best represent their exposure. For this report, the contaminant concentrations in fish were assumed to be normally distributed.

G.6.4.8 Estimated Whole Fish Concentrations

Contaminant concentrations in whole fish were estimated using contaminant-specific fillet-to-whole-fish ratios. Data to generate ratios were available only for PCBs in largemouth bass and channel catfish from the Clinch River. Ratios for metals were obtained from spotted bass samples from near the Portsmouth Gaseous Diffusion Plant in Ohio. Applicability of these ratios to species other than those from which they were developed is unknown. Similarly, applicability of metal ratios from Ohio spotted bass to fish on the ORR is unknown.

G.6.4.9 Spatial averaging of exposures to estimates

To evaluate exposure and risks to wildlife at the BC OU 1 and BCV levels, Monte Carlo simulations were performed on the average exposures within these areas. This approach assumes that wildlife forage equally over the entire area and that biases associated with preferential foraging in or deliberate sampling of hot spots are balanced or insignificant. The validity of this assumption is unknown.

G.6.5 Future Chemical Risks to Wildlife

As conditions within the BCV change in the future, risks that chemicals present to wildlife may change. The future chemical risks to wildlife were evaluated for inventory wastes in the sources areas that are capped and currently not available and for modeled future surface water exposures.

Future risks to wildlife in the BCV floodplain were not specifically estimated. Assuming no new sources, contamination in the BCV floodplain is expected to decrease over time due to degradation, erosion, and other factors. Therefore future risks to wildlife from chemical contaminants in the floodplain were assumed to be equivalent to or lower than what has been estimated under the current case.

G.6.5.1 Inventory Wastes

The exposure sources evaluated in the following sections are the capped sludges at the S-3 Ponds and the capped waste inventories in the BCBG area. Contaminants in the S-3 Ponds sludges and the BCBG waste inventory are discussed in Appendix A (Vol.2 of the BCV RI Report). The sludge and waste inventory assessments evaluate future risks, assuming that caps and/or covers over the wastes degrade, allowing ready access by short-tailed shrews to the soils. Contaminant concentrations are calculated for solid media in the waste inventory by assuming a homogeneous mixing of contaminants in solid media at the storage locations.

G.6.5.1.1 Exposure Assessment

Potential future exposure of wildlife to contaminants in the S-3 Pond sludges and the BCBG area waste inventory sites was evaluated for short-tailed shrews only because they typically ingest large amounts of soil, resulting in a higher exposure of shrews to soil contaminants than occurs in mice. Therefore, these estimates are conservative for small mammals at the sites.

Combined data for S-3 Pond sludges were used to compute source term concentrations at the S-3 Ponds (Table A.3), and waste inventory data for the BCBG area were used to compute source term concentrations at the BCBG (Table A.14). For the purposes of this assessment, contaminants at the BCBG waste inventory sites were considered to be in soil. A single contaminant concentration was determined at each site, either because concentrations were computed from analytical sampling data (S-3 Ponds sludges) or from historic inventory information (BCBG waste inventory). These data were used to evaluate future risks at the S-3 Ponds and BCBG areas. For future risks at capped sites, it is assumed that the cap is no longer present and that the contaminants are freely accessible.

Oral ingestion exposure

Oral ingestion of contaminants was estimated by evaluating ingestion of earthworms and soil by short-tailed shrews. Parameters for oral ingestion of contaminants are presented in Sect. G.6.1.1. It is assumed that short-tailed shrews eat only earthworms from the contaminated sites.

Soil-biota uptake factors

Exposure estimates were calculated using bioaccumulation data for earthworms (Table G.39) derived from studies on BCV floodplain soils and biota. Concentrations of contaminants in earthworms, which take up contaminants from soil and are the primary food items of short-tailed shrews, were not measured. Instead, contaminant concentrations were estimated by using concentrations in the solid media and the bioaccumulation factors presented in Table G.39.

Contaminant concentrations in soil

Concentrations of contaminants above background in the waste inventory samples are presented in Table G.73. Single values were available for contaminant concentrations at each of these sites, so upper confidence limits values were not calculated for these sites. It is assumed that the single sample taken is representative of each site.

Exposure modeling using point estimates

Exposure modeling for point estimates of exposure at the disposal and waste inventory sites was done following the procedures described in Sect. G.6.1.5. Species-specific parameters necessary to estimate exposure to short-tailed shrews using Eq. 1 (Sect. G.6.1.1) are found in Sect. G.6.1.5 and are based on data found in Table G.49. Single-point estimates of exposure to single contaminants were made using Eq. 3 (Sect. G.6.1.1).

Unlike the exposures in the source units and the BC floodplain (Sect. G.6.1), which are represented by a range of contaminant concentrations, exposures at the waste inventory sites are assumed to be homogeneous because there is a single contaminant concentration for each location. Therefore, Monte Carlo simulations, which represent exposure to the distribution of contaminant concentrations and were used in Sect. G.6.3.1, were not used to model distributions of exposure.

G.6.5.1.2 Chemical Effects Assessment for Wildlife

Procedures for evaluation of toxicity data and development of toxicity benchmarks are presented in Sect. G.6.2.1. Because toxicity data are not available for short-tailed shrews, toxicity benchmarks were derived from published data for other small mammals (Sect. G.6.2.1). Toxicity benchmarks are based on reported NOAELs and LOAELs for small mammals. NOAEL-based and LOAEL-based toxicity benchmarks used to evaluate risks to short-tailed shrews from the waste inventory exposures are presented in Tables G.65 and G.66.

G.6.5.1.3 Characterization of Chemical Risks to Wildlife

Risk characterization compares the exposure point concentrations (Sect. G.6.5.1) with data on toxicity thresholds (Sect. G.6.2) to estimate risks to wildlife. Procedures for evaluating risks to wildlife are presented in Sect. G.6.3. A single line of evidence—literature-derived single-chemical toxicity evaluations—is used for the evaluation of risks to wildlife from the waste inventories in BCV.

Single-chemical toxicity data

To determine if the potential contaminant exposures at waste inventory sites are hazardous, estimated oral exposures at the waste inventory sites were compared with NOAEL-based and LOAEL-based toxicity benchmarks. Each contaminant detected above its soil background concentration for which

there was a toxicity benchmark was evaluated. Any contaminant whose exposure at a site exceeded its NOAEL-based toxicity benchmark was identified as a COPEC at that site. The results of these comparisons are shown in Table G.74. Estimated exposures, toxicity benchmarks, and the resulting HQs are shown for each analyte with a concentration above background. HQs >1 indicate exposures above the NOAEL or LOAEL. Exceeding the NOAEL indicates that adverse effects are possible, while exceeding the LOAEL indicates that adverse effects are likely.

Summaries of the analytes exceeding background and with HQ >1, along with the waste inventory locations where they occur, are presented for the S-3 Ponds and BCBG areas (Table G.75). In the S-3 Ponds sludges, NOAEL-based HQs for future exposure of short-tailed shrews were greatest for uranium and zirconium; HQs were near 20. Mercury, molybdenum, and Aroclor 1248 had NOAEL-based HQs >1 and LOAEL-based HQs below or only slightly above 1. At the BCBG waste inventory sites, the most widespread contaminant was uranium, which had HQs at 13 locations ranging from 8 to >3000, followed by beryllium, tetrachloroethene, and PCBs. Chemical risks from other contaminants ranged from LOAEL-based HQs <1 to a NOAEL-based HQ of 19 for mercury. Risks from radiation exposure at the waste inventory sites are evaluated in Sect. G.7.3.

Effects of retained contaminants

Sect. G.6.2 discusses the toxic effects of cadmium, copper, and mercury to wildlife. Additional retained contaminants for the S-3 Ponds and BCBG waste inventory areas are beryllium, uranium, zirconium, and PCBs. Summaries of their toxic effects to small mammals follow:

Beryllium

The mammalian NOAEL for beryllium was derived from a study of rats fed beryllium sulfate in water for >1 year (Schroeder and Mitchener 1975). The single dose tested, 5 mg Be/L, caused weight loss in males in months 2 through 6, but no significant adverse effects were observed. Therefore, this study represents a chronic NOAEL. No LOAEL for exposure of mammals to beryllium is available. The results of this study indicate that exposure of small mammals to beryllium at concentrations >NOAEL may not result in adverse effects.

Uranium

The mammalian NOAEL and LOAEL for uranium were derived from a study of mice intubated with uranyl acetate (Paternain et al. 1989). Dosage was given 60 d before gestation, followed by exposure during gestation, parturition, and lactation. Dose rates were 5, 10, and 25 mg uranyl acetate/kg/d. Significant increases in number of dead young per litter and reductions in size and weight of offspring were observed at the 10 and 25 mg/kg/d dose rates but not at 5 mg/kg/d. The NOAEL was calculated from the latter dose rate, and the LOAEL was calculated from the dose rate of 10 mg/kg/d. Because this study includes a critical life stage, both benchmarks are considered to be chronic. This study indicates that small mammals chronically exposed to concentrations >LOAEL are likely to experience decreased reproductive success.

Zirconium

The mammalian NOAEL for zirconium was derived from a study of mice fed zirconium sulfate at 5 mg zirconium/L in water for >1 year (Schroeder et al. 1968b). The endpoint was effect on life span. No effect was detected at the concentration used; therefore, this study represents a chronic NOAEL. No

LOAEL for exposure of mammals to zirconium is available. The results of this study indicate that exposure of small mammals to zirconium at concentrations >NOAEL may not result in adverse effects.

PCBs

The small-mammal NOAEL and LOAEL for Aroclor 1254 were used as the benchmarks for exposure to PCBs when the Aroclor mixture was not specified. The mammalian NOAEL and LOAEL for PCBs was derived from a study of mink fed Aroclor 1254 for 4.5 months (Aulerich and Ringer 1977). While consumption of 0.69 mg/kg/d Aroclor 1254 reduced kit survivorship, no effects were observed at the 0.14 mg/kg/d exposure level. The 0.14 mg/kg/d exposure was considered to be a chronic NOAEL; the 0.69 mg/kg/d exposure was considered to be a chronic LOAEL. Based on the results of Aulerich and Ringer (1977), small mammals experiencing exposure $\geq$ LOAEL are likely to display reduced survivorship of young.

Weight of evidence

The significance of the single-chemical exposures as indications of risk is evaluated by weight of evidence logic. This logic combines the results of risk evaluation with other information relevant to exposure at the site (e.g., background concentrations, habitat quality, media toxicity studies, and biota surveys). No information is available on ambient media toxicity to short-tailed shrews, and no biota surveys were performed at the capped sites. Therefore, the weight of evidence evaluations are based on single-chemical toxicity and exposure evaluations, background concentrations, and habitat quality.

Short-tailed shrews

A single line of evidence, literature toxicity data, was available to evaluate potential risk to short-tailed shrews in the S-3 Ponds sludges, and in the BCBG waste inventory areas. Point estimates of exposure indicated that multiple contaminants exceeded NOAELs at each location and a smaller number exceeded LOAELs. Of the COPECs listed in Table G.75, molybdenum is <25% above background in the S-3 Ponds sludges. Other COPECs have no listed background concentrations.

The S-3 Ponds sludges and the BCBG waste inventory do not provide any current habitat for, or credible exposure to, small mammals. Future development of suitable habitat in the S-3 Ponds sludges, even assuming loss of the current cap, is unlikely without homogenization of the sludges with soil underlying the cap and consequent dilution of contaminants. Future development of suitable habitat in the BCBG waste inventory is highly unlikely because the inventory consists largely of metal debris mixed with solid waste. Any habitat that could develop, assuming loss of the current caps, would necessarily be highly homogeneous, and bioavailable concentrations of contaminants would likely be lower than those reported in the inventory.

In the S-3 Ponds sludges, mercury and molybdenum had LOAEL-based HQs <1, while Aroclor 1248 exceeded the LOAEL by only 4%. Considering the likely soil mixing processes that would accompany the restoration of habitat at the S-3 Ponds site, it is unlikely that these contaminants would pose a significant future risk to small mammals at this site. Uranium and zirconium remain as COCs in the S-3 Ponds sludges.

In the BCBG waste inventory, lead and lithium exceed the NOAEL but not the LOAEL, showing that short-tailed shrew populations are not at risk from these contaminants. Two volatile organics, tetrachloroethene and trichloroethene, exceed toxicity benchmarks but would not be expected to remain in soil at the observed concentrations if the cap were removed and soil at the site were disturbed.

Considering the likely soil mixing processes that would accompany the restoration of habitat at the capped BCBG waste sites, it is unlikely that these contaminants would pose a significant future risk to small mammals in the BCBG area. Beryllium, mercury, uranium, and PCBs remain as COCs in the BCBG waste inventory.

In summary, the weight of evidence suggests uranium and zirconium in the S-3 Ponds sludges, and beryllium, mercury, uranium, and PCBs in the BCBG waste inventory represent significant risks to the short-tailed shrew population. Risks do not currently occur from the S-3 Ponds sludges or the BCBG waste inventory. The site that poses the highest future risk to short-tailed shrews if unlimited exposure becomes possible is the BCBG waste inventory. Exposure of wildlife to contaminants in the BCBG waste inventories, especially uranium, would be extremely hazardous.

G.6.5.1.4 Uncertainties Concerning Risks to Wildlife at the Waste Inventory Sites

The uncertainties discussed in Sect. G.6.4 also apply to evaluation of risks at the waste inventory sites. In addition, uncertainty about the range of contaminants concentrations exists since only a single contaminant concentration for solid media was calculated for each of the S-3 Pond and BCBG area waste inventory locations. Little uncertainty exists in the mean contaminant concentrations in the S-3 Ponds sludges, which were derived from several samples. However, the distributions of contaminants and the maximum concentrations are uncertain because they were based on recorded estimates of the amounts of material disposed at the sites. In addition, many of the materials are solid wastes and metal scraps, so they do not occur as a homogeneous mixture at the disposal sites. Therefore, maximum concentrations of each contaminant are much higher in some cases than the concentrations used in the exposure evaluation, resulting in underestimates of the maximum exposure.

G.6.5.2 Risks from Future Surface Water Exposures

To evaluate the potential future risk that contaminants in surface water present to wildlife, the maximum estimated for concentrations in surface water were compared with LOAEL water benchmarks (from Table G-68) for all species. HQs (water concentration/benchmark value) were calculated for all species and are presented in Table G.76. No benchmarks were exceeded for any endpoint at any location. Most HQs ranged from 10^{-2} to 10^{-3} or greater, indicating minimal future risks to wildlife from contaminants in BCV surface water.

G.7 RISKS TO WILDLIFE FROM EXPOSURE TO RADIONUCLIDES

Sources of radioactivity in the environment include naturally occurring radionuclides, fallout from atmospheric testing, runoff from watersheds that have received atmospheric deposition, and radioactive effluents from medical, industrial, and nuclear facilities discharged either routinely or accidentally. The discharge of radioactive effluents to the environment has the potential for contaminating terrestrial and aquatic environments, which results in long-term, low-dose-rate exposures to an ecosystem and its components. Sources of radionuclides in the Bear Creek watershed are discussed in Appendix D.

This section discusses the potential risks to terrestrial biota (plants, invertebrates, wildlife) from current exposure to radionuclides in surface soil collected from 11 transects perpendicular to Bear Creek [Sect. B.5.3.1 of Appendix B (Vol. 2 of the BCV RI Report)] and from identified source areas (the S-3 Ponds area, BYBY, the combined SL and OLF, the BG, the Creekside Debris Burial Area, and the Roadside Debris Burial Area). Potential current exposures to radionuclides in surface water was also evaluated for 13 locations in Bear Creek and its tributaries as well as four seep areas. Future water-related exposures were evaluated using predicted maximum surface water activity levels at four locations (NT-1, NT-3, NT-7, and NT-8). In addition, hypothetical future exposures to waste inventories (assumed radionuclides in soil) at the C-West, C-East, and A-North Burial Grounds were evaluated.

G.7.1 EXPOSURE ASSESSMENT

Native biota may receive external radiation exposure from radionuclides in air, water, soil, and sediment. Organisms also receive internal radiation exposure from radionuclides ingested via food and water and from radionuclides absorbed through the skin and respiratory organs (Templeton et al. 1971, IAEA 1976, Blaylock and Trabalka 1978, Woodhead 1984). Evaluation of the resulting radiation doses received by biota requires quantitative information on the radionuclides to which they are exposed. In all cases, the radiation source must be known in terms of the quantity of each specific radionuclide and the corresponding energy released per disintegration. Factors to correct for specific conditions that may effect exposures are applied when appropriate.

Radiation dose rates (mrad/d) were calculated for plants, earthworms, and representative terrestrial and semiaquatic wildlife species in the Bear Creek watershed using methodology adapted from Blaylock et al. (1993) and Baker and Soldat (1992). The methodology was modified to address site-specific conditions and receptors. Dose rates from internal exposures via ingestion of food, soil, and water and inhalation of dust were evaluated, as were dose rates from external exposures via soil and water.

The representative terrestrial and semiaquatic wildlife selected as endpoints for the radiological assessment were the same as those for the chemical data assessment: short-tailed shrew, white-footed mouse, red fox, white-tailed deer, red-tailed hawk, mink, and belted kingfisher (refer to Sect. G.6). Life history parameters used in the radiological assessment were identical to those used for the chemical data assessment (Table G.49–G.55). In addition, it was necessary to develop species-specific values for fraction of time spent above and below ground, underwater, or at the water's surface. The mink was assumed to spend 50% of its time above ground, 20% below ground (in burrows), 20% swimming at the water's surface, and, conservatively, 10% of its time immersed in water. Kingfishers were assumed to split their time equally among perching above water or soil and roosting in burrows. The short-tailed shrew, white-footed mouse, and red fox were all assumed to spend 75% of their time above ground and

25% below the soil surface in dens or burrows. White-tailed deer spend 100% of their time above ground and were assigned a value of 1. Red-tailed hawks also spend 100% of their time above ground, but much of this is flying or perched high in trees; thus, it was assumed that hawks would only be exposed to external radiation 10% of the time.

G.7.1.1 Exposure Models

Terrestrial receptors may receive both external and internal doses of radiation. Internal exposures are a result of ingestion of contaminated food, soil, or water or inhalation of contaminated soil. Receptors on the ground surface receive external exposures from contaminated surface soil via direct radiation. Both above-ground and below-ground exposures are possible, depending on the habits of the receptor. Baker and Soldat (1992) provide general equations for estimating dose rates to wildlife. An adaptation of Blaylock et al.'s (1993) methodology was used in estimating radiation dose rates in the RI for Waste Area Grouping 5 at Oak Ridge National Laboratory (DOE 1995a). The Blaylock et al. methodology was further modified for the current assessment to account for the availability of site-specific uptake and biota data. The general methodology and the equations specific to each exposure route used in estimation of dose rates for Bear Creek wildlife are described in this subsection. Equations used in this assessment estimate the daily dose from current conditions. Dose from α , β , and γ emissions (only β and γ for external exposures of earthworms and plants and only γ for external exposures of wildlife receptors) were calculated for each radionuclide, including the dose rates from all short-lived daughter products. Dose from each radionuclide was then summed over all exposure routes and all radionuclides to arrive at the overall dose received for each receptor at each site.

External exposures: direct radiation from soil

The equation for estimating above ground external dose rates (mrad/d) for terrestrial receptors exposed to contaminated soil uses dose coefficients published by Eckerman and Ryman (1993). Dose rate reduction factors are used to account for the fraction of time the receptor spends above ground. Dose coefficients assume the source region is a smooth plane (Eckerman and Ryman 1993), but this is rarely the case in a terrestrial habitat. A representative average dose reduction factor for ground roughness is 0.7 (Eckerman and Ryman 1993). For the shrew, mouse, and mink, all relatively small mammals which are effectively much closer than 1 m to the source, an elevation correction factor of 2 was applied to account for the increased dose expected at ground level relative to the effective height of a standard human used to derive the dose coefficients. For plants it was assumed that the dose represents that to the reproductive part of the plant with an effective height similar to that of the standard human. The equation for above ground dose from external exposures for a plant or wildlife receptor is written

Above soil exposures:

$$D_{above\,grd} = F_{above} F_{rnf} \sum C_{soil,i} DF_{grd,i} CFb ECF$$

where

- $D_{above\,grd}$ = External dose rate to receptor from above-ground exposures to contaminated soil (mrad/d)
- F_{above} = Dose rate reduction factor accounting for the fraction of time the receptor spends above ground (unitless)
- F_{rnf} = Dose rate reduction factor accounting for ground roughness (unitless). Representative average of 0.7 (Eckerman and Ryman 1993) used for this assessment.
- $C_{soil,i}$ = Activity of radionuclide i in top 0–16 in. of soil (pCi/g)

$DF_{\text{grd},i}$	=	Dose coefficient for radionuclide I in soil contaminated to depth of 15 cm (Table III.6, Eckerman and Ryman 1993) (Sv/s per Bq/m ³)
C_{fb}	=	Conversion factor to change Sv/s per Bq/m ³ to mrad g/pCi d. Equals 5.12×10^{14} .
ECF	=	Elevation correction factor to adjust dose coefficients to value representative of effective height of animal above ground.

Dose from alpha radiation is not a concern for external sources, as alpha radiation lacks penetrating power. The effective dose coefficients from Eckerman and Ryman (1993) incorporate both high energy β and γ emissions. Radionuclide-specific parameters are provided in Table G.77. The lower of the UCL95 and the maximum detected concentration in soils data from 0–16 in. deep were used in estimating the dose from external exposures. Summary statistics for 0–16-in. surface soil data collected at transects along Bear Creek are provided in Table G.41; data for the source areas are provided in Table G.42.

Below-ground exposures are calculated assuming immersion in a continuous soil medium. Dose coefficients were unavailable for the immersion scenario, so exposures were modeled as dose to soil adjusted for absorption by a small volume of tissue. The exposure fraction reflects the fraction of time the receptor spends below ground. Because white-tailed deer and red-tailed hawks do not go below ground, they do not receive a dose via this exposure route. Only γ radiations with energies greater than 0.01 MeV were evaluated for wildlife receptors as those with lower energies are unlikely to penetrate skin. Both β and γ radiations were evaluated for earthworms. The equation for below-ground external exposures of earthworms and wildlife receptors is written

Below-ground exposures:

$$D_{\text{belowgrd}} = 1.05 F_{\text{below}} \sum C_{\text{soil},i} \epsilon_i C_{\text{Fa}}$$

where

D_{belowgrd}	=	External dose rate to earthworm or wildlife receptor in burrow from contaminated soil (mrad/d)
F_{below}	=	Dose rate reduction factor accounting for the fraction of time the receptor spends below ground (unitless)
ϵ_i	=	Energy for γ emissions by nuclide I (MeV/nt).
1.05	=	Conversion factor to account for immersion in soil vs water (Estimated value; Keith Eckerman, Health Sciences Research Division, Oak Ridge National Laboratory, personal communication)
C_{Fa}	=	Conversion factor to go from MeV/nt to g mrad/pCi d. (5.12×10^{-2})

All other parameters are as defined for above-ground exposures.

External Exposures: Direct radiation from water

The equation for estimating external dose rates (mrad/d) for terrestrial receptors exposed to radionuclides in water uses dose coefficients published by Eckerman and Ryman (1993) and is similar to the equation used for soil. Dose rate reduction factors are used to account for the fraction of time the receptor spends underwater or at the water's surface. The equation for dose from external exposures for an organism immersed in water is written

Underwater exposures:

$$D_{\text{underwater}} = F_{\text{underwater}} \sum C_{\text{water},i} \frac{1}{WD} DF_{\text{water},i} CF_w$$

where

- $D_{\text{underwater}}$ = External dose rate to receptor from underwater exposures to contaminated soil (mrad/d)
 $F_{\text{underwater}}$ = Dose rate reduction factor accounting for the fraction of time the receptor spends underwater (unitless)
 $C_{\text{water},i}$ = Activity of radionuclide i in water (pCi/L)
 WD = Density of water (1000 g/L)
 $DF_{\text{water},i}$ = Dose coefficient for radionuclide i for organism immersed in water (Eckerman and Ryman 1993) (Sv m³/Bq s)
 CF_w = Conversion factor to change Sv m³/Bq s to mrad g/pCi d. Equals 3.20×10^{14} .

Dose from alpha radiation is not a concern for external sources, as alpha radiation lacks penetrating power. The effective dose coefficients from Eckerman and Ryman (1993) incorporate both high energy β and γ emissions. Radionuclide-specific parameters are provided in Table G.77. The mink is the only representative wildlife species likely to spend time underwater.

Exposures at the water surface are calculated similarly. However, the exposure fraction is adjusted to reflect the fraction of time the receptor spends at the water surface. Because organisms at the water's surface are exposed from below instead of from above and below, a dose reduction factor of 0.5 is applied. Mink were assumed to spend 20% of their time swimming at the water surface, and kingfishers were assumed to spend 33% of their time perched close to the water surface. Other receptors were not expected to spend significant time in water, so external water exposures were not addressed. The equation for external exposures at the water surface is written

Water surface exposures:

$$D_{\text{surface}} = F_{\text{surface}} 0.5 \sum C_{\text{water},i} \frac{1}{WD} DF_{\text{water},i} CF_w$$

where

- D_{surface} = External dose rate to receptor from exposures at the water surface (mrad/d)
 F_{surface} = Dose rate reduction factor accounting for the fraction of time the receptor spends at the water surface (unitless)
 0.5 = Dose reduction factor to account for the difference between being immersed in water and being at the water surface (unitless).

All other parameters are the same as those defined for underwater exposures.

Internal exposures: ingestion

Wildlife receptors may receive internal radiation doses after ingesting contaminated prey, soil, or water or after inhaling contaminated dust. Blaylock et al. (1993) provide an equation for estimating the internal dose to fish contaminated with radionuclides. This equation can be modified to address

consumers' eating a variety of prey types, ingesting soil, and drinking water as well as plants and invertebrates taking up contaminants directly from the soil:

$$D_{ing} = \sum QF C_{tissue} \epsilon_i Cfa AF$$

where

D_{ing}	=	Internal dose rate received after ingestion of contaminated prey and soil (mrad/d).
QF	=	Quality factor to account for the greater biological effectiveness of α particles. (20 for α ; 1 for β and γ emissions; unitless).
C_{tissue}	=	Activity (pCi/g) of radionuclide I in tissue of organism.
ϵ_i	=	Energy for α , β , or γ emissions by nuclide I (MeV/nt).
Cfa	=	Conversion factor to go from MeV/nt to g mrad/pCi d. (5.12×10^{-2})
AF	=	Absorption factor (unitless)

Radionuclide activity in tissue was determined a number of ways depending on data availability. Measured plant, earthworm, and small mammal data were used when available. When site-specific tissue data were lacking but soil-to-tissue uptake factors were available, tissue concentrations were estimated as

$$C_{tissue} = UF_i C_{soil}$$

where

UF_i	=	Soil-to-tissue uptake factor for plant, worm, or wildlife receptor (unitless)
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When soil-to-tissue uptake factors were unavailable for wildlife receptors, literature-derived bioaccumulation factors were used to obtain wildlife tissue concentrations:

$$C_{tissue} = BAF_i (C_{ij} P_j + C_{soil} P_{soil})$$

where

BAF_i	=	Bioaccumulation factor for radionuclide I . (pCi/g tissue over pCi/g food)
C_{ij}	=	Activity (pCi/g) of radionuclide I in prey type j
P_j	=	Proportion of prey type j in receptor's diet (unitless)
C_{soil}	=	Activity (pCi/g) of radionuclide I in surface soil.
P_{soil}	=	Proportion of soil in receptor diet. (unitless)

Absorbed energy fractions for α radiations were assumed unity for all receptors. Absorption fractions for β radiations were assumed unity for wildlife receptors, but β absorption fractions for large insects from Blaylock et al. (1993) were used for plants (assuming small reproductive parts of greatest concern) and earthworms. Absorption fractions for γ radiations for plants and earthworms were also obtained from those for large insects presented in Blaylock et al. (1993). Absorption fractions for γ radiations derived for infant, 1 yr-old, and adult humans using the methodology described in Cristy and Eckerman (1987) were used for wildlife receptors of similar sizes. Table G.77 presents absorption factors used for each receptor-radionuclide combination evaluated in this report.

Dose from internal exposures was calculated for α , β , and γ energies of each radionuclide. Energies were obtained from Eckerman and Ryman (1993) and are provided in Table G.77. Because different types of radiation differ in their relative biological effectiveness per unit of absorbed dose, a quality factor derived from data on humans is normally applied (NCRP 1987). A quality factor of 1 is used for β and γ radiation and 20 for α radiation (Blaylock et al. 1993).

Bear Creek watershed-specific uptake factors for three plant types (browse, canopy vegetation, and herbaceous vegetation), earthworms, and mammals were available for a number of radionuclides and were used in the assessment. When site-specific uptake factors were unavailable for specific radionuclides, values were derived from those for related isotopes with measured values, from measured values of the elemental form of the radionuclide, or from available literature sources. Uptake factors used in this assessment are provided in Table G.78. It was assumed that uptake of radionuclides from ingested food, water, and soil was similar.

Site-specific biota concentrations were also available for the three plant types (browse, canopy vegetation, and herbaceous vegetation), earthworms, and mammals for a number of radionuclides (Tables G.43–G.47). Site-specific concentrations were used whenever available. To evaluate radionuclides (and their short-lived daughter products) for which site-specific data were unavailable, prey species concentrations were estimated by multiplying the appropriate uptake factor by soil activity levels (for plants and earthworms) or by food activity levels (for small mammals). A generic small mammalian prey species was assumed with a diet of 50% earthworms and 50% herbaceous plants and soil ingestion amounting to 2% of its overall ingestion rate. Concentrations in fish were estimated by multiplying water concentrations by fish bioconcentration factors obtained from Blaylock et al. (1993).

The lower of the UCL95 and the maximum detected concentration in soils data collected from 0–4 in. deep were used in estimating dose rates from internal exposures assuming most of the soil ingested by terrestrial wildlife would come from the upper layers of soil. Summary statistics for 0–4-in. surface soil data collected at transects along Bear Creek are provided in Table G.40; data for the source areas are provided in Table G.42.

Internal exposures: inhalation

Wildlife species using burrows receive an additional internal dose from inhalation of dust originating from contaminated soil. Intake of radionuclide *I* by inhalation is estimated as (DOE 1995b):

$$D_{inh} = QF F_{below} \sum C_{soil,i} A \frac{1}{AD} \epsilon_i CFa AF$$

where

D_{inh}	=	Internal dose rate from inhalation of contaminated soil (mrad/d)
F_{exp}	=	Dose reduction factor for fraction of time receptor spends below ground (unitless)
A	=	Mass of respirable dust per volume of air breathed (0.1 g/m ³ ; DOE 1995b)
AD	=	Air density (1200 g/m ³ ; Eckerman and Ryman 1993)
ϵ_i	=	α , β , or γ radiation energies for radionuclide <i>I</i> (MeV)
Cfa	=	Conversion factor to go from MeV to mrad g/pCi/d (5.12×10^{-2})
AF	=	Absorption factor (unitless)

Healy (1980) suggests that 0.0001 g/m³ would be a conservative value when addressing human exposures to dust. Because burrowing animals are likely to spend a greater portion of their time in a confined space (burrow) than humans and are physically closer to the soil surface, an air mass loading of 0.1 g/m³ was selected as a conservative estimate of the mass of respirable dust (*A*) to which these animals may be exposed.

Total internal exposures are obtained by adding ingestion and inhalation dose rates over all radionuclides, including all short-lived daughter products.

G.7.2 EFFECTS LEVELS FOR RADIONUCLIDES

The discharge of radioactive waste into the environment results in long-term, low-dose exposure to organisms. In most cases, acute mortality can be discounted. Any potential increase in morbidity and mortality that might result from the exposure to chronic irradiation above background is unlikely to be detected because of natural fluctuations in the size of populations. The International Atomic Energy Agency (IAEA) recommends limiting the dose for terrestrial organisms to 100 mrad/d (IAEA 1992). Species-specific effects data were not available, so 100 mrad/d was selected as the threshold dose for all representative wildlife receptors. A dose rate of 1 rad/d is generally considered protective of plant and invertebrate populations (IAEA 1992, Barnhouse 1995). Therefore, 1 rad/d was selected as the threshold dose for effects on plant and invertebrate populations.

G.7.3 RISK CHARACTERIZATION FOR WILDLIFE RECEPTORS EXPOSED TO RADIONUCLIDES

Risk characterization integrates the results of the exposure assessment (Sect. G.7.1) and the effects assessment (Sect. G.7.2) to estimate the likelihood of effects based on exposures. Generally a weight-of-evidence approach is used to determine the best estimate of risk to each assessment endpoint. Only a single line of evidence, comparison of estimated exposures to recommended dose rate limits, was available for the radionuclide assessment. Current exposures to radionuclides in floodplain soils along Bear Creek and in surface soil in the source areas as well as in surface water of Bear Creek and its tributaries are evaluated in this assessment. In addition, potential future exposures to radionuclides in floodplain soils and source area soils, Bear Creek surface water, and waste inventory areas are discussed.

G.7.3.1 Current Exposures

Potential risks to plants, earthworms, and selected terrestrial and semiaquatic wildlife receptors from current exposures to radionuclides in surface soil were estimated for each of 11 sites (transects) along Bear Creek and six source areas (the S-3 Ponds area, BYBY, the combined SL and OLF, the BG, the Creekside Debris Burial Area, and the Roadside Debris Burial Area). Exposures to radionuclides in surface water were estimated for 13 locations in Bear Creek and its tributaries as well as four seep areas. Dose rates were summed for all radionuclides over all exposure routes to obtain the overall dose in mrad/d received by each receptor at each site. Tables G.79–G.96 present internal, external, and overall exposures from soil and water for each receptor by site.

No detectable radiation effects are anticipated for plant, earthworm, or terrestrial or semiaquatic wildlife receptors frequenting the Bear Creek floodplain or source area sites. The overall dose rate was below the effects threshold of 100 mrad/d for all wildlife receptors at all sites. Overall dose rates for plants and earthworms were well below the effects threshold of 1 rad/d at all sites.

Watershed-wide population level effects are unlikely considering that even if a receptor were to receive 100% of its soil-related (soil and terrestrial food) dose from the most contaminated soil area and 100% of its water-related (water and aquatic food) dose from the most contaminated water area (an unlikely situation), its overall dose would be below the recommended limit. Wide-ranging wildlife such as fox, deer, and hawk would average their exposures over their entire home range; therefore, the actual dose rate to these receptors would be much lower.

Alpha radiation exposures related to ingestion of contaminated prey accounted for virtually all of the dose for all receptors. External exposures were inconsequential. The dose rates presented in

Tables G.79–G.103 represent the overall dose rates after applying the 20-fold quality factor for alpha radiation. The actual dose would be lower, but because alpha radiation is considered to have a greater effect, the effective dose is increased by a factor of 20. Uranium-238, ^{234}U , ^{241}Am , and ^{238}Pu , the primary contributors to doses at most sites, are all alpha emitters.

Soil Invertebrate Exposures to Radionuclides in Soil

Soil-related dose rates for earthworms were highest at the Roadside DBA (151 mrad/d) and Transect 1 near the intersection of NT-2 and Bear Creek (37.4 mrad/d), both well below the dose limit of 1 rad/d (Table 6.79). Uranium-234 accounts for 84% of the dose to earthworms at the DBA while Uranium-238 and ^{234}U were the primary contributors to dose rates at Transect 1. Earthworm dose rates were higher than those for any of the other receptors at all locations except the Creekside DBA.

Plant Exposures to Radionuclides in Soil

Dose rates to plants were <6.9 mrad/d at all locations except for canopy vegetation at Transect 3 (15.99 mrad/d) and Transect 6 (6.33 mrad/d) where ^{241}Am contributed >80% of the dose, and canopy and herbaceous vegetation at the Creekside DBA (23.7 and 20.3 mrad/d, respectively) (Tables G.81 and G.82). All plant dose rates were well below the dose rate limit of 1 rad/d.

Wildlife Exposures to Radionuclides in Soil

Soil-related dose rates to wildlife receptors ranged from <0.1 mrad/d to a maximum of 18.6 mrad/d (for white-footed mice and short-tailed shrews at the Creekside DBA). The maximum estimated dose rate is well below the dose rate limit of 100 mrad/d. Plutonium-238 accounted for over 66% of the dose for mice and shrews at the DBA. Soil-related dose rates for all other wildlife receptors at all other sites were <7 mrad/d.

Wildlife Exposures to Radionuclides in Water

Water-related dose rates were <2 mrad/d for all wildlife receptors at all sites except for kingfishers. The highest dose rate calculated for belted kingfishers was 17.86 mrad/d at the NT-3 area. Uranium-238 and $^{233/234}\text{U}$ contributed over 95% of the dose at NT-3. The kingfisher diet consists entirely of aquatic prey exposed to radionuclides in surface water; therefore, kingfishers receive a higher dose than the other receptors evaluated.

G.7.3.2 Future Exposures

Terrestrial Biota Exposed to Radionuclides in Surface Soil

Future soil-related radiation exposures at sites along Bear Creek and at the primary source areas were conservatively assumed equivalent to current exposures. No adverse effects are expected to populations of terrestrial plants, invertebrates, or wildlife due to current exposures, so no adverse effects are expected in the future. Over time, radiation exposures are expected to decrease.

Wildlife Exposed to Radionuclides in Surface Water

No adverse effects from future exposures to radionuclides in surface water are anticipated. Future water-related radiation exposures were evaluated for wildlife receptors at NT-1, NT-3, NT-7,

and NT-8 using predicted future maximum activity levels from modeled surface water data. Radionuclide activities had generally decreased, and this is reflected in the dose rate estimates provided in Tables G.97-103. Dose rates summed over all radionuclides were compared to the recommended dose rate limit of 100 mrad/d.

Estimated dose rates for all receptors from exposure to maximum predicted surface water radionuclide activities were well below the dose rate limit for all receptors. The highest dose rate (11.4 mrad/d) was estimated for belted kingfishers in the NT-3 area (Table G.103). No other receptors had dose rates exceeding 1.0 mrad/d at any location.

Terrestrial Biota Exposed to Radionuclides in Burial Ground Soil

In addition to the assessment of potential risks from exposure to radionuclides along Bear Creek and from surface soils at the primary source areas, potential risks associated with exposure to radiation levels at the C-East, C-West, and A-North Burial Grounds were assessed based on waste inventory data assuming failure of existing caps. Data were limited for these areas. At C-East, Thorium (assumed Thorium-228 for assessment) was present at 1.54×10^6 pCi/g (Table A.19) while at C-West, Thorium was present at 5.9×10^6 pCi/g and Technetium-99 was present at 3.44×10^6 pCi/g (Table A.20). Technetium was also present at A-North at 9.7×10^5 pCi/g (Table A.14).

These activities are substantially higher than those observed along Bear Creek or in the source areas, and exposure to radiation of this magnitude would result in significant risks to plants, invertebrates, and wildlife (Table G.104). The recommended limit of 100 mrad/d is exceeded by 1-4 orders of magnitude for short-tailed shrews, white-footed mice, red fox, white-tailed deer, and red-tailed hawk at C-East and C-West. Plant and earthworm dose rates would exceed the 1 rad/d dose limit by a factor of 0.5 to 1000. Thorium accounts for greater than 90% of the dose to wildlife at both sites, but Technetium-99 in C-West contributes up to 187 mrad/d to the dose rate received by the shrew, mouse, and deer. Plant and earthworm dose rates would exceed the 1 rad/d dose limit by three orders of magnitude at C-West and by 1-2 orders of magnitude at C-East. Technetium-99 at A-North also would result in dose rates 1000 times the recommended limit for plants and earthworms, but wildlife receptor dose rates were below the wildlife dose limit of 100 mrad/d (Table G.104).

G.7.4 UNCERTAINTIES IN THE RADIOLOGICAL RISK ASSESSMENT

A number of areas of uncertainty exist in the estimation of risks to wildlife from exposure to radionuclides at Bear Creek. It is believed that the methodology used in this assessment overestimates the dose rates that would be received. Whereas some of the information needed to implement the methodology is well-known, much is unknown or unspecified statistically. A conservative but reasonable approach to model assumptions and radiological exposure scenarios was adopted for this assessment in order to avoid underestimating risks to biota. Many of the uncertainties identified in the plant, soil invertebrate, and wildlife sections also apply to the radionuclide assessment. Specific uncertainties identified in the radionuclide assessment are presented here.

- It was assumed that uptake of radionuclides from soil, food, and water are similar. Radionuclides bound to soil may be less available than those in tissue or water. Therefore, assuming uptake from soil equal to uptake from food may result in a conservative estimate of actual uptake.

- Uptake factors from soil to earthworms were not available for many radionuclides. If uptake factors were unavailable, the higher of the plant or mammal uptake factors was used for earthworms. It is unknown whether actual earthworm uptake factors for these radionuclides would be higher or lower than those used, but use of the larger of the plant and mammal values was a conservative approach. Where measured values were available, earthworm uptake factors were generally lower than at least one of the corresponding plant or small mammal values.
- Uptake factors were not available for birds for all radionuclides. In the absence of bird-specific uptake factors, radionuclide activities in red-tailed hawk tissues were estimated using mammal uptake factors assuming that uptake would be similar for hawks and mammals. It is unknown whether actual bird uptake factors would be higher or lower than those used here.
- Mammal soil-to-tissue uptake factors were calculated from measured data on small rodents. While these clearly apply directly to white-footed mice, they were also used for the other small mammalian receptor, the short-tailed shrew. Short-tailed shrew diets differ somewhat from that of white-footed mice as shrews eat a higher proportion of invertebrates. However, it was assumed that site-specific data on mice was more applicable to shrews than literature-derived bioaccumulation factors.
- Literature-derived bioaccumulation factors were used to estimate radionuclide activities in mammal and bird tissues when site-specific data were unavailable. While these values are believed to be representative of bioaccumulation likely to be observed on site, actual values may be higher or lower than used in this assessment.
- Radiation dose rates estimated based on the waste inventories of the Burial Grounds were calculated using the same models and model parameters used for the floodplain soils and source areas. In the case of uptake factors, this assumes the ratio of radionuclides in tissue to soil or food remains the same even at the extremely high activity levels observed in the waste inventories. Dose rates based on the waste inventory data may be overestimated if the ratio is not linear to such high activities.
- Species-specific time budget information is lacking, so it was necessary to make a number of assumptions regarding the fraction of time each receptor spends above or below ground, underwater, or at the water's surface. The fractions used in this assessment were selected based on general knowledge of species behavior patterns, but actual fractions may be higher or lower.
- Wide-ranging wildlife species such as the red fox, white-tailed deer, and red-tailed hawk are unlikely to receive 100% of their exposure at any one location. Therefore, dose rates presented for these species are likely overestimated as they would average their exposures over a broader area than a single source area or transect location.
- The dose coefficients obtained from Eckerman and Ryman (1993) used to estimate dose rates from external exposures were developed for application in determining dose rates to humans. These dose coefficients were applied directly for wildlife receptors or adjusted based on the effective height of the receptors, but the actual dose coefficients for wildlife, given differences in size, behavior, and general morphology, may be greater or lesser than those developed for humans.
- Dietary information for the wildlife receptors evaluated here was obtained from available literature. Diets of given species in the White Oak Creek watershed may vary somewhat from those reported in the literature from other areas.
- The air mass loading factor of 0.1 g/m^3 used in estimating exposures from inhalation of radionuclide-contaminated dust was selected as a conservative value. Healy (1980) suggested 0.0001 g/m^3 would be a conservative value for estimating human exposures from inhalation of dust.

G.8 SUMMARY AND CONCLUSIONS

Significant ecological risks were identified in the BCV CA from chemicals in water, sediment, soil, and shallow groundwater for one or more receptors. Metals and PCBs were the primary COECs and source area and floodplain soils, including floodplain transects away from the source areas (i.e., west of BCK 9.4), contribute to these risks. These conclusions are summarized in Figs. G.74 through G.78.

The weight of evidence suggests that water from Bear Creek and tributaries NT-2 through NT-8 currently does not pose a significant risk of a 20% reduction in fish species richness or abundance due to a toxic effect. Although water from Reach 1 and NT-2 was consistently toxic to *C. dubia* and metals occurred at concentrations likely to be toxic, the species richness and total density of the fish community in Reach 1 has increased since 1989 and is comparable to reference communities. The lower densities observed at some sites (e.g., BCK 11.09 and BCK 7.87) appear to be attributable to poor habitat quality, including low stream flow and siltation from construction activities. The Tennessee dace population in Bear Creek does not appear to be degraded due to a toxic effect, given that the highest densities occur at the most highly contaminated site (BCK 12.36) and the lower densities observed in Reach 2 and upper Reach 3 are primarily attributable to poor habitat quality. Future risks may become significant in NT-1, NT-2, NT-7, NT-8, and Bear Creek at BCK 9.47, based on predicted maximum contaminant concentrations in surface water.

The weight of evidence suggests that water in Reaches 1 and 2, NT-2, SS-1, and SS-4 poses a significant risk of a 20% reduction in benthic invertebrate species richness and abundance due to a toxic effect. The distribution of observed effects and toxic concentrations strongly suggests that discharges from the S-3 Ponds continue to be the primary contributor to risks. The community is severely degraded in Reach 1, moderately degraded in Reach 2, and fully recovered in lower Reach 3 (BCK 3.25) and Reach 4. Survival and reproduction of the sensitive test organism *C. dubia* in water from Reach 1 and NT-2 continues to be drastically reduced, but the water from Reach 3 has never been shown to be toxic. Concentrations of dissolved calcium, cadmium, manganese, nickel, and uranium are likely to be toxic at one or more of the upper Bear Creek locations, but none of the COECS are likely to be toxic in Reaches 3 and 4. Habitat quality also is a contributing factor at sites in Reaches 2 and 3. Future risks are expected to remain significant in NT-1, NT-2 and most of Bear Creek Reaches 1 and 2 and may become significant in NT-7 and NT-8, based on predicted maximum contaminant concentrations in surface water.

The weight of evidence suggests that sediment from 3 of the 18 sites poses a significant risk to benthic invertebrates inhabiting those sites due to a toxic effect. However, it is unlikely that the soft-sediment benthic invertebrate community as a whole is reduced by 20% in species richness or abundance. Community survey data are not available for the depositional areas of Bear Creek. The toxicity tests of NT-2 and NT-6 sediment were too ambiguous to interpret, but the chemical analyses suggest that the reduced survival of *D. magna* is likely the result of manganese and, potentially, selenium and 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T). Significant risks are indicated at SD 17 in lower Bear Creek, but the toxic agent could not be identified. The sediment from this site was unambiguously toxic. However, none of the detected chemicals occur at concentrations reported to be toxic, and all chemicals detected at this site for which toxicological data were not available are present at higher concentrations at other sites where toxicity was not evident. Because the toxic agent could not be identified, sources other than the operations in upper Bear Creek cannot be ruled out.

Soil from the floodplain transects and the BCBG area does not appear to present a significant risk to soil invertebrates due to a toxic effect. Risks of a toxic effect to soil invertebrates are estimated to be significant in the S-3 Ponds area, SL/OLF area, BYBY area, Creekside Burial area, and the Bear Creek Road Debris Burial area. The BYBY area had the highest HQs. The lack of toxicity tests at these sites makes the conclusions somewhat less certain than the conclusions regarding the Bear Creek floodplain. The S-3 Ponds area, the major part of which is paved, provides little habitat for soil invertebrates.

Soil at isolated locations along two floodplain transects in upper Bear Creek (i.e., transects 3 and 4) appear to pose a significant risk to plants. Metals occur at potentially toxic concentrations, and soil from two transects was apparently toxic in laboratory tests with lettuce, though an appropriate reference site was not available. Toxicity tests were not available for the source area soils, but vegetation surveys suggest that there are no significant risks to plants. The lack of toxicity tests makes these conclusions somewhat less certain than the conclusions for the floodplain.

The plant community in the BCV floodplain and source areas are not currently negatively impacted by contaminants in shallow groundwater or springs. However, the plant community near NT-1 and NT-2, and to a lesser extent, NT-7 and NT-8 Walk in Pits may be adversely affected by metals in ground water in the future.

Short-tailed shrews are estimated to be significantly at risk of a 20% reduction in population production from high soil concentrations of metals and PCBs. Risks are significant for both the source area and BCV populations. Chemicals in source area and floodplain soils, including transects west of BCK 9.4, contribute to these risks.

Risks to white-footed mice were observed from only in the source area from only one contaminant, mercury. Mice inhabiting the floodplain are not at significant risk from any contaminants.

Risks to white-tailed deer in BCV are estimated to be insignificant. Although concentrations of three metals and PCBs exceeded LOAELs at one or more sites, the deer inhabiting the watershed do not appear to be significantly at risk of a 20% reduction in population production.

Risks to red-tailed hawks inhabiting BCV are estimated to be insignificant, but fox were estimated to be significantly at risk of a 20% reduction in population production. Copper and mercury in source area and floodplain soils, including transects west of BCK 9.4, contribute to these risks.

Both mink and kingfishers inhabiting the watershed were estimated to be significantly at risk of a 20% reduction in population production. Risks to mink are based on mercury in fish from lower Bear Creek. Copper and mercury in source area and floodplain soils, including transects west of BCK 9.4, contribute to these risks. Risks to kingfisher are based on mercury concentrations in fish, which exceeded the kingfisher LOAEL in upper and lower Bear Creek.

Red-tailed hawks were used as surrogates to estimate risks to T&E species that may be present in the BCV (cooper's hawks, sharp-shinned hawks and northern pine snakes). Because risks to red-tailed hawks were determined to be insignificant, risks to these three T&E species were also determined to be insignificant.

Radionuclide concentrations in BCV surface water and soil do not appear to present a significant to any of the assessment endpoints. Dose rates were below the recommended limits for fish, benthic invertebrates, plants, earthworms, and wildlife.

G.9 REMEDIAL GOAL OPTIONS

Because ecological risk assessments may be based on a weighing of multiple lines of evidence, the procedure for developing risk-based remedial goal options (RBRGOs) must also be based on weight of evidence. The procedure is depicted diagrammatically in Fig. G.79.

The procedure begins with input from the ecological risk characterization. RBRGOs must be developed for each endpoint for which risks have been characterized as significant. The first step is to determine what means are available for determining what areas or concentrations in media may require remediation. These alternative means are the lines of evidence used to characterize ecological risks: biological surveys, media toxicity tests, and single chemical toxicities. The manner of weighing them is as follows:

- If biological surveys have been performed and are judged to be sufficiently conclusive to be used for this purpose, the areas within which the surveys reveal a significant degradation are the areas requiring remediation.
- If the biological survey results are inconclusive or absent, media toxicity tests are potentially the most conclusive line of evidence because they indicate the toxicity of the media that are subject to remediation. Areas requiring remediation are those in which media toxicity was observed that exceed the levels specified in the assessment endpoint.
- If the biological surveys and the media toxicity tests are inconclusive or absent, the comparisons of ambient chemical concentrations with single chemical toxicity data must be used to derive RBRGOs. Areas requiring remediation are those in which ambient concentrations are estimated to cause effects that exceed the levels specified in the ecological assessment endpoint. The concentrations that are estimated to cause unacceptable effects should be compared with estimates of background concentration to ensure that the RBRGO does not propose remediating to below background.

The output of this weighing of evidence will be a set of areas that are candidates for remediation based on risks to a particular ecological assessment endpoint. If it is possible that the remediation would consist of treatment of a source or of contaminated media within the defined areas, rather than simply removing or isolating the contaminated media (e.g., dredging or capping), then the RBRGOs should be defined as concentrations that should be achieved within those areas. This should be done by referring to the characterization of risk based on ambient chemical concentrations and single chemical toxicity. The RBRGOs should be to eliminate all concentrations of contaminants that are estimated to cause significant risks to the endpoint.

G.9.1 RISK-BASED REMEDIAL GOAL OPTIONS FOR THE FISH COMMUNITY

The weight of evidence suggests that the fish communities in BCV are not currently degraded due to a contaminant effect. Therefore, RBRGOs are not indicated for this assessment endpoint.

The screening of predicted future aqueous contaminant concentrations suggests that exposures are expected to increase, and future risks to the fish community are expected to be significant, in NT-1, NT-2, NT-7, NT-8, in Bear Creek at BCK 9.47, and, potentially, between BCK 9.47 and NT-1. RBRGOs are presented in Table G.105 for chemicals for which adverse effects of predicted future concentrations

are possible or expected and loading is not at steady-state. As noted previously, the RBRGOs were selected from the available aqueous benchmarks in the following order of preference. The preferred benchmark is the chronic NAWQC, adjusted to 200 mg/L hardness for hardness dependent metals. The secondary chronic values are used for mercury and total PCBs because these NAWQCs are not based on the protection of aquatic life. If a NAWQC is not available, the lower of the LCV for daphnids and the LCV for fish is used. If these are not available (e.g., for lithium), the secondary chronic value is used. If the selected benchmark is less than the background criterion, the RBRGO defaults to the background criterion. It is important to note that, generally, risks in NT-7 and NT-8 are expected to increase slowly over the next 1000 years. The exception is that risks from cyanide are expected to peak in the next 50 years. However, chemical concentrations, and therefore risks to fish, in NT-1 and NT-2 are expected to peak in the next 50 to 350 years. The peak time for BCK 9.47 could not be estimated.

G.9.2 RISK-BASED REMEDIAL GOAL OPTIONS FOR BENTHIC INVERTEBRATES IN EROSIONAL AREAS

The weight of evidence suggests that water in Reaches 1 and 2, NT-2, SS-1, and SS-4 poses a significant risk to benthic invertebrates from high concentrations of calcium, cadmium, manganese, nickel, and uranium. The distribution of observed effects and toxic concentrations strongly suggests that discharges from the S-3 Ponds continue to be the primary contributor to risks. The first two lines of evidence (i.e., biological surveys and media toxicity tests) are sufficiently conclusive to determine the areas requiring remediation and the ultimate RBRGO for water, which is the reduction of risks to the BCV benthic invertebrate community due to a contaminant effect. Removal of the water is not a viable alternative. Therefore, RBRGOs are presented for those chemicals which are likely to be significantly toxic (Table G.106). The RBRGO for cadmium is for a water hardness of 200 mg/L, and should be adjusted to account for changes in hardness as a result of remedial actions. Water collected from SS-4 during and immediately after a rainstorm in August 1994 was toxic, but chemical analyses were not available for that event. The characterization of risks based on the single chemical toxicity data did not identify any chemicals in water collected from this seep that are likely to be toxic. Hence, the RBRGO for SS-4 is the reduction of toxicity due to a contaminant effect during storm events. However, two of the metals that are potentially toxic at this seep (nickel and uranium) are likely to be toxic elsewhere and have associated RBRGOs.

The weight of evidence for future risks to benthic invertebrates is based solely on the screening of predicted future aqueous contaminant concentrations, which suggest that exposures are expected to increase, and future risks to the benthic invertebrate community are expected to continue to be significant in NT-1, NT-2, Bear Creek at BCK 9.47 (i.e., the lower end of Reach 2), and potentially between BCK 9.47 and NT-1. Exposures are expected to increase, and future risks to the benthic invertebrate community are expected to become significant in NT-7 and NT-8. The RBRGOs for future risks to benthic invertebrates are the same as those for future risks to fish and are presented in Table G.105 for chemicals for which adverse effects of predicted future concentrations are possible or expected. Chemical concentrations and therefore risks to benthic invertebrates in NT-1 and NT-2 are expected to peak in the next 50 to 350 years. Generally, risks in NT-7 and NT-8 are expected to increase slowly over the next 1000 years. The exception is that risks from cyanide are expected to peak in the next 50 years. The peak time for BCK 9.47 could not be estimated.

G.9.3 RISK-BASED REMEDIAL GOAL OPTIONS FOR BENTHIC INVERTEBRATES IN DEPOSITIONAL AREAS

As noted previously, RBRGOs must first define an area requiring remediation. The weight of evidence indicates that sediments pose a significant risk to the benthic invertebrates inhabiting three locations in the BCV CA: NT-2, NT-6, and SD-17. However, it is unlikely that the benthic invertebrate community as a whole is degraded. That is, the sediments in NT-2, NT-6, and SD-17 probably do not constitute an ecologically significant portion of the available soft-sediment habitat in the adjoining areas and actions are not required to protect this community. If the risk managers determine that protection of the benthic invertebrates inhabiting individual depositional areas or tributaries is warranted, actions should be taken to meet the following RBRGOs.

RBRGOs were developed for the chemicals that were characterized as presenting a significant risk in NT-2 or NT-6 (manganese, selenium, and 2,4,5-T). Two estimates of whole sediment concentrations at which effects are expected are the generic effects levels from the literature (i.e., benchmarks) and the site-specific no apparent effects levels (SSNAEL). The SSNAEL is the highest measured concentration at which toxicity was not observed at the site. If significant toxicity was observed in laboratory tests for a site, the individual chemical concentrations at that site were considered potentially toxic. If significant toxicity was not observed at a site, the associated individual chemical concentrations were considered to be nontoxic. The principal uncertainties in the SSNAEL are the same uncertainties associated with the toxicity tests. For example, do the measured concentrations reflect the exposures received during toxicity tests. This uncertainty is small, because the chemical analyses and toxicity tests were conducted on the same sediment sample. Another uncertainty is the effect of differences in physical properties between sites. Organic carbon content may affect the bioavailability of potential contaminants and varied among sediment sites. Background levels of inorganics, which are presumed to be non-toxic to local biota, also must be considered when setting RBRGOs. The recommended RBRGO for whole sediment is the higher of the generic PEL, the SSNAEL, and the background criterion (Table G.107). That is, the RBRGO should not be lower than background or the site-specific concentrations that were tested and shown to be nontoxic.

The toxicity tests indicate that sediment at SD-17 poses a significant risk to the benthic invertebrates inhabiting that site. Because a likely causative agent could not be determined from the available chemical data, the RBRGO for SD-17 must be defined by the sediment toxicity test results. Hence, if a removal action is taken to reduce the risks at this site, the area to be remediated is dependent on toxicity, rather than chemical analyses.

G.9.4 RISK-BASED REMEDIAL GOAL OPTIONS FOR THE TERRESTRIAL PLANT COMMUNITY IN BEAR CREEK VALLEY SOILS

The weight of evidence indicates that the plant community is adversely impacted by contaminants in soil at near-creek locations in floodplain transects 3 and . Future risks to plants are indicated if plants are exposed to the S-3 Ponds sludges or BCBG wash inventory. Measures may be taken to ensure that chemicals at the sites do not exceed concentrations that are associated with effects. Where possible, we suggest the use of the SSNAEL. The SSNAEL is the largest concentration of a particular contaminant that exceeds the phytotoxicity benchmark and the upper tolerance limit (background), but was not associated with ambient soil toxicity in the floodplain. This standard assumes that chemical properties of the soil are similar from transect to transect to source area. The SSNAEL for each contaminant is derived using mean concentrations for the top 16 in. of soil at each station where the maximum detected concentration of a contaminant exceeded the benchmark. The top 16 in. of soil were used in toxicity

tests. If the mean concentration at a station does not exceed the benchmark at sites where lettuce toxicity was tested and not observed, the benchmark or upper tolerance limit is used as the RBRGO. RBRGOs for reducing risk to plants in soil are presented in Table G.108.

Considerations other than chemical concentration in soil may be considered in a clean-up decision. For example, risk managers must decide if a plant community in a small contaminated area should be remediated to reduce risk if the community is defined by similar vegetation across a wide geographic region. Also, if the source of contaminated soil is remediated, clean sediment deposits and water may dilute the concentration of contaminants in the floodplain, allowing vegetation to recover.

G.9.5 RISK-BASED REMEDIAL GOAL OPTIONS FOR PLANTS EXPOSED TO GROUNDWATER

The weight of evidence indicates no unacceptable risk to the plant community from contaminants in soil solution at current concentrations at locations near tributaries NT4, NT7, and NT8. The evaluation was based on concentrations of contaminants in shallow groundwater from wells in the source areas. However, the vegetation survey indicated probable toxicity to plants in a seep at the north edge of HCDA. Contaminants responsible for this toxicity were not identified, but it is likely that they leached from HCDA. Therefore, remediation of HCDA rather than the seep would be required to prevent toxicity to plants at this location. Risks to plants from future groundwater exposures are predicted in the next 100 to 160 years at NT-1 and NT-2, based on the movement of contaminants from S-3 Ponds sludges. Risks from groundwater in the vicinity of NT-7 and NT-8 may also increase in the next 1000 years. If it is deemed necessary to protect plants from future exposures to contaminants in soil solution, we suggest the use of solution toxicity benchmarks as RBRGOs. This recommendation assumes that chemical properties of soil solution are the same as those of test solutions used to derive the toxicity benchmarks and that shallow groundwater from wells is chemically similar to soil solution. RBRGOs for reducing future risk to plants in soil are presented in Table G.109.

G.9.6 RISK-BASED REMEDIAL GOAL OPTIONS FOR SOIL INVERTEBRATES IN BEAR CREEK VALLEY SOILS

The weight of evidence indicates that soil invertebrates are negatively impacted by contaminants at the S-3 Ponds area, the SL/OLF area, the BYBY area, the Creekside Burial area, and the Bear Creek Road Debris Burial area. Measures may be taken to ensure that chemicals at the sites do not exceed concentrations that are associated with effects. Where possible, we suggest the use of the SSNAEL, described in the section on RBRGOs for the plant community. The SSNAEL is the largest concentration of a particular contaminant that exceeds the phytotoxicity benchmark and the upper tolerance limit (background) but was not associated with ambient soil toxicity. RBRGOs for reducing risk to soil invertebrates are presented in Table G.109

Considerations other than chemical concentration in soil may be considered in a clean-up decision. For example, risk managers must decide if soil invertebrates are significant enough assessment endpoints to drive remedial decisions.

G.9.7 RISK-BASED REMEDIAL GOAL OPTIONS FOR WILDLIFE

The procedure for developing RBRGOs outlined earlier in this section was employed for wildlife. Because biological surveys and media toxicity tests were not performed for wildlife, RBRGOs were developed using the only remaining line of evidence, literature toxicity data. RBRGOs were developed for those endpoints and analytes where population-level risks were identified. These included: antimony for shrews; copper for shrews, fox, and mink; mercury for shrews, mice, fox, mink and kingfishers; vanadium and PCBs for shrews (Table G.72). RBRGOs were calculated based on soil concentration and the UCL95 for Bear Creek-specific soil-to-biota contaminant uptake factors (Table G.39). RBRGOs were calculated by manipulating the soil concentration in the exposure model (Sect. G.6.1, Eq. 3) such that an exposure estimate equivalent to the appropriate LOAEL was achieved. If a contaminant presented a risk to more than one species, the suggested RBRGO was set to the lowest RBRGO calculated. These values were then compared with background concentrations. If the calculated RBRGO was less than background, the RBRGO was set to the background concentration. Results of this analysis and suggested RBRGOs for wildlife are listed in Table G.111. It should be noted that all RBRGOs, with the exception of that for mercury and kingfishers, represent concentrations in surface soil. The RBRGO for kingfishers represents the mercury concentration in forage fish.

To determine which sites should be remediated to reduce the estimated population-level risk to an acceptable level (e.g., % of population experiencing exposures >LOAEL is <20%), Monte Carlo simulations were recalculated, and exposures at the most contaminated sites (e.g., the sites with the highest HQs) set to either zero (for PCBs) or to the estimated exposure at background (for inorganics). PCB exposures were set to 0 because it was assumed that if these sites were remediated using clean soil, the PCB content of these soils (and therefore the exposure to them) should be 0. Because inorganic contaminants that present risks may and frequently are also present at much lower concentrations in uncontaminated background soils and these (or similar) uncontaminated soils are likely to be used to remediate the contaminated sites, exposure was set to that estimated for background.

This approach focuses on the most contaminated sites with the goal of reducing population-level risk to an acceptable level. As a consequence, some sites, where point estimates of exposure indicate risks may be present, will not be recommended for remediation. While these sites may present a hazard to individuals that use these sites extensively, their remediation is not required to prevent risks at the population level. Effects of the remediation of selected sites on population-level risks to wildlife are presented in Table G.112. To reduce population-level risks to wildlife in the BCV and within BC OU 1, surface soils at 8 of the 17 locations evaluated are recommended for remediation. Five locations contribute significantly to risks from multiple contaminants to multiple species: the Roadside and Creekside areas, the S-3 Ponds area, the BYBY, and the OLF. The remaining locations (the BG, TS07, and TS10) only present risks to shrews from PCBs (Table G.112). Risks to kingfisher from mercury may be alleviated by reducing mercury concentrations in fish to the RBRGO level (Table G.124) at BCK 12.4, BCK 4.5, and BCK 0.6.

The recommendation that the BC OU 1 locations (the S-3 Ponds area, the BYBY, the OLF, and the BG) should be remediated to reduce current on-site risk should be viewed with some caution. These sites are generally small in size and generally provide minimal habitat. The S-3 Ponds area in particular is a paved parking lot and has virtually no habitat currently available. While the risk analysis may overestimate the current risks that these sites present, because the BC OU 1 locations are situated at the headwaters of the Bear Creek watershed and may serve as significant sources of contamination to downstream locations, they should still be considered for remediation.

G.10 FIGURES

Fig. G.1. Conceptual model for current exposures of receptors inhabiting Bear Creek Valley source areas. The dark-lined boxes indicate assessment endpoints.

Fig. G.2. Conceptual model for current exposures of receptors inhabiting Bear Creek, tributaries and seeps, and the Bear Creek floodplain. The dark-lined boxes indicate assessment endpoints.

Fig. G.3. Conceptual model for current exposures of wide-ranging receptors inhabiting Bear Creek Valley. The dark-lined boxes indicate assessment endpoints.

Fig. G.4. Conceptual model for hypothetical exposures of receptors to inventoried wastes. The dark-lined boxes indicate assessment endpoints.

**BEAR CREEK VALLEY
ECOLOGICAL RISK ASSESSMENT
STREAM REACH**

LEGEND:

.....	ROADS
.....	100' CONTOUR
.....	REACH 1
.....	NT-1 and Bear Creek to NT-3
.....	REACH 2
.....	NT-3 To BCK-9.40
.....	REACH 3
.....	BCK-9.40 to ET-4
.....	REACH 4
.....	ET-4 to EFPC

Fig. G.5. Reaches for aquatic biota.

Fig. G.6. Plot of UCL95 of unfiltered water concentrations of COPECs normalized to toxic units (TU). The Upper contour of the graph is the sum of TU for the locations. It includes COPECs with maximum TUs >0.01.

Fig. G.7. Plot of UCL95 of filtered water concentrations of COPECs normalized to toxic units (TU). The Upper contour of the graph is the sum of TU for the locations. It includes COPECs with maximum TUs >0.01.

Fig. G.8. Empirical distribution functions for acute toxicity and chronic toxicity of cadmium to aquatic organisms and individual measurements of cadmium in filtered water at locations for which potentially significant concentrations were reported.

Fig. G.9. Empirical distribution functions for acute toxicity and chronic toxicity of copper to aquatic organisms and individual measurements of copper in filtered water at locations for which potentially significant concentrations were reported.

Fig. G.10. Empirical distribution functions for acute toxicity and chronic toxicity of cyanide to aquatic organisms and individual measurements of cyanide in whole water at locations for which potentially significant concentrations were reported.

Fig. G.11. Empirical distribution functions for acute toxicity and chronic toxicity of lead to aquatic organisms and individual measurements of lead in filtered water at locations for which potentially significant concentrations were reported.

Fig. G.12. Empirical distribution functions for acute toxicity and chronic toxicity of mercury to aquatic organisms and individual measurements of mercury in filtered water at locations for which potentially significant concentrations were reported.

Fig. G.13. Empirical distribution functions for acute toxicity and chronic toxicity of nickel to aquatic organisms and individual measurements of nickel in filtered water at locations for which potentially significant concentrations were reported.

Fig. G.14. Empirical distribution functions for acute toxicity and chronic toxicity of silver to aquatic organisms and individual measurements of silver in filtered water at locations for which potentially significant concentrations were reported.

Fig. G.15. Range of maximum modeled surface water concentrations, compared to aqueous toxicity benchmark for (A) barium and (B) beryllium.

Fig. G.16. Range of maximum modeled surface water concentrations, compared to aqueous toxicity benchmark for (A) boron and (B) cadmium.

Fig. G.17. Range of maximum modeled surface water concentrations, compared to aqueous toxicity benchmark for (A) calcium and (B) copper.

Fig. G.18. Range of maximum modeled surface water concentrations, compared to aqueous toxicity benchmark for (A) cyanide and (B) lead.

Fig. G.19. Range of maximum modeled surface water concentrations, compared to aqueous toxicity benchmark for (A) lithium and (B) mercury.

Fig. G.20. Range of maximum modeled surface water concentrations, compared to aqueous toxicity benchmark for (A) nickel and (B) selenium.

Fig. G.21. Range of maximum modeled surface water concentrations, compared to aqueous toxicity benchmark for (A) uranium and (B) bis(2-ethylhexyl)phthalate.

Fig. G.22. Range of maximum modeled surface water concentrations, compared to aqueous toxicity benchmark for (A) tetrachloroethene and (B) total PCBs.

Fig. G.23. Percent reduction in survival and reproduction of *Ceriodaphnia dubia*, relative to controls, in aqueous toxicity tests conducted in May 1994.

Fig. G.24. Percent reduction in survival and reproduction of *Ceriodaphnia dubia*, relative to controls, in aqueous toxicity tests conducted in August 1994.

Fig. G.25. Mean species richness of the fish communities at sites in Bear Creek, Grassy Creek, Gum Hollow Creek, Pinhook Branch, and Mill Branch in spring and fall of each year, 1991-93. (BCK 0.7 not sampled in 1991.) Vertical bars represent ± 2 S.E. BCK = Bear Creek kilometer; GCK = Grassy Creek kilometer; GHK = Gum Hollow Creek kilometer; PHK = Pinhook Branch kilometer; MBK = Mill Branch kilometer. Source: Hinzman et al. 1995

Fig. G.26. Mean total density of the fish communities at sites in Bear Creek, Grassy Creek, Gum Hollow Creek, Pinhook Branch, and Mill Branch in spring and fall of each year, 1991-93. Vertical bars represent ± 2 S.E. BCK = Bear Creek kilometer; GCK = Grassy Creek kilometer; GHK = Gum Hollow Creek kilometer; PHK = Pinhook Branch kilometer; MBK = Mill Branch kilometer. Source: Hinzman et al. 1995

Fig. G.27. Mean total density of Tennessee dace at sites in Bear Creek, Gum Hollow Creek, Pinhook Branch, and Mill Branch in spring and fall of each year, 1992-94. Vertical bars represent ± 2 S.E. BCK = Bear Creek kilometer; GHK = Gum Hollow Creek kilometer; PHK = Pinhook Branch kilometer; MBK = Mill Branch kilometer. Source: Hinzman et al. 1995 and Schilling 1996

Fig. G.28. Mean total richness of the benthic macroinvertebrate communities at sites in Bear Creek, Grassy Creek, Gum Hollow Branch, Mill Branch, and UT Farm Creek in April of each year, 1985–93. Vertical bars represent ± 1 S.E. GCK = Grassy Creek kilometer; GHK = Gum Hollow kilometer; MBK = Mill Branch kilometer; UTK = UT Farm Creek kilometer. (Figure originally presented in Hinzman et al., 1995.)

Fig. G.29. Mean richness of Ephemeroptera, Plecoptera, and Trichoptera at sites in Bear Creek, Grassy Creek, Gum Hollow Branch, Mill Branch, and UT Farm Creek in April of each year, 1985–93. Vertical bars represent ± 1 S.E. GCK = Grassy Creek kilometer; GHK = Gum Hollow kilometer; MBK = Mill Branch kilometer; UTK = UT Farm Creek kilometer. (Figure originally presented in Hinzman et al., 1995.)

Fig. G.30. Plot of measured concentration of whole sediment COPECs normalized to toxic units (TU)—four general categories. The upper contour of the graph is the sum of TU for the locations. Includes COPECs with maximum TUs >0.01. This graph consists of four general categories of COPECs.

Fig. G.31. Plot of measured concentration of whole sediment COPECs normalized to toxic units (TU)—metals. The upper contour of the graph is the sum of TU for the locations. Includes COPECs with maximum TUs >0.01. This graph consists of four general categories of COPECs.

Fig. G.32. Plot of measured concentration of whole sediment COPECs normalized to toxic units (TU)—pesticides. The upper contour of the graph is the sum of TU for the locations. Includes COPECs with maximum TUs >0.01. This graph consists of four general categories of COPECs.

Arsenic

Fig. G.33. Empirical distribution functions for sediment toxicity of arsenic to sediment-associated organisms and individual measurements of arsenic in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Fig. G.34. Empirical distribution functions for sediment toxicity of cadmium to sediment-associated organisms and individual measurements of cadmium in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Fig. G.35. Empirical distribution functions for sediment toxicity of chromium to sediment-associated organisms and individual measurements of chromium in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Fig. G.36. Empirical distribution functions for sediment toxicity of copper to sediment-associated organisms and individual measurements of copper in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Fig. G.37. Empirical distribution functions for sediment toxicity of lead to sediment-associated organisms and individual measurements of lead in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Fig. G.38. Empirical distribution functions for sediment toxicity of mercury to sediment-associated organisms and individual measurements of mercury in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Nickel

Fig. G.39. Empirical distribution functions for sediment toxicity of nickel to sediment-associated organisms and individual measurements of nickel in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Silver

Fig. G.40. Empirical distribution functions for sediment toxicity of silver to sediment-associated organisms and individual measurements of silver in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Zinc

Fig. G.41. Empirical distribution functions for sediment toxicity of zinc to sediment-associated organisms and individual measurements of zinc in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Fig. G.42. Empirical distribution functions for sediment toxicity of Total PAHs to sediment-associated organisms and individual measurements of Total PAHs in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Fig. G.43. Empirical distribution functions for sediment toxicity of Total PCBs to sediment-associated organisms and individual measurements of Total PCBs in sediments at locations in Bear Creek Valley where potentially significant concentrations were reported.

Fig. G.44. Range of maximum modeled future groundwater concentrations, compared tophytoxicity benchmark for arsenic (A) and beryllium (B).

Fig. G.45. Range of maximum modeled future groundwater concentrations, compared to phytotoxicity benchmark for boron (A) and cadmium (B).

Fig. G.46. Range of maximum modeled future groundwater concentrations, compared to phytotoxicity benchmark for chromium (A) and copper (B).

Fig. G.47. Range of maximum modeled future groundwater concentrations, compared to phytoxicity benchmark for lead (A) and manganese (B).

Fig. G.48. Range of maximum modeled future groundwater concentrations, compared tophytotoxicity benchmark for mercury (A) and nickel (B).

Fig. G.49. Range of maximum modeled future groundwater concentrations, compared to phytoxicity benchmark for tetrachloroethene.

Fig. G.50. Summary of LOAEL-based toxic units for short-tailed shrews in the Bear Creek Valley (including BC OU 1). Bur_grnd=burial ground area; olf_slf=oil land farm/sanitary landfill area; byby=boneyard burnyard area; s3=s3 ponds area.

Fig. G.50. (continued)

Fig. G.51. Summary of LOAEL-based toxic units for white-footed mice in the Bear Creek Valley (including BC OU 1).
 Bur_grnd=burial ground area; olf_slf=oil land farm/sanitary landfill area; byby=boneyard burnyard area; s3=s3 ponds area.

Fig. G.52. Summary of LOAEL-based toxic units for white-tailed deer in the Bear Creek Valley (including BC OU 1). Bur_grnd=burial ground area; olf_slf=oil land farm/sanitary landfill area; byby=boneyard burnyard area; s3=s3 ponds area.

Fig. G.53. Summary of LOAEL-based toxic units for red fox in the Bear Creek Valley (including BC OU 1). Bur_grnd=burial ground area; olf_slf=oil land farm/sanitary landfill area; byby=boneyard burnyard area; s3=s3 ponds area.

Fig. G.54. Summary of LOAEL-based toxic units for red-tailed hawks in the Bear Creek Valley (including BC OU 1). Bur_grnd=burial ground area; olf_slf=oil land farm/sanitary landfill area; byby=boneyard burnyard area; s3=s3 ponds area.

Fig. G.55. Summary of LOAEL-based toxic units for mink in the Bear Creek Valley (including BC OU 1). Bur_grnd=burial ground area; olf_slf=oil land farm/sanitary landfill area; byby=boneyard burnyard area; s3=s3 ponds area.

Fig. G.56. Summary of LOAEL-based toxic units for belted kingfisher in the Bear Creek Valley (including BC OU 1).

Fig. G.57. Cumulative binomial probability of short-tailed shrews experiencing exposure to antimony in BCV in excess of the LOAEL.

Fig. G.58. Cumulative binomial probability of short-tailed shrews experiencing exposure to antimony in BC OU I in excess of the LOAEL.

Fig. G.59. Cumulative binomial probability of short-tailed shrews experiencing exposure to cadmium in BCY in excess of the LOAEL.

Fig. G.60. Cumulative binomial probability of short-tailed shrews experiencing exposure to cadmium in BC OU 1 in excess of the LOAEL.

Fig. G.61. Cumulative binomial probability of short-tailed shrews experiencing exposure to molybdenum in BCV in excess of the LOAEL.

Fig. G.62. Cumulative binomial probability of short-tailed shrews experiencing exposure to selenium in BCV in excess of the LOAEL.

Fig. G.63. Cumulative binomial probability of short-tailed shrews experiencing exposure to selenium in BC OU 1 in excess of the LOAEL.

Fig. G.64. Cumulative binomial probability of short-tailed shrews experiencing exposure to vanadium in BC OU 1 in excess of the LOAEL.

Fig. G.65. Cumulative binomial probability of white-footed mice experiencing exposure to cadmium in BCV in excess of the LOAEL.

Fig. G.66. Cumulative binomial probability of white-footed mice perceiving exposure to cadmium in BC OU 1 in excess of the LOAEL.

Fig. G.67. Cumulative binomial probability of white-footed mice experiencing exposure to chromium in BCV in excess of the LOEL.

Fig. G.68. Cumulative binomial probability of white-footed mice experiencing exposure to mercury in BCV in excess of the LOAEL.

Fig. G.69. Cumulative binomial probability of white-footed mice experiencing exposure to mercury in BC OU 1 in excess of the LOAEL.

Fig. G.70. Cumulative binomial probability of red fox experiencing exposure to antimony in BCV in excess of the

Fig. G.71. Cumulative binomial probability of red fox experiencing exposure to PCBs in BCV in excess of the

Fig. G.72. Cumulative binomial probability of mink experiencing exposure to copper in BCV in excess of the LOAEL.

Fig. G.73. Cumulative binomial probability of mink experiencing exposure to mercury in BCV in excess of the LOAEL.

Fig. G.74. Summary of risk characterization for fish in Bear Creek Valley.

Fig. G.76. Summary of risk characterization for terrestrial invertebrates in Bear Creek Valley.

Fig. G.77. Summary of risk characterization for terrestrial plants in Bear Creek Valley.

Fig. G.78. Distribution of risks posed to ecological receptors in Bear Creek Valley.

Fig. G.79. Estimation of risk-based RBRGOs.

G.11 TABLES

Table G.1. Descriptions of the ecotoxicological screening benchmarks for aquatic biota*

Benchmark	Abbreviation	Description
Acute National Ambient Water Quality Criteria	NAWQC_ACU	Current national criteria for protection of aquatic life from lethal effects in episodic exposures. Adjusted for hardness of 100 mg/L CaCO ₃ for hardness-dependent metals.
Chronic National Ambient Water Quality Criteria	NAWQC_CHR	Current national criteria for protection of aquatic life from lethal and sublethal effects in extended exposures. Criteria for uses of aquatic life (i.e., fish consumption) are not included. Adjusted for hardness of 100 mg/L CaCO ₃ for hardness-dependent metals.
Acute National Ambient Water Quality Criteria at 200 mg/L hardness	NACU_200	Acute NAWQC adjusted for hardness of 200 mg/L CaCO ₃ for hardness-dependent metals.
Chronic National Ambient Water Quality Criteria at 200 mg/L hardness	NCHR_200	Chronic NAWQC adjusted for hardness of 200 mg/L CaCO ₃ for hardness-dependent metals.
Secondary Acute Value	S_ACU_V	Values estimated with 80% confidence to not exceed the unknown acute NAWQC. Used when data are inadequate to calculate the acute criterion.
Secondary Chronic Value	S_CHR_V	Values estimated with 80% confidence to not exceed the unknown chronic NAWQC. Used when data are inadequate to calculate the chronic criterion.
Lowest Chronic Value for fish	LCV_FISH	The lowest value, from acceptable fish chronic toxicity tests, of the geometric mean of the Lowest Observed Effect Concentration (LOEC) and the No Observed Effect Concentration (NOEC).
Lowest Chronic Value for daphnids	LCV_DAPH	The lowest value, from acceptable daphnid chronic toxicity tests, of the geometric mean of the LOEC and the NOEC.
Lowest Chronic Value for non-daphnid invertebrates	LCV_NDI	The lowest value of the geometric mean of the LOEC and the NOEC from acceptable chronic toxicity tests of nondaphnid invertebrate species.
Lowest Plant Value	LCV_AQPL	The lowest value from an acceptable aquatic plant toxicity test of the geometric mean of the LOEC and the NOEC.

Table G.1 (continued)

Benchmark	Abbreviation	Description
Lowest Test EC20 for Fish	LTV_FISH	The lowest value, from acceptable fish chronic toxicity tests, of the lowest concentration causing at least a 20% reduction in the weight of young per female or the weight of young per egg.
Lowest Test EC20 for Daphnids	LTV_DAPH	The lowest value from an acceptable daphnid chronic toxicity test of the lowest concentration causing at least a 20% reduction in the product of survivorship, and fecundity.

*More details are presented by Suter and Mabrey (1994).

Table G.2. Exposure factors for the radionuclides detected in BCV sediment or surface water and their short-lived progeny

Radionuclide ^a	K _d ^b	Biological concentration factor ^c	Emission energies (MeV)				Absorbed fraction			
			Average alpha	Maximum beta	Average beta	Average gamma	Beta for small invertebrates	Beta for small fish	Gamma for small invertebrates	Gamma for small fish
Cesium-137 + Barium-137m	1000	2000		1.17E+00	2.52E-01	5.96E-01	0.6	0.99	0.003	0.015
Potassium-40	N/A	10000		1.32E+00	5.23E-01	1.56E-01	0.55	0.98	0.002	0.012
Strontium-90 + Yttrium-90	N/A	60		2.79E+00	1.13E+00	1.69E-06	0.25	0.83	0.4	0.6
Technetium-99	1.5	20		2.95E-01	1.01E-01		1	1		
Thorium-232	150000	100	4.07E+00		1.25E-02	1.33E-03	1	1	0.4	0.6
Radium-228					1.69E-02	4.14E-09	1	1	0.4	0.6
Actinium-228					4.60E-01	9.30E-01	0.95	1	0.003	0.015
Thorium-232	150000	100	5.49E+00		2.05E-02	3.30E-03	1	1	0.4	0.6
Radium-224			5.78E+00							
Radon-220			6.40E+00		8.19E-06	3.85E-04	1	1	0.4	0.6
Polonium-216			6.91E+00		1.61E-07	1.69E-05	1	1	0.4	0.6
Lead-212					1.75E-01	1.48E-01	1	1	0.002	0.012
Bismuth-212			2.22E+00	5.80E-01	4.69E-01	1.85E-01	0.95	1	0.002	0.012
Polonium-212			8.95E+00	2.25E+00			0.3	0.89		

Table G.2 (continued)

Radionuclide ^a	K _d ^b	Biological concentration factor ^c	Emission energies (MeV)				Absorbed fraction			
			Average alpha	Maximum beta	Average beta	Average gamma	Beta for small invertebrates	Beta for small fish	Gamma for small invertebrates	Gamma for small fish
Americium-241	700	30	5.57E+00		5.19E-02	3.24E-02	1	1	0.01	0.05
Uranium-238	450	10	4.26E+00		1.00E-02	1.36E-03	1	1	0.4	0.6
Thorium-234					5.92E-02	9.34E-03	1	1	0.4	0.6
Protactinium-234m				2.29E+00	8.20E-01	1.13E-02	0.3	0.87	0.2	0.5
Uranium-234	450	10	4.84E+00		1.32E-02	1.73E-03	1	1	0.4	0.6
Thorium-230	150000	100	4.74E+00		1.46E-02	1.55E-03	1	1	0.4	0.6
Uranium-235	450	10	4.47E+00		4.80E-02	1.54E-01	1	1	0.002	0.012
Thorium-231					1.63E-01	2.55E-02	1	1	0.03	0.15

Sources: Biological concentration factors, emission energies, and absorbed fractions are from Blaylock et al. (1993). Absorbed fractions were estimated from graphs. Soil-water partitioning coefficients are from Baes et al. (1984).

^aDesignation of parent radionuclides and short-lived progeny are taken from Tables A.1 and A.2 in Blaylock et al. (1993). For naturally occurring alpha decay series, the parent is listed first and progeny are listed immediately below in order of occurrence.

^bSoil-water partitioning coefficients are presented only for parent isotopes detected in BCV sediments.

^cBiological concentration factors are presented only for parent isotopes detected in BCV.

**Table G.3. Fish densities (number of fish/m²) and species richness in Bear Creek and in three reference streams—
Gum Hollow Creek, Pinhook Branch, and Mill Branch in 1994**

Sampling periods	Sites ^a											
	BCK 0.7	BCK 3.25	BCK 7.87	BCK 9.40	BCK 9.91	BCK 11.09	BCK 11.83	BCK 12.36	GHK 2.9	PHK 1.6	MBK 1.6	
April 1994												
Tennessee dace	-	<0.01	0.12	0.06	0.21	0.11	0.01	1.22	0.08	0.33 ^b	0.01	
Total density	0.74	0.78	3.38	2.53	3.78	1.68	2.07	5.23	0.95	1.19	0.48	
Species richness	18	11	7	7	7	4	4	4	3	3	12	
October–December 1994												
Tennessee dace	-	-	0.92	0.53	0.34 ^b	0.07	0.65	0.88	0.81	0.31	<0.01	
Total density	1.59	2.26	5.37	6.50	4.09	1.29	4.55	5.87	5.14	3.18	0.63	
Species richness	14	12	7	7	6	4	4	4	3	3	13	

Source: Schilling, E. M., Oak Ridge National Laboratory, Oak Ridge, personal communication, Jan. 26, 1996.

^aBCK = Bear Creek kilometer; GHK = Gum Hollow Creek kilometer; PHK = Pinhook Branch kilometer; MBK = Mill Branch kilometer.

^bIncludes one specimen of a hybrid Tennessee dace.

Table G.4. Results of screening of chemicals in surface water that exceed background criteria and benchmarks for COPECs

Chemical	COPEC	Reason for inclusion or rejection
Aluminum	Yes	Total exceeds the NAWQ_CHR, LCV_AQPL, and/or the LTV_DAPH in Bear Creek Reach 1, BCK 9.4 (Reach 2) and BCK 9.4-SS5 (Reach 3), NT-2, NT-7, NT-8, SS-1, SS-4, SS-6; the NAWQ_ACU in Reach 1, BCK 9.4 (Reach 2) and BCK 9.4-SS5 (Reach 3), NT-2, NT-7, and NT-8; the LCV_DAPH in BCK 9.4 (Reach 2) and BCK 9.4-SS5 (Reach 3), NT-7 and NT-8; and the LCV_FISH and LTV_FISH in BCK 9.4 (Reach 2) and NT-7. Dissolved was less than background at all locations.
Barium	Yes	Exceeds the S_ACU_V and S_CHR_V in Bear Creek in Reach 1, BCK 9.4 (Reach 2), NT-2, SS-1, and SS-4.
Boron	Yes	Total and dissolved concentrations exceed the LTV_DAPH in Bear Creek in all areas (Reach 1, BCK 9.4 in Reach 2, BCK 9.4-SS5 and BCK 4.55 in Reach 3, and BCK 0.63 in Reach 4) and in SS-1, SS-4, SS-5, SS-6, and SS-8 and the S_CHR_V in Bear Creek at BCK 9.4 (Reach 2). No other benchmarks were exceeded at any other sites.
Cadmium	Yes	Exceeds all benchmarks in whole water in Reach 1 and all benchmarks except NACU_200 in whole water in SS-1. Dissolved concentrations exceed all benchmarks in Reach 1 and all benchmarks except NACU_200 in Bear Creek at BCK 9.4 and in SS-1.
Calcium	Yes	Total and dissolved exceed the LCV_DAPH in Bear Creek Reach 1, NT-2, and SS-1. Total and dissolved exceed background, but not the LCV_DAPH, at all other sampled locations.
Cobalt	Yes	Dissolved exceeds the S_CHR_V at Reach 1. All other detected concentrations were below background.
Copper	Yes	Total exceeds the LCV_DAPH, LTV_DAPH, and LCV_AQPL in Bear Creek Reach 1, BCK 4.55 (Reach 3), and BCK 0.63 (Reach 4), but not at BCK 9.40 (Reach 2). Total exceeds all benchmarks at NT-7 and SS-6. Dissolved exceeds the LCV_DAPH, LTV_DAPH, and LCV_AQPL at all sites; the LCV_FISH in Bear Creek Reach 1, BCK 4.55 (Reach 3), and BCK 0.63 (Reach 4), SS-1, SS-5, and SS-8; and the LTV_FISH, and LCV_NDI in Bear Creek Reach 1, BCK 4.55 (Reach 3), SS-8.
Cyanide	Yes	Exceeds NAWQC_CHR and LTV_FISH in whole water from Bear Creek Reach 1, NT_2, NT-4, NT-7, and NT-8. Also exceeds LCV_FISH in NT-8, but no other benchmarks in any other locations. Not detected in filtered water samples. A local background value was not available.

Chemical	COPEC	Reason for inclusion or rejection
Iron	Yes	Total exceeds the LTV_DAPH and LCV_DAPH in BCK 9.4 (Reach 2), BCK 9.4-SS5 (Reach 3), NT-7 and SS-1. Also exceeds the NAWQ_CHR and LCV_FISH in BCK 9.4 (Reach 2), BCK 9.4-SS5 (Reach 3), and NT-7. Dissolved is below background at all locations.
Lead	Yes	Total exceeds the NAWQ_CHR, but not the NCHR_200, at SS-1 and SS-5. Dissolved exceeds the NAWQ_CHR in Bear Creek Reach 1 and SS-4. Also exceeds the NCR_200 and LCV_DAPH at NT-1.
Lithium	Yes	Total exceeds the S_CHR_V in BCK 9.4 (Reach 2), BCK 9.4-SS5 (Reach 3), NT-3, NT-6, NT-7, NT-8, and SS-4. Dissolved exceeds the S_CHR_V in BCK 9.4 (Reach 2), BCK 9.4-SS5 (Reach 3), NT-3, NT-7, NT-8, and SS-4.
Manganese	Yes	Total exceeds the S_CHR_V in SS-1 and SS-4, but is less than background at all other locations. Dissolved is less than background at all locations.
Mercury	Yes	Total exceeds LCV_FISH in NT-3, but is less than benchmarks at all other locations. Dissolved exceeds the LCV_FISH in NT-8, but is less than benchmarks at all other locations.
Nickel	Yes	Total exceeds the LCV_AQPL and LCV_DAPH in Bear Creek Reach 1, BCK 9.4 (Reach 2), BCK 9.4-SS5 (Reach 3), NT-7, SS-1, and SS-4 and the LCV_FISH and LTV_DAPH in Bear Creek Reach 1. Dissolved exceeds the LCV_AQPL and LCV_DAPH in Bear Creek Reach 1, BCK 9.4 (Reach 2), SS-1, SS-4, SS-5, SS-6, and SS-8 and the LCV_FISH and LTV_DAPH in Reach 1.
Selenium	No	Detected in 1 of 23 samples from Bear Creek Reach 1. The screening value, but not the single detected concentration, exceeded background and the NAWQ_CHR. Selenium was infrequently detected elsewhere in whole water (1 of 22 at BCK 9.4 and 1 of 21 at NT-6) and filtered water (1 of 22 at BCK 9.4 and 2 of 14 at NT-8) and never exceeded background and benchmarks. Therefore, the one exceedence in Reach 1 is considered to be an anomaly and does not warrant the inclusion of selenium as a COPEC.
Silver	Yes	Total exceeds the LCV_FISH, LTV_FISH, S_CHR_V, LTV_DAPH, and LCV_DAPH in Bear Creek Reach 1, BCK 4.55 (Reach 3), SS-1, SS-4, SS-6, and SS-8. Dissolved in Reach 1 and BCK 4.55 (Reach 3) also exceeds these benchmarks. The NACU_200 was not exceeded by total or dissolved at any location.
Strontium	Yes	Total and dissolved exceed the S_CHR_V in Bear Creek Reach 1.

Chemical	COPEC	Reason for inclusion or rejection
Uranium	Yes	Total exceeds the S_CHR_V and S_ACU_V in Bear Creek in all areas (Reach 1, BCK 9.4 in Reach 2, BCK 9.4-SS5 and BCK 4.55 in Reach 3, and BCK 0.63 in Reach 4), SS-1, SS-4, and SS-5, and the LCV_FISH in Reach 1, BCK 9.4-SS5 (Reach 3), and SS-4. Dissolved exceeds the S_CHR_V and S_ACU_V in Bear Creek in all areas (Reach 1, BCK 9.4 in Reach 2, BCK 9.4-SS5 and BCK 4.55 in Reach 3, and BCK 0.63 in Reach 4), SS-1, SS-4, and SS-5; The S_CHR_V in SS-8; and the LCV_FISH in Reach 1, BCK 9.4-SS5 (Reach 3), and SS-4.
Zinc	Yes	Total exceeds the LCV_AQPL in Bear Creek Reach 1, BCK 9.4-SS5 (Reach 3) and NT-7 and the LCV_FISH in BCK 9.4-SS5 (Reach 3) and NT-7. Dissolved is below background and benchmarks at all areas.
1,2-Dichloroethene	Yes	Exceeds the S_CHR_V in NT-7 and NT-8.

Table G.5. Exposure concentrations, benchmarks, and the HQs for aqueous COPECs^a

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Aluminum	WHOL	BC9.4-SS5	18	37	5.13E+00	8.82E+00	8.70E-02	NAWQ_CHR	101.338
Aluminum	WHOL	BC9.4-SS5	18	37	5.13E+00	8.82E+00	4.60E-01	LCV_AQPL	19.166
Aluminum	WHOL	BC9.4-SS5	18	37	5.13E+00	8.82E+00	5.40E-01	LTV_DAPH	16.327
Aluminum	WHOL	BC9.4-SS5	18	37	5.13E+00	8.82E+00	7.50E-01	NAWQ_ACU	11.755
Aluminum	WHOL	BC9.4-SS5	18	37	5.13E+00	8.82E+00	1.90E+00	LCV_DAPH	4.640
Aluminum	WHOL	BC9.4-SS5	18	37	5.13E+00	8.82E+00	3.29E+00	LCV_FISH	2.681
Aluminum	WHOL	BC9.4-SS5	18	37	5.13E+00	8.82E+00	4.70E+00	LTV_FISH	1.876
Aluminum	WHOL	BCK 9.40	26	35	1.68E+00	3.18E+00	8.70E-02	NAWQ_CHR	36.502
Aluminum	WHOL	BCK 9.40	26	35	1.68E+00	3.18E+00	4.60E-01	LCV_AQPL	6.904
Aluminum	WHOL	BCK 9.40	26	35	1.68E+00	3.18E+00	5.40E-01	LTV_DAPH	5.881
Aluminum	WHOL	BCK 9.40	26	35	1.68E+00	3.18E+00	7.50E-01	NAWQ_ACU	4.234
Aluminum	WHOL	BCK 9.40	26	35	1.68E+00	3.18E+00	1.90E+00	LCV_DAPH	1.671
Aluminum	WHOL	BCK 9.40	26	35	1.68E+00	3.18E+00	3.29E+00	LCV_FISH	0.966
Aluminum	WHOL	BCK 9.40	26	35	1.68E+00	3.18E+00	4.70E+00	LTV_FISH	0.676
Aluminum	WHOL	NT2	18	21	1.15E+00	1.84E+00	8.70E-02	NAWQ_CHR	21.101
Aluminum	WHOL	NT2	18	21	1.15E+00	1.84E+00	4.60E-01	LCV_AQPL	3.991
Aluminum	WHOL	NT2	18	21	1.15E+00	1.84E+00	5.40E-01	LTV_DAPH	3.400
Aluminum	WHOL	NT2	18	21	1.15E+00	1.84E+00	7.50E-01	NAWQ_ACU	2.448
Aluminum	WHOL	NT2	18	21	1.15E+00	1.84E+00	1.90E+00	LCV_DAPH	0.966
Aluminum	WHOL	NT2	18	21	1.15E+00	1.84E+00	3.29E+00	LCV_FISH	0.558
Aluminum	WHOL	NT2	18	21	1.15E+00	1.84E+00	4.70E+00	LTV_FISH	0.391
Aluminum	WHOL	NT7	12	21	3.55E+00	6.26E+00	8.70E-02	NAWQ_CHR	71.990

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Aluminum	WHOL	NT7	12	21	3.55E+00	6.26E+00	4.60E-01	LCV_AQPL	13.615
Aluminum	WHOL	NT7	12	21	3.55E+00	6.26E+00	5.40E-01	LTV_DAPH	11.598
Aluminum	WHOL	NT7	12	21	3.55E+00	6.26E+00	7.50E-01	NAWQ_ACU	8.351
Aluminum	WHOL	NT7	12	21	3.55E+00	6.26E+00	1.90E+00	LCV_DAPH	3.296
Aluminum	WHOL	NT7	12	21	3.55E+00	6.26E+00	3.29E+00	LCV_FISH	1.905
Aluminum	WHOL	NT7	12	21	3.55E+00	6.26E+00	4.70E+00	LTV_FISH	1.333
Aluminum	WHOL	NT8	7	14	1.29E+00	2.42E+00	8.70E-02	NAWQ_CHR	27.812
Aluminum	WHOL	NT8	7	14	1.29E+00	2.42E+00	4.60E-01	LCV_AQPL	5.260
Aluminum	WHOL	NT8	7	14	1.29E+00	2.42E+00	5.40E-01	LTV_DAPH	4.481
Aluminum	WHOL	NT8	7	14	1.29E+00	2.42E+00	7.50E-01	NAWQ_ACU	3.226
Aluminum	WHOL	NT8	7	14	1.29E+00	2.42E+00	1.90E+00	LCV_DAPH	1.274
Aluminum	WHOL	NT8	7	14	1.29E+00	2.42E+00	3.29E+00	LCV_FISH	0.736
Aluminum	WHOL	NT8	7	14	1.29E+00	2.42E+00	4.70E+00	LTV_FISH	0.515
Aluminum	WHOL	Reach 1	33	38	1.08E+00	1.87E+00	8.70E-02	NAWQ_CHR	21.528
Aluminum	WHOL	Reach 1	33	38	1.08E+00	1.87E+00	4.60E-01	LCV_AQPL	4.072
Aluminum	WHOL	Reach 1	33	38	1.08E+00	1.87E+00	5.40E-01	LTV_DAPH	3.468
Aluminum	WHOL	Reach 1	33	38	1.08E+00	1.87E+00	7.50E-01	NAWQ_ACU	2.497
Aluminum	WHOL	Reach 1	33	38	1.08E+00	1.87E+00	1.90E+00	LCV_DAPH	0.986
Aluminum	WHOL	Reach 1	33	38	1.08E+00	1.87E+00	3.29E+00	LCV_FISH	0.570
Aluminum	WHOL	Reach 1	33	38	1.08E+00	1.87E+00	4.70E+00	LTV_FISH	0.398
Aluminum	WHOL	SSI	20	27	3.37E-01	5.62E-01	8.70E-02	NAWQ_CHR	6.463

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Aluminum	WHOL	SS1	20	27	3.37E-01	5.62E-01	4.60E-01	LCV_AQPL	1.222
Aluminum	WHOL	SS1	20	27	3.37E-01	5.62E-01	5.40E-01	LTV_DAPH	1.041
Aluminum	WHOL	SS1	20	27	3.37E-01	5.62E-01	7.50E-01	NAWQ_ACU	0.750
Aluminum	WHOL	SS1	20	27	3.37E-01	5.62E-01	1.90E+00	LCV_DAPH	0.296
Aluminum	WHOL	SS1	20	27	3.37E-01	5.62E-01	3.29E+00	LCV_FISH	0.171
Aluminum	WHOL	SS1	20	27	3.37E-01	5.62E-01	4.70E+00	LTV_FISH	0.120
Aluminum	WHOL	SS4	19	27	3.36E-01	5.40E-01	8.70E-02	NAWQ_CHR	6.212
Aluminum	WHOL	SS4	19	27	3.36E-01	5.40E-01	4.60E-01	LCV_AQPL	1.175
Aluminum	WHOL	SS4	19	27	3.36E-01	5.40E-01	5.40E-01	LTV_DAPH	1.001
Aluminum	WHOL	SS4	19	27	3.36E-01	5.40E-01	7.50E-01	NAWQ_ACU	0.721
Aluminum	WHOL	SS4	19	27	3.36E-01	5.40E-01	1.90E+00	LCV_DAPH	0.284
Aluminum	WHOL	SS4	19	27	3.36E-01	5.40E-01	3.29E+00	LCV_FISH	0.164
Aluminum	WHOL	SS4	19	27	3.36E-01	5.40E-01	4.70E+00	LTV_FISH	0.115
Aluminum	WHOL	SS6	18	25	2.47E-01	5.01E-01	8.70E-02	NAWQ_CHR	5.753
Aluminum	WHOL	SS6	18	25	2.47E-01	5.01E-01	4.60E-01	LCV_AQPL	1.088
Aluminum	WHOL	SS6	18	25	2.47E-01	5.01E-01	5.40E-01	LTV_DAPH	0.927
Aluminum	WHOL	SS6	18	25	2.47E-01	5.01E-01	7.50E-01	NAWQ_ACU	0.667
Aluminum	WHOL	SS6	18	25	2.47E-01	5.01E-01	1.90E+00	LCV_DAPH	0.263
Aluminum	WHOL	SS6	18	25	2.47E-01	5.01E-01	3.29E+00	LCV_FISH	0.152
Aluminum	WHOL	SS6	18	25	2.47E-01	5.01E-01	4.70E+00	LTV_FISH	0.106
Barium	FLTR	BCK 9.40	34	35	9.11E-02	1.05E-01	3.80E-03	S_CHR_V	27.624

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Barium	FLTR	BCK 9.40	34	35	9.11E-02	1.05E-01	6.91E-02	S_ACU_V	1.519
Barium	FLTR	BCK 9.40	34	35	9.11E-02	1.05E-01	5.80E+00	LCV_DAPH	0.018
Barium	FLTR	NT2	21	21	3.05E-01	3.91E-01	3.80E-03	S_CHR_V	102.776
Barium	FLTR	NT2	21	21	3.05E-01	3.91E-01	6.91E-02	S_ACU_V	5.652
Barium	FLTR	NT2	21	21	3.05E-01	3.91E-01	5.80E+00	LCV_DAPH	0.067
Barium	FLTR	Reach 1	38	38	3.49E-01	4.05E-01	3.80E-03	S_CHR_V	106.500
Barium	FLTR	Reach 1	38	38	3.49E-01	4.05E-01	6.91E-02	S_ACU_V	5.857
Barium	FLTR	Reach 1	38	38	3.49E-01	4.05E-01	5.80E+00	LCV_DAPH	0.070
Barium	FLTR	SS1	26	27	1.10E-01	1.43E-01	3.80E-03	S_CHR_V	37.734
Barium	FLTR	SS1	26	27	1.10E-01	1.43E-01	6.91E-02	S_ACU_V	2.075
Barium	FLTR	SS1	26	27	1.10E-01	1.43E-01	5.80E+00	LCV_DAPH	0.025
Barium	FLTR	SS4	26	27	1.41E-01	1.58E-01	3.80E-03	S_CHR_V	41.452
Barium	FLTR	SS4	26	27	1.41E-01	1.58E-01	6.91E-02	S_ACU_V	2.280
Barium	FLTR	SS4	26	27	1.41E-01	1.58E-01	5.80E+00	LCV_DAPH	0.027
Barium	WHOL	NT2	21	21	3.07E-01	3.90E-01	3.80E-03	S_CHR_V	102.657
Barium	WHOL	NT2	21	21	3.07E-01	3.90E-01	6.91E-02	S_ACU_V	5.645
Barium	WHOL	NT2	21	21	3.07E-01	3.90E-01	5.80E+00	LCV_DAPH	0.067
Barium	WHOL	Reach 1	38	38	3.74E-01	4.31E-01	3.80E-03	S_CHR_V	113.525
Barium	WHOL	Reach 1	38	38	3.74E-01	4.31E-01	6.91E-02	S_ACU_V	6.243
Barium	WHOL	Reach 1	38	38	3.74E-01	4.31E-01	5.80E+00	LCV_DAPH	0.074
Barium	WHOL	SS1	27	27	1.13E-01	1.49E-01	3.80E-03	S_CHR_V	39.202

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Barium	WHOL	SS1	27	27	1.13E-01	1.49E-01	6.91E-02	S_ACU_V	2.156
Barium	WHOL	SS1	27	27	1.13E-01	1.49E-01	5.80E+00	LCV_DAPH	0.026
Boron	FLTR	BC9.4-SS5	2	2	2.17E-01	5.40E-01	7.00E-03	LTV_DAPH	77.115
Boron	FLTR	BC9.4-SS5	2	2	2.17E-01	5.40E-01	5.47E-01	S_CHR_V	0.987
Boron	FLTR	BC9.4-SS5	2	2	2.17E-01	5.40E-01	8.83E+00	LCV_DAPH	0.061
Boron	FLTR	BC9.4-SS5	2	2	2.17E-01	5.40E-01	1.10E+01	S_ACU_V	0.049
Boron	FLTR	BCK 0.63	14	14	1.01E-01	1.37E-01	7.00E-03	LTV_DAPH	19.562
Boron	FLTR	BCK 0.63	14	14	1.01E-01	1.37E-01	5.47E-01	S_CHR_V	0.250
Boron	FLTR	BCK 0.63	14	14	1.01E-01	1.37E-01	8.83E+00	LCV_DAPH	0.016
Boron	FLTR	BCK 0.63	14	14	1.01E-01	1.37E-01	1.10E+01	S_ACU_V	0.012
Boron	FLTR	BCK 4.55	14	14	1.21E-01	1.59E-01	7.00E-03	LTV_DAPH	22.719
Boron	FLTR	BCK 4.55	14	14	1.21E-01	1.59E-01	5.47E-01	S_CHR_V	0.291
Boron	FLTR	BCK 4.55	14	14	1.21E-01	1.59E-01	8.83E+00	LCV_DAPH	0.018
Boron	FLTR	BCK 4.55	14	14	1.21E-01	1.59E-01	1.10E+01	S_ACU_V	0.014
Boron	FLTR	BCK 9.40	13	13	7.51E-01	1.38E+00	7.00E-03	LTV_DAPH	196.703
Boron	FLTR	BCK 9.40	13	13	7.51E-01	1.38E+00	5.47E-01	S_CHR_V	2.517
Boron	FLTR	BCK 9.40	13	13	7.51E-01	1.38E+00	8.83E+00	LCV_DAPH	0.156
Boron	FLTR	BCK 9.40	13	13	7.51E-01	1.38E+00	1.10E+01	S_ACU_V	0.125
Boron	FLTR	Reach 1	16	16	9.98E-02	1.56E-01	7.00E-03	LTV_DAPH	22.289
Boron	FLTR	Reach 1	16	16	9.98E-02	1.56E-01	5.47E-01	S_CHR_V	0.285
Boron	FLTR	Reach 1	16	16	9.98E-02	1.56E-01	8.83E+00	LCV_DAPH	0.018

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Boron	FLTR	Reach 1	16	16	9.98E-02	1.56E-01	1.10E+01	S_ACU_V	0.014
Boron	FLTR	SS1	13	14	5.41E-02	6.50E-02	7.00E-03	LTV_DAPH	9.281
Boron	FLTR	SS1	13	14	5.41E-02	6.50E-02	5.47E-01	S_CHR_V	0.119
Boron	FLTR	SS1	13	14	5.41E-02	6.50E-02	8.83E+00	LCV_DAPH	0.007
Boron	FLTR	SS1	13	14	5.41E-02	6.50E-02	1.10E+01	S_ACU_V	0.006
Boron	FLTR	SS4	14	14	1.22E-01	1.56E-01	7.00E-03	LTV_DAPH	22.308
Boron	FLTR	SS4	14	14	1.22E-01	1.56E-01	5.47E-01	S_CHR_V	0.285
Boron	FLTR	SS4	14	14	1.22E-01	1.56E-01	8.83E+00	LCV_DAPH	0.018
Boron	FLTR	SS4	14	14	1.22E-01	1.56E-01	1.10E+01	S_ACU_V	0.014
Boron	FLTR	SS5	14	14	6.44E-02	8.58E-02	7.00E-03	LTV_DAPH	12.251
Boron	FLTR	SS5	14	14	6.44E-02	8.58E-02	5.47E-01	S_CHR_V	0.157
Boron	FLTR	SS5	14	14	6.44E-02	8.58E-02	8.83E+00	LCV_DAPH	0.010
Boron	FLTR	SS5	14	14	6.44E-02	8.58E-02	1.10E+01	S_ACU_V	0.008
Boron	FLTR	SS6	11	12	3.94E-02	7.44E-02	7.00E-03	LTV_DAPH	10.626
Boron	FLTR	SS6	11	12	3.94E-02	7.44E-02	5.47E-01	S_CHR_V	0.136
Boron	FLTR	SS6	11	12	3.94E-02	7.44E-02	8.83E+00	LCV_DAPH	0.008
Boron	FLTR	SS6	11	12	3.94E-02	7.44E-02	1.10E+01	S_ACU_V	0.007
Boron	WHOL	BC9.4-SS5	2	2	2.18E-01	5.37E-01	7.00E-03	LTV_DAPH	76.764
Boron	WHOL	BC9.4-SS5	2	2	2.18E-01	5.37E-01	5.47E-01	S_CHR_V	0.982
Boron	WHOL	BC9.4-SS5	2	2	2.18E-01	5.37E-01	8.83E+00	LCV_DAPH	0.061
Boron	WHOL	BC9.4-SS5	2	2	2.18E-01	5.37E-01	1.10E+01	S_ACU_V	0.049

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Boron	WHOL	BCK 0.63	14	14	1.12E-01	1.49E-01	7.00E-03	LTV_DAPH	21.343
Boron	WHOL	BCK 0.63	14	14	1.12E-01	1.49E-01	5.47E-01	S_CHR_V	0.273
Boron	WHOL	BCK 0.63	14	14	1.12E-01	1.49E-01	8.83E+00	LCV_DAPH	0.017
Boron	WHOL	BCK 0.63	14	14	1.12E-01	1.49E-01	1.10E+01	S_ACU_V	0.014
Boron	WHOL	BCK 4.55	70	70	6.28E-02	7.33E-02	7.00E-03	LTV_DAPH	10.477
Boron	WHOL	BCK 4.55	70	70	6.28E-02	7.33E-02	5.47E-01	S_CHR_V	0.134
Boron	WHOL	BCK 4.55	70	70	6.28E-02	7.33E-02	8.83E+00	LCV_DAPH	0.008
Boron	WHOL	BCK 4.55	70	70	6.28E-02	7.33E-02	1.10E+01	S_ACU_V	0.007
Boron	WHOL	BCK 9.40	13	13	8.05E-01	1.39E+00	7.00E-03	LTV_DAPH	197.945
Boron	WHOL	BCK 9.40	13	13	8.05E-01	1.39E+00	5.47E-01	S_CHR_V	2.533
Boron	WHOL	BCK 9.40	13	13	8.05E-01	1.39E+00	8.83E+00	LCV_DAPH	0.157
Boron	WHOL	BCK 9.40	13	13	8.05E-01	1.39E+00	1.10E+01	S_ACU_V	0.126
Boron	WHOL	Reach 1	16	16	6.97E-02	8.20E-02	7.00E-03	LTV_DAPH	11.715
Boron	WHOL	Reach 1	16	16	6.97E-02	8.20E-02	5.47E-01	S_CHR_V	0.150
Boron	WHOL	Reach 1	16	16	6.97E-02	8.20E-02	8.83E+00	LCV_DAPH	0.009
Boron	WHOL	Reach 1	16	16	6.97E-02	8.20E-02	1.10E+01	S_ACU_V	0.007
Boron	WHOL	SS1	14	14	5.14E-02	5.98E-02	7.00E-03	LTV_DAPH	8.537
Boron	WHOL	SS1	14	14	5.14E-02	5.98E-02	5.47E-01	S_CHR_V	0.109
Boron	WHOL	SS1	14	14	5.14E-02	5.98E-02	8.83E+00	LCV_DAPH	0.007
Boron	WHOL	SS1	14	14	5.14E-02	5.98E-02	1.10E+01	S_ACU_V	0.005
Boron	WHOL	SS4	14	14	1.10E-01	1.42E-01	7.00E-03	LTV_DAPH	20.236

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Boron	WHOL	SS4	14	14	1.10E-01	1.42E-01	5.47E-01	S_CHR_V	0.259
Boron	WHOL	SS4	14	14	1.10E-01	1.42E-01	8.83E+00	LCV_DAPH	0.016
Boron	WHOL	SS4	14	14	1.10E-01	1.42E-01	1.10E+01	S_ACU_V	0.013
Boron	WHOL	SS5	13	14	7.54E-02	1.03E-01	7.00E-03	LTV_DAPH	14.711
Boron	WHOL	SS5	13	14	7.54E-02	1.03E-01	5.47E-01	S_CHR_V	0.188
Boron	WHOL	SS5	13	14	7.54E-02	1.03E-01	8.83E+00	LCV_DAPH	0.012
Boron	WHOL	SS5	13	14	7.54E-02	1.03E-01	1.10E+01	S_ACU_V	0.009
Boron	WHOL	SS8	11	12	1.75E-02	2.24E-02	7.00E-03	LTV_DAPH	3.193
Boron	WHOL	SS8	11	12	1.75E-02	2.24E-02	5.47E-01	S_CHR_V	0.041
Boron	WHOL	SS8	11	12	1.75E-02	2.24E-02	8.83E+00	LCV_DAPH	0.003
Boron	WHOL	SS8	11	12	1.75E-02	2.24E-02	1.10E+01	S_ACU_V	0.002
Cadmium	FLTR	BCK 9.40	1	11	1.40E-03	2.05E-03	2.00E-04	LCV_DAPH	13.655
Cadmium	FLTR	BCK 9.40	1	11	1.40E-03	2.05E-03	8.00E-04	LTV_DAPH	2.731
Cadmium	FLTR	BCK 9.40	1	11	1.40E-03	2.05E-03	1.10E-03	NAWQ_CHR	1.862
Cadmium	FLTR	BCK 9.40	1	11	1.40E-03	2.05E-03	1.70E-03	LCV_FISH	1.205
Cadmium	FLTR	BCK 9.40	1	11	1.40E-03	2.05E-03	1.80E-03	LTV_FISH	1.138
Cadmium	FLTR	BCK 9.40	1	11	1.40E-03	2.05E-03	2.00E-03	LCV_AQPL	1.024
Cadmium	FLTR	BCK 9.40	1	11	1.40E-03	2.05E-03	2.00E-03	NCHR_200	1.024
Cadmium	FLTR	BCK 9.40	1	11	1.40E-03	2.05E-03	3.90E-03	NAWQ_ACU	0.525
Cadmium	FLTR	BCK 9.40	1	11	1.40E-03	2.05E-03	8.60E-03	NACU_200	0.238
Cadmium	FLTR	Reach 1	8	12	6.46E-03	9.94E-03	1.50E-04	LCV_DAPH	66.273

Table G-5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK_value	BMK_name	HQ ^d
Cadmium	FLTR	Reach 1	8	12	6.46E-03	9.94E-03	7.50E-04	LTV_DAPH	13.255
Cadmium	FLTR	Reach 1	8	12	6.46E-03	9.94E-03	1.10E-03	NAWQ_CHR	9.037
Cadmium	FLTR	Reach 1	8	12	6.46E-03	9.94E-03	1.70E-03	LCV_FISH	5.848
Cadmium	FLTR	Reach 1	8	12	6.46E-03	9.94E-03	1.80E-03	LTV_FISH	5.523
Cadmium	FLTR	Reach 1	8	12	6.46E-03	9.94E-03	2.00E-03	LCV_AQPL	4.970
Cadmium	FLTR	Reach 1	8	12	6.46E-03	9.94E-03	2.00E-03	NCHR_200	4.970
Cadmium	FLTR	Reach 1	8	12	6.46E-03	9.94E-03	3.90E-03	NAWQ_ACU	2.549
Cadmium	FLTR	Reach 1	8	12	6.46E-03	9.94E-03	8.60E-03	NACU_200	1.156
Cadmium	FLTR	SS1	1	12	2.80E-03	5.89E-03	2.00E-04	LCV_DAPH	39.285
Cadmium	FLTR	SS1	1	12	2.80E-03	5.89E-03	8.00E-04	LTV_DAPH	7.857
Cadmium	FLTR	SS1	1	12	2.80E-03	5.89E-03	1.10E-03	NAWQ_CHR	5.357
Cadmium	FLTR	SS1	1	12	2.80E-03	5.89E-03	1.70E-03	LCV_FISH	3.466
Cadmium	FLTR	SS1	1	12	2.80E-03	5.89E-03	1.80E-03	LTV_FISH	3.274
Cadmium	FLTR	SS1	1	12	2.80E-03	5.89E-03	2.00E-03	LCV_AQPL	2.946
Cadmium	FLTR	SS1	1	12	2.80E-03	5.89E-03	2.00E-03	NCHR_200	2.946
Cadmium	FLTR	SS1	1	12	2.80E-03	5.89E-03	3.90E-03	NAWQ_ACU	1.511
Cadmium	FLTR	SS1	1	12	2.80E-03	5.89E-03	8.60E-03	NACU_200	0.685
Cadmium	WHOL	Reach 1	8	12	7.24E-03	1.13E-02	1.50E-04	LCV_DAPH	75.430
Cadmium	WHOL	Reach 1	8	12	7.24E-03	1.13E-02	7.50E-04	LTV_DAPH	15.086
Cadmium	WHOL	Reach 1	8	12	7.24E-03	1.13E-02	1.10E-03	NAWQ_CHR	10.286
Cadmium	WHOL	Reach 1	8	12	7.24E-03	1.13E-02	1.70E-03	LCV_FISH	6.656

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Cadmium	WHOL	Reach 1	8	12	7.24E-03	1.13E-02	1.80E-03	LTV_FISH	6.286
Cadmium	WHOL	Reach 1	8	12	7.24E-03	1.13E-02	2.00E-03	LCV_AQPL	5.657
Cadmium	WHOL	Reach 1	8	12	7.24E-03	1.13E-02	2.00E-03	NCHR_200	5.657
Cadmium	WHOL	Reach 1	8	12	7.24E-03	1.13E-02	3.90E-03	NAWQ_ACU	2.901
Cadmium	WHOL	Reach 1	8	12	7.24E-03	1.13E-02	8.60E-03	NACU_200	1.316
Cadmium	WHOL	SS1	1	12	2.90E-03	6.36E-03	2.00E-04	LCV_DAPH	42.415
Cadmium	WHOL	SS1	1	12	2.90E-03	6.36E-03	8.00E-04	LTV_DAPH	8.483
Cadmium	WHOL	SS1	1	12	2.90E-03	6.36E-03	1.10E-03	NAWQ_CHR	5.784
Cadmium	WHOL	SS1	1	12	2.90E-03	6.36E-03	1.70E-03	LCV_FISH	3.743
Cadmium	WHOL	SS1	1	12	2.90E-03	6.36E-03	1.80E-03	LTV_FISH	3.535
Cadmium	WHOL	SS1	1	12	2.90E-03	6.36E-03	2.00E-03	LCV_AQPL	3.181
Cadmium	WHOL	SS1	1	12	2.90E-03	6.36E-03	2.00E-03	NCHR_200	3.181
Cadmium	WHOL	SS1	1	12	2.90E-03	6.36E-03	3.90E-03	NAWQ_ACU	1.631
Cadmium	WHOL	SS1	1	12	2.90E-03	6.36E-03	8.60E-03	NACU_200	0.740
Calcium	FLTR	BC9.4-SS5	37	37	4.11E+01	4.72E+01	1.16E+02	LCV_DAPH	0.407
Calcium	FLTR	BCK 0.63	14	14	4.01E+01	4.63E+01	1.16E+02	LCV_DAPH	0.399
Calcium	FLTR	BCK 4.55	14	14	4.10E+01	4.67E+01	1.16E+02	LCV_DAPH	0.403
Calcium	FLTR	BCK 9.40	35	35	6.41E+01	7.27E+01	1.16E+02	LCV_DAPH	0.627
Calcium	FLTR	NT2	21	21	9.81E+01	1.29E+02	1.16E+02	LCV_DAPH	1.112
Calcium	FLTR	NT3	21	21	6.82E+01	7.97E+01	1.16E+02	LCV_DAPH	0.687
Calcium	FLTR	NT4	12	12	3.59E+01	3.99E+01	1.16E+02	LCV_DAPH	0.344

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Calcium	FLTR	NT5	13	13	3.21E+01	3.87E+01	1.16E+02	LCV_DAPH	0.333
Calcium	FLTR	NT6	21	21	3.11E+01	3.52E+01	1.16E+02	LCV_DAPH	0.303
Calcium	FLTR	NT7	21	21	4.48E+01	5.27E+01	1.16E+02	LCV_DAPH	0.454
Calcium	FLTR	NT8	14	14	4.19E+01	4.64E+01	1.16E+02	LCV_DAPH	0.400
Calcium	FLTR	Reach 1	38	38	1.74E+02	1.98E+02	1.16E+02	LCV_DAPH	1.705
Calcium	FLTR	SS1	27	27	1.84E+02	1.94E+02	1.16E+02	LCV_DAPH	1.677
Calcium	FLTR	SS4	27	27	1.01E+02	1.11E+02	1.16E+02	LCV_DAPH	0.961
Calcium	FLTR	SS5	27	27	6.28E+01	6.91E+01	1.16E+02	LCV_DAPH	0.596
Calcium	FLTR	SS6	26	26	3.57E+01	4.12E+01	1.16E+02	LCV_DAPH	0.355
Calcium	FLTR	SS8	25	25	3.41E+01	3.66E+01	1.16E+02	LCV_DAPH	0.316
Calcium	WHOL	BC9.4-SS5	37	37	4.51E+01	5.01E+01	1.16E+02	LCV_DAPH	0.432
Calcium	WHOL	BCK 0.63	14	14	4.03E+01	4.63E+01	1.16E+02	LCV_DAPH	0.399
Calcium	WHOL	BCK 4.55	70	70	4.16E+01	4.41E+01	1.16E+02	LCV_DAPH	0.380
Calcium	WHOL	BCK 9.40	35	35	6.47E+01	7.06E+01	1.16E+02	LCV_DAPH	0.609
Calcium	WHOL	NT2	21	21	1.09E+02	1.40E+02	1.16E+02	LCV_DAPH	1.210
Calcium	WHOL	NT3	21	21	6.88E+01	8.03E+01	1.16E+02	LCV_DAPH	0.693
Calcium	WHOL	NT4	12	12	3.78E+01	4.24E+01	1.16E+02	LCV_DAPH	0.365
Calcium	WHOL	NT5	13	13	3.24E+01	3.85E+01	1.16E+02	LCV_DAPH	0.332
Calcium	WHOL	NT6	21	21	3.18E+01	3.56E+01	1.16E+02	LCV_DAPH	0.307
Calcium	WHOL	NT7	21	21	4.79E+01	5.46E+01	1.16E+02	LCV_DAPH	0.470
Calcium	WHOL	NT8	14	14	4.34E+01	4.74E+01	1.16E+02	LCV_DAPH	0.409

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Calcium	WHOL	Reach 1	38	38	1.82E+02	2.04E+02	1.16E+02	LCV_DAPH	1.761
Calcium	WHOL	SS1	27	27	1.85E+02	1.95E+02	1.16E+02	LCV_DAPH	1.679
Calcium	WHOL	SS4	27	27	1.00E+02	1.10E+02	1.16E+02	LCV_DAPH	0.949
Calcium	WHOL	SS5	27	27	6.27E+01	6.89E+01	1.16E+02	LCV_DAPH	0.594
Chloride	WHOL	BC9.4-SS5	37	37	1.26E+01	1.42E+01	2.30E+02	S_CHR_V	0.062
Chloride	WHOL	BC9.4-SS5	37	37	1.26E+01	1.42E+01	8.60E+02	S_ACU_V	0.016
Chloride	WHOL	BCK 0.63	13	13	6.52E+00	8.11E+00	2.30E+02	S_CHR_V	0.035
Chloride	WHOL	BCK 0.63	13	13	6.52E+00	8.11E+00	8.60E+02	S_ACU_V	0.009
Chloride	WHOL	BCK 4.55	69	70	7.47E+00	8.06E+00	2.30E+02	S_CHR_V	0.035
Chloride	WHOL	BCK 4.55	69	70	7.47E+00	8.06E+00	8.60E+02	S_ACU_V	0.009
Chloride	WHOL	BCK 9.40	34	34	1.71E+01	1.93E+01	2.30E+02	S_CHR_V	0.084
Chloride	WHOL	BCK 9.40	34	34	1.71E+01	1.93E+01	8.60E+02	S_ACU_V	0.022
Chloride	WHOL	NT2	21	21	4.68E+00	5.82E+00	2.30E+02	S_CHR_V	0.025
Chloride	WHOL	NT2	21	21	4.68E+00	5.82E+00	8.60E+02	S_ACU_V	0.007
Chloride	WHOL	NT3	21	21	2.37E+00	2.79E+00	2.30E+02	S_CHR_V	0.012
Chloride	WHOL	NT3	21	21	2.37E+00	2.79E+00	8.60E+02	S_ACU_V	0.003
Chloride	WHOL	NT4	12	12	4.17E+00	4.52E+00	2.30E+02	S_CHR_V	0.020
Chloride	WHOL	NT4	12	12	4.17E+00	4.52E+00	8.60E+02	S_ACU_V	0.005
Chloride	WHOL	NT5	13	13	3.35E+00	5.12E+00	2.30E+02	S_CHR_V	0.022
Chloride	WHOL	NT5	13	13	3.35E+00	5.12E+00	8.60E+02	S_ACU_V	0.006
Chloride	WHOL	NT6	21	21	4.20E+00	4.73E+00	2.30E+02	S_CHR_V	0.021

Table G.5 (continued)

Analyte	Media ^a	Site	Det.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Chloride	WHOL	NT6	21	21	4.20E+00	4.73E+00	8.60E+02	S_ACU_V	0.005
Chloride	WHOL	NT7	21	21	1.79E+01	2.20E+01	2.30E+02	S_CHR_V	0.096
Chloride	WHOL	NT7	21	21	1.79E+01	2.20E+01	8.60E+02	S_ACU_V	0.026
Chloride	WHOL	NT8	14	14	1.24E-01	1.48E+01	2.30E+02	S_CHR_V	0.064
Chloride	WHOL	NT8	14	14	1.24E-01	1.48E+01	8.60E+02	S_ACU_V	0.017
Chloride	WHOL	Reach 1	37	38	8.54E+01	1.38E+02	2.30E+02	S_CHR_V	0.599
Chloride	WHOL	Reach 1	37	38	8.54E+01	1.38E+02	8.60E+02	S_ACU_V	0.160
Chloride	WHOL	SS1	27	27	5.51E+01	6.13E+01	2.30E+02	S_CHR_V	0.266
Chloride	WHOL	SS1	27	27	5.51E+01	6.13E+01	8.60E+02	S_ACU_V	0.071
Chloride	WHOL	SS4	26	26	2.59E+01	2.95E+01	2.30E+02	S_CHR_V	0.128
Chloride	WHOL	SS4	26	26	2.59E+01	2.95E+01	8.60E+02	S_ACU_V	0.034
Chloride	WHOL	SS5	26	26	1.35E+01	1.55E+01	2.30E+02	S_CHR_V	0.068
Chloride	WHOL	SS5	26	26	1.35E+01	1.55E+01	8.60E+02	S_ACU_V	0.018
Chloride	WHOL	SS6	17	24	2.76E+00	3.39E+00	2.30E+02	S_CHR_V	0.015
Chloride	WHOL	SS6	17	24	2.76E+00	3.39E+00	8.60E+02	S_ACU_V	0.004
Chloride	WHOL	SS8	24	24	2.82E+00	3.15E+00	2.30E+02	S_CHR_V	0.014
Chloride	WHOL	SS8	24	24	2.82E+00	3.15E+00	8.60E+02	S_ACU_V	0.004
Cobalt	FLTR	Reach 1	12	38	3.38E-03	4.32E-03	3.06E-03	S_CHR_V	1.411
Cobalt	FLTR	Reach 1	12	38	3.38E-03	4.32E-03	4.40E-03	LTV_DAPH	0.981
Cobalt	FLTR	Reach 1	12	38	3.38E-03	4.32E-03	5.10E-03	LCV_DAPH	0.847
Cobalt	FLTR	Reach 1	12	38	3.38E-03	4.32E-03	1.95E-01	S_ACU_V	0.022

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Cobalt	FLTR	Reach 1	12	38	3.38E-03	4.32E-03	2.90E-01	LCV_FISH	0.015
Cobalt	FLTR	Reach 1	12	38	3.38E-03	4.32E-03	8.10E-01	LTV_FISH	0.005
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	2.00E-04	LCV_DAPH	17.125
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	2.00E-04	LTV_DAPH	19.213
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	1.00E-03	LCV_AQPL	3.939
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	3.80E-03	LCV_FISH	1.037
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	5.00E-03	LTV_FISH	0.788
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	6.10E-03	LCV_NDI	0.649
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	1.20E-02	NAWQ_CHR	0.328
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	1.80E-02	NAWQ_ACU	0.219
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	2.14E-02	NCHR_200	0.184
Copper	FLTR	BCK 0.63	4	14	3.10E-03	3.94E-03	3.41E-02	NACU_200	0.116
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	2.00E-04	LCV_DAPH	27.110
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	2.00E-04	LTV_DAPH	30.416
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	1.00E-03	LCV_AQPL	6.235
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	3.80E-03	LCV_FISH	1.641
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	5.00E-03	LTV_FISH	1.247
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	6.10E-03	LCV_NDI	1.028
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	1.20E-02	NAWQ_CHR	0.520
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	1.80E-02	NAWQ_ACU	0.346
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	2.14E-02	NCHR_200	0.291

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Copper	FLTR	BCK 4.55	3	14	3.80E-03	6.24E-03	3.41E-02	NACU_200	0.183
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	2.00E-04	LCV_DAPH	14.523
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	2.00E-04	LTV_DAPH	16.294
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	1.00E-03	LCV_AQPL	3.340
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	3.80E-03	LCV_FISH	0.879
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	5.00E-03	LTV_FISH	0.668
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	6.10E-03	LCV_NDI	0.551
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	1.20E-02	NAWQ_CHR	0.278
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	1.80E-02	NAWQ_ACU	0.186
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	2.14E-02	NCHR_200	0.156
Copper	FLTR	BCK 9.40	7	35	2.70E-03	3.34E-03	3.41E-02	NACU_200	0.098
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	2.05E-04	LTV_DAPH	30.461
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	2.30E-04	LCV_DAPH	27.150
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	1.00E-03	LCV_AQPL	6.245
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	3.80E-03	LCV_FISH	1.643
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	5.00E-03	LTV_FISH	1.249
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	6.07E-03	LCV_NDI	1.029
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	1.20E-02	NAWQ_CHR	0.520
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	1.80E-02	NAWQ_ACU	0.347
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	2.14E-02	NCHR_200	0.292
Copper	FLTR	Reach 1	7	38	4.18E-03	6.24E-03	3.41E-02	NACU_200	0.183

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	2.00E-04	LCV_DAPH	18.500
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	2.00E-04	LTV_DAPH	20.756
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	1.00E-03	LCV_AQPL	4.255
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	3.80E-03	LCV_FISH	1.120
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	5.00E-03	LTV_FISH	0.851
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	6.10E-03	LCV_NDI	0.701
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	1.20E-02	NAWQ_CHR	0.355
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	1.80E-02	NAWQ_ACU	0.236
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	2.14E-02	NCHR_200	0.199
Copper	FLTR	SS1	6	27	3.10E-03	4.25E-03	3.41E-02	NACU_200	0.125
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	2.00E-04	LCV_DAPH	16.176
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	2.00E-04	LTV_DAPH	18.149
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	1.00E-03	LCV_AQPL	3.721
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	3.80E-03	LCV_FISH	0.979
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	5.00E-03	LTV_FISH	0.744
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	6.10E-03	LCV_NDI	0.613
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	1.20E-02	NAWQ_CHR	0.310
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	1.80E-02	NAWQ_ACU	0.207
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	2.14E-02	NCHR_200	0.174
Copper	FLTR	SS4	7	27	2.90E-03	3.72E-03	3.41E-02	NACU_200	0.109
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	2.00E-04	LCV_DAPH	16.797

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	2.00E-04	LTV_DAPH	18.846
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	1.00E-03	LCV_AQPL	3.863
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	3.80E-03	LCV_FISH	1.017
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	5.00E-03	LTV_FISH	0.773
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	6.10E-03	LCV_NDI	0.637
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	1.20E-02	NAWQ_CHR	0.322
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	1.80E-02	NAWQ_ACU	0.215
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	2.14E-02	NCHR_200	0.181
Copper	FLTR	SS5	5	27	2.80E-03	3.86E-03	3.41E-02	NACU_200	0.113
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	2.00E-04	LCV_DAPH	16.090
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	2.00E-04	LTV_DAPH	18.052
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	1.00E-03	LCV_AQPL	3.701
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	3.80E-03	LCV_FISH	0.974
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	5.00E-03	LTV_FISH	0.740
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	6.10E-03	LCV_NDI	0.610
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	1.20E-02	NAWQ_CHR	0.308
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	1.80E-02	NAWQ_ACU	0.206
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	2.14E-02	NCHR_200	0.173
Copper	FLTR	SS6	5	26	2.90E-03	3.70E-03	3.41E-02	NACU_200	0.109
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	2.00E-04	LCV_DAPH	41.841
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	2.00E-04	LTV_DAPH	46.943

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	1.00E-03	LCV_AQPL	9.623
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	3.80E-03	LCV_FISH	2.532
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	5.00E-03	LTV_FISH	1.925
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	6.10E-03	LCV_NDI	1.586
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	1.20E-02	NAWQ_CHR	0.802
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	1.80E-02	NAWQ_ACU	0.535
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	2.14E-02	NCHR_200	0.450
Copper	FLTR	SS8	2	25	4.90E-03	9.62E-03	3.41E-02	NACU_200	0.282
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	2.00E-04	LCV_DAPH	19.570
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	2.00E-04	LTV_DAPH	21.957
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	1.00E-03	LCV_AQPL	4.501
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	3.80E-03	LCV_FISH	1.185
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	5.00E-03	LTV_FISH	0.900
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	6.10E-03	LCV_NDI	0.742
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	1.20E-02	NAWQ_CHR	0.375
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	1.80E-02	NAWQ_ACU	0.250
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	2.14E-02	NCHR_200	0.210
Copper	WHOL	BCK 0.63	3	14	3.20E-03	4.50E-03	3.41E-02	NACU_200	0.132
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	2.00E-04	LCV_DAPH	14.295
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	2.00E-04	LTV_DAPH	16.038
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	1.00E-03	LCV_AQPL	3.288

Table G.5 (continued)

Analyte	Media ^b	Site	Deis.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	3.80E-03	LCV_FISH	0.865
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	5.00E-03	LTV_FISH	0.658
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	6.10E-03	LCV_NDI	0.542
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	1.20E-02	NAWQ_CHR	0.274
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	1.80E-02	NAWQ_ACU	0.183
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	2.14E-02	NCHR_200	0.154
Copper	WHOL	BCK 4.55	2	70	3.00E-03	3.29E-03	3.41E-02	NACU_200	0.096
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	2.00E-04	LCV_DAPH	29.896
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	2.00E-04	LTV_DAPH	33.542
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	1.00E-03	LCV_AQPL	6.876
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	3.80E-03	LCV_FISH	1.810
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	5.00E-03	LTV_FISH	1.375
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	6.10E-03	LCV_NDI	1.134
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	1.20E-02	NAWQ_CHR	0.573
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	1.80E-02	NAWQ_ACU	0.382
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	2.14E-02	NCHR_200	0.321
Copper	WHOL	NT7	1	21	4.40E-03	6.88E-03	3.41E-02	NACU_200	0.202
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	2.05E-04	LTV_DAPH	18.143
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	2.30E-04	LCV_DAPH	16.171
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	1.00E-03	LCV_AQPL	3.719
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	3.80E-03	LCV_FISH	0.979

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	5.00E-03	LTV_FISH	0.744
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	6.07E-03	LCV_NDI	0.613
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	1.20E-02	NAWQ_CHR	0.310
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	1.80E-02	NAWQ_ACU	0.207
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	2.14E-02	NCHR_200	0.174
Copper	WHOL	Reach 1	5	38	3.04E-03	3.72E-03	3.41E-02	NACU_200	0.109
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	2.00E-04	LCV_DAPH	30.675
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	2.00E-04	LTV_DAPH	34.416
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	1.00E-03	LCV_AQPL	7.055
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	3.80E-03	LCV_FISH	1.857
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	5.00E-03	LTV_FISH	1.411
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	6.10E-03	LCV_NDI	1.163
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	1.20E-02	NAWQ_CHR	0.588
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	1.80E-02	NAWQ_ACU	0.392
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	2.14E-02	NCHR_200	0.330
Copper	WHOL	SS6	2	25	3.80E-03	7.06E-03	3.41E-02	NACU_200	0.207
Cyanide	WHOL	NT2	2	21	5.70E-03	6.60E-03	5.20E-03	NAWQ_CHR	1.269
Cyanide	WHOL	NT2	2	21	5.70E-03	6.60E-03	5.30E-03	LTV_FISH	1.245
Cyanide	WHOL	NT2	2	21	5.70E-03	6.60E-03	7.80E-03	LCV_FISH	0.846
Cyanide	WHOL	NT2	2	21	5.70E-03	6.60E-03	1.83E-02	LCV_NDI	0.360
Cyanide	WHOL	NT2	2	21	5.70E-03	6.60E-03	2.20E-02	NAWQ_ACU	0.300

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Cyanide	WHOL	NT2	2	21	5.70E-03	6.60E-03	3.00E-02	LCV_AQPL	0.220
Cyanide	WHOL	NT4	1	12	5.70E-03	6.89E-03	5.20E-03	NAWQ_CHR	1.324
Cyanide	WHOL	NT4	1	12	5.70E-03	6.89E-03	5.30E-03	LTV_FISH	1.299
Cyanide	WHOL	NT4	1	12	5.70E-03	6.89E-03	7.80E-03	LCV_FISH	0.883
Cyanide	WHOL	NT4	1	12	5.70E-03	6.89E-03	1.83E-02	LCV_NDI	0.376
Cyanide	WHOL	NT4	1	12	5.70E-03	6.89E-03	2.20E-02	NAWQ_ACU	0.313
Cyanide	WHOL	NT4	1	12	5.70E-03	6.89E-03	3.00E-02	LCV_AQPL	0.230
Cyanide	WHOL	NT7	1	21	5.40E-03	6.15E-03	5.20E-03	NAWQ_CHR	1.184
Cyanide	WHOL	NT7	1	21	5.40E-03	6.15E-03	5.30E-03	LTV_FISH	1.161
Cyanide	WHOL	NT7	1	21	5.40E-03	6.15E-03	7.80E-03	LCV_FISH	0.789
Cyanide	WHOL	NT7	1	21	5.40E-03	6.15E-03	1.83E-02	LCV_NDI	0.336
Cyanide	WHOL	NT7	1	21	5.40E-03	6.15E-03	2.20E-02	NAWQ_ACU	0.280
Cyanide	WHOL	NT7	1	21	5.40E-03	6.15E-03	3.00E-02	LCV_AQPL	0.205
Cyanide	WHOL	NT8	1	14	6.20E-03	8.27E-03	5.20E-03	NAWQ_CHR	1.590
Cyanide	WHOL	NT8	1	14	6.20E-03	8.27E-03	5.30E-03	LTV_FISH	1.560
Cyanide	WHOL	NT8	1	14	6.20E-03	8.27E-03	7.80E-03	LCV_FISH	1.060
Cyanide	WHOL	NT8	1	14	6.20E-03	8.27E-03	1.83E-02	LCV_NDI	0.451
Cyanide	WHOL	NT8	1	14	6.20E-03	8.27E-03	2.20E-02	NAWQ_ACU	0.376
Cyanide	WHOL	NT8	1	14	6.20E-03	8.27E-03	3.00E-02	LCV_AQPL	0.276
Cyanide	WHOL	Reach 1	1	22	5.74E-03	7.00E-03	5.20E-03	NAWQ_CHR	1.347
Cyanide	WHOL	Reach 1	1	22	5.74E-03	7.00E-03	5.30E-03	LTV_FISH	1.321

Table G.5 (continued)

Analyte	Media ^a	Site	Detls.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Cyanide	WHOL	Reach 1	1	22	5.74E-03	7.00E-03	7.80E-03	LCV_FISH	0.898
Cyanide	WHOL	Reach 1	1	22	5.74E-03	7.00E-03	1.83E-02	LCV_NDI	0.382
Cyanide	WHOL	Reach 1	1	22	5.74E-03	7.00E-03	2.20E-02	NAWQ_ACU	0.318
Cyanide	WHOL	Reach 1	1	22	5.74E-03	7.00E-03	3.00E-02	LCV_AQPL	0.233
Iron	WHOL	BC9.4-SS5	29	36	7.22E+00	1.21E+01	1.60E-02	LTV_DAPH	755.374
Iron	WHOL	BC9.4-SS5	29	36	7.22E+00	1.21E+01	1.58E-01	LCV_DAPH	76.494
Iron	WHOL	BC9.4-SS5	29	36	7.22E+00	1.21E+01	1.00E+00	NAWQ_CHR	12.086
Iron	WHOL	BC9.4-SS5	29	36	7.22E+00	1.21E+01	1.30E+00	LCV_FISH	9.297
Iron	WHOL	BCK 9.40	34	35	2.39E+00	4.35E+00	1.60E-02	LTV_DAPH	271.956
Iron	WHOL	BCK 9.40	34	35	2.39E+00	4.35E+00	1.58E-01	LCV_DAPH	27.540
Iron	WHOL	BCK 9.40	34	35	2.39E+00	4.35E+00	1.00E+00	NAWQ_CHR	4.351
Iron	WHOL	BCK 9.40	34	35	2.39E+00	4.35E+00	1.30E+00	LCV_FISH	3.347
Iron	WHOL	NT7	17	21	5.70E+00	9.74E+00	1.60E-02	LTV_DAPH	608.726
Iron	WHOL	NT7	17	21	5.70E+00	9.74E+00	1.58E-01	LCV_DAPH	61.643
Iron	WHOL	NT7	17	21	5.70E+00	9.74E+00	1.00E+00	NAWQ_CHR	9.740
Iron	WHOL	NT7	17	21	5.70E+00	9.74E+00	1.30E+00	LCV_FISH	7.492
Iron	WHOL	SS1	23	27	5.00E-01	8.71E-01	1.60E-02	LTV_DAPH	54.465
Iron	WHOL	SS1	23	27	5.00E-01	8.71E-01	1.58E-01	LCV_DAPH	5.515
Iron	WHOL	SS1	23	27	5.00E-01	8.71E-01	1.00E+00	NAWQ_CHR	0.871
Iron	WHOL	SS1	23	27	5.00E-01	8.71E-01	1.30E+00	LCV_FISH	0.670
Lead	FLTR	BCK 4.55	1	12	2.40E-03	3.19E-03	3.20E-03	NAWQ_CHR	0.996

Table G.5 (continued)

Analyte	Media ^b	Site	Det.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Lead	FLTR	BCK 4.55	1	12	2.40E-03	3.19E-03	7.70E-03	NCHR_200	0.414
Lead	FLTR	BCK 4.55	1	12	2.40E-03	3.19E-03	1.23E-02	LCV_DAPH	0.260
Lead	FLTR	BCK 4.55	1	12	2.40E-03	3.19E-03	1.89E-02	LCV_FISH	0.169
Lead	FLTR	BCK 4.55	1	12	2.40E-03	3.19E-03	2.20E-02	LTV_FISH	0.145
Lead	FLTR	BCK 4.55	1	12	2.40E-03	3.19E-03	2.55E-02	LCV_NDI	0.125
Lead	FLTR	BCK 4.55	1	12	2.40E-03	3.19E-03	8.20E-02	NAWQ_ACU	0.039
Lead	FLTR	BCK 4.55	1	12	2.40E-03	3.19E-03	1.97E-01	NACU_200	0.016
Lead	FLTR	BCK 4.55	1	12	2.40E-03	3.19E-03	5.00E-01	LCV_AQPL	0.006
Lead	FLTR	Reach 1	2	12	3.99E-03	6.56E-03	3.20E-03	NAWQ_CHR	2.051
Lead	FLTR	Reach 1	2	12	3.99E-03	6.56E-03	7.70E-03	NCHR_200	0.852
Lead	FLTR	Reach 1	2	12	3.99E-03	6.56E-03	1.23E-02	LCV_DAPH	0.535
Lead	FLTR	Reach 1	2	12	3.99E-03	6.56E-03	1.89E-02	LCV_FISH	0.348
Lead	FLTR	Reach 1	2	12	3.99E-03	6.56E-03	2.20E-02	LTV_FISH	0.298
Lead	FLTR	Reach 1	2	12	3.99E-03	6.56E-03	2.55E-02	LCV_NDI	0.258
Lead	FLTR	Reach 1	2	12	3.99E-03	6.56E-03	8.20E-02	NAWQ_ACU	0.080
Lead	FLTR	Reach 1	2	12	3.99E-03	6.56E-03	1.97E-01	NACU_200	0.033
Lead	FLTR	Reach 1	2	12	3.99E-03	6.56E-03	5.00E-01	LCV_AQPL	0.013
Lead	FLTR	SS4	1	12	2.50E-03	3.35E-03	3.20E-03	NAWQ_CHR	1.047
Lead	FLTR	SS4	1	12	2.50E-03	3.35E-03	7.70E-03	NCHR_200	0.435
Lead	FLTR	SS4	1	12	2.50E-03	3.35E-03	1.23E-02	LCV_DAPH	0.273
Lead	FLTR	SS4	1	12	2.50E-03	3.35E-03	1.89E-02	LCV_FISH	0.178

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Lead	FLTR	SS4	1	12	2.50E-03	3.35E-03	2.20E-02	LTV_FISH	0.152
Lead	FLTR	SS4	1	12	2.50E-03	3.35E-03	2.55E-02	LCV_NDI	0.132
Lead	FLTR	SS4	1	12	2.50E-03	3.35E-03	8.20E-02	NAWQ_ACU	0.041
Lead	FLTR	SS4	1	12	2.50E-03	3.35E-03	1.97E-01	NACU_200	0.017
Lead	FLTR	SS4	1	12	2.50E-03	3.35E-03	5.00E-01	LCV_AQPL	0.007
Lead	WHOL	SS1	1	12	4.00E-03	7.60E-03	3.20E-03	NAWQ_CHR	2.375
Lead	WHOL	SS1	1	12	4.00E-03	7.60E-03	7.70E-03	NCHR_200	0.987
Lead	WHOL	SS1	1	12	4.00E-03	7.60E-03	1.23E-02	LCV_DAPH	0.620
Lead	WHOL	SS1	1	12	4.00E-03	7.60E-03	1.89E-02	LCV_FISH	0.402
Lead	WHOL	SS1	1	12	4.00E-03	7.60E-03	2.20E-02	LTV_FISH	0.345
Lead	WHOL	SS1	1	12	4.00E-03	7.60E-03	2.55E-02	LCV_NDI	0.298
Lead	WHOL	SS1	1	12	4.00E-03	7.60E-03	8.20E-02	NAWQ_ACU	0.093
Lead	WHOL	SS1	1	12	4.00E-03	7.60E-03	1.97E-01	NACU_200	0.039
Lead	WHOL	SS1	1	12	4.00E-03	7.60E-03	5.00E-01	LCV_AQPL	0.015
Lead	WHOL	SS5	1	12	2.80E-03	4.33E-03	3.20E-03	NAWQ_CHR	1.353
Lead	WHOL	SS5	1	12	2.80E-03	4.33E-03	7.70E-03	NCHR_200	0.562
Lead	WHOL	SS5	1	12	2.80E-03	4.33E-03	1.23E-02	LCV_DAPH	0.353
Lead	WHOL	SS5	1	12	2.80E-03	4.33E-03	1.89E-02	LCV_FISH	0.229
Lead	WHOL	SS5	1	12	2.80E-03	4.33E-03	2.20E-02	LTV_FISH	0.197
Lead	WHOL	SS5	1	12	2.80E-03	4.33E-03	2.55E-02	LCV_NDI	0.170
Lead	WHOL	SS5	1	12	2.80E-03	4.33E-03	8.20E-02	NAWQ_ACU	0.053

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Lead	WHOL	SS5	1	12	2.80E-03	4.33E-03	1.97E-01	NACU_200	0.022
Lead	WHOL	SS5	1	12	2.80E-03	4.33E-03	5.00E-01	LCV_AQPL	0.009
Lithium	FLTR	BC9.4-SS5	12	14	3.40E-02	4.15E-02	1.44E-02	S_CHR_V	2.878
Lithium	FLTR	BC9.4-SS5	12	14	3.40E-02	4.15E-02	2.58E-01	S_ACU_V	0.161
Lithium	FLTR	BCK9.40	6	7	5.54E-02	7.79E-02	1.44E-02	S_CHR_V	5.410
Lithium	FLTR	BCK9.40	6	7	5.54E-02	7.79E-02	2.58E-01	S_ACU_V	0.302
Lithium	FLTR	NT2	6	7	5.90E-03	7.01E-03	1.44E-02	S_CHR_V	0.487
Lithium	FLTR	NT2	6	7	5.90E-03	7.01E-03	2.58E-01	S_ACU_V	0.027
Lithium	FLTR	NT3	7	7	1.34E-01	1.70E-01	1.44E-02	S_CHR_V	11.788
Lithium	FLTR	NT3	7	7	1.34E-01	1.70E-01	2.58E-01	S_ACU_V	0.658
Lithium	FLTR	NT4	3	7	1.40E-03	1.88E-03	1.44E-02	S_CHR_V	0.131
Lithium	FLTR	NT4	3	7	1.40E-03	1.88E-03	2.58E-01	S_ACU_V	0.007
Lithium	FLTR	NT5	3	7	1.40E-03	1.87E-03	1.44E-02	S_CHR_V	0.130
Lithium	FLTR	NT5	3	7	1.40E-03	1.87E-03	2.58E-01	S_ACU_V	0.007
Lithium	FLTR	NT6	7	7	1.11E-02	1.28E-02	1.44E-02	S_CHR_V	0.889
Lithium	FLTR	NT6	7	7	1.11E-02	1.28E-02	2.58E-01	S_ACU_V	0.050
Lithium	FLTR	NT7	7	7	4.77E-02	5.84E-02	1.44E-02	S_CHR_V	4.058
Lithium	FLTR	NT7	7	7	4.77E-02	5.84E-02	2.58E-01	S_ACU_V	0.226
Lithium	FLTR	NT8	7	7	1.54E-01	1.67E-01	1.44E-02	S_CHR_V	11.574
Lithium	FLTR	NT8	7	7	1.54E-01	1.67E-01	2.58E-01	S_ACU_V	0.646
Lithium	FLTR	Reach 1	6	7	6.15E-03	7.05E-03	1.44E-02	S_CHR_V	0.489

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Lithium	FLTR	Reach 1	6	7	6.15E-03	7.05E-03	2.58E-01	S_ACU_V	0.027
Lithium	FLTR	SSI	6	7	3.30E-03	3.85E-03	1.44E-02	S_CHR_V	0.267
Lithium	FLTR	SSI	6	7	3.30E-03	3.85E-03	2.58E-01	S_ACU_V	0.015
Lithium	FLTR	SS4	7	7	2.91E-02	3.34E-02	1.44E-02	S_CHR_V	2.319
Lithium	FLTR	SS4	7	7	2.91E-02	3.34E-02	2.58E-01	S_ACU_V	0.129
Lithium	FLTR	SS5	6	7	9.30E-03	1.17E-02	1.44E-02	S_CHR_V	0.809
Lithium	FLTR	SS5	6	7	9.30E-03	1.17E-02	2.58E-01	S_ACU_V	0.045
Lithium	FLTR	SS6	6	7	3.00E-03	3.74E-03	1.44E-02	S_CHR_V	0.260
Lithium	FLTR	SS6	6	7	3.00E-03	3.74E-03	2.58E-01	S_ACU_V	0.014
Lithium	FLTR	SS8	1	7	3.80E-03	9.75E-03	1.44E-02	S_CHR_V	0.677
Lithium	FLTR	SS8	1	7	3.80E-03	9.75E-03	2.58E-01	S_ACU_V	0.038
Lithium	WHOL	BC9.4-SS5	14	14	3.74E-02	4.46E-02	1.44E-02	S_CHR_V	3.094
Lithium	WHOL	BC9.4-SS5	14	14	3.74E-02	4.46E-02	2.58E-01	S_ACU_V	0.173
Lithium	WHOL	BCK 4.55	8	56	1.18E-02	1.28E-02	1.44E-02	S_CHR_V	0.892
Lithium	WHOL	BCK 4.55	8	56	1.18E-02	1.28E-02	2.58E-01	S_ACU_V	0.050
Lithium	WHOL	BCK 9.40	7	7	6.03E-02	7.64E-02	1.44E-02	S_CHR_V	5.303
Lithium	WHOL	BCK 9.40	7	7	6.03E-02	7.64E-02	2.58E-01	S_ACU_V	0.296
Lithium	WHOL	NT2	7	7	7.20E-03	8.50E-03	1.44E-02	S_CHR_V	0.590
Lithium	WHOL	NT2	7	7	7.20E-03	8.50E-03	2.58E-01	S_ACU_V	0.033
Lithium	WHOL	NT3	7	7	1.35E-01	1.71E-01	1.44E-02	S_CHR_V	11.893
Lithium	WHOL	NT3	7	7	1.35E-01	1.71E-01	2.58E-01	S_ACU_V	0.664

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Lithium	WHOL	NT4	6	7	3.10E-03	4.35E-03	1.44E-02	S_CHR_V	0.302
Lithium	WHOL	NT4	6	7	3.10E-03	4.35E-03	2.58E-01	S_ACU_V	0.017
Lithium	WHOL	NT5	7	7	3.10E-03	4.53E-03	1.44E-02	S_CHR_V	0.315
Lithium	WHOL	NT5	7	7	3.10E-03	4.53E-03	2.58E-01	S_ACU_V	0.018
Lithium	WHOL	NT6	7	7	1.32E-02	1.62E-02	1.44E-02	S_CHR_V	1.125
Lithium	WHOL	NT6	7	7	1.32E-02	1.62E-02	2.58E-01	S_ACU_V	0.063
Lithium	WHOL	NT7	7	7	4.99E-02	5.70E-02	1.44E-02	S_CHR_V	3.961
Lithium	WHOL	NT7	7	7	4.99E-02	5.70E-02	2.58E-01	S_ACU_V	0.221
Lithium	WHOL	NT8	7	7	1.56E-01	1.72E-01	1.44E-02	S_CHR_V	11.917
Lithium	WHOL	NT8	7	7	1.56E-01	1.72E-01	2.58E-01	S_ACU_V	0.665
Lithium	WHOL	Reach 1	7	7	7.67E-03	8.59E-03	1.44E-02	S_CHR_V	0.597
Lithium	WHOL	Reach 1	7	7	7.67E-03	8.59E-03	2.58E-01	S_ACU_V	0.033
Lithium	WHOL	SS1	7	7	4.10E-03	4.92E-03	1.44E-02	S_CHR_V	0.342
Lithium	WHOL	SS1	7	7	4.10E-03	4.92E-03	2.58E-01	S_ACU_V	0.019
Lithium	WHOL	SS4	7	7	2.93E-02	3.32E-02	1.44E-02	S_CHR_V	2.302
Lithium	WHOL	SS4	7	7	2.93E-02	3.32E-02	2.58E-01	S_ACU_V	0.128
Lithium	WHOL	SS5	7	7	1.03E-02	1.17E-02	1.44E-02	S_CHR_V	0.813
Lithium	WHOL	SS5	7	7	1.03E-02	1.17E-02	2.58E-01	S_ACU_V	0.045
Lithium	WHOL	SS6	7	7	4.30E-03	4.90E-03	1.44E-02	S_CHR_V	0.340
Lithium	WHOL	SS6	7	7	4.30E-03	4.90E-03	2.58E-01	S_ACU_V	0.019
Lithium	WHOL	SS8	3	7	1.10E-03	1.51E-03	1.44E-02	S_CHR_V	0.105

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Lithium	WHOL	SS8	3	7	1.10E-03	1.51E-03	2.58E-01	S_ACU_V	0.006
Manganese	WHOL	SS1	26	27	1.93E-01	4.44E-01	8.03E-02	S_CHR_V	5.531
Manganese	WHOL	SS1	26	27	1.93E-01	4.44E-01	1.10E+00	LCV_DAPH	0.404
Manganese	WHOL	SS1	26	27	1.93E-01	4.44E-01	1.10E+00	LTV_DAPH	0.404
Manganese	WHOL	SS1	26	27	1.93E-01	4.44E-01	1.27E+00	LTV_FISH	0.350
Manganese	WHOL	SS1	26	27	1.93E-01	4.44E-01	1.47E+00	S_ACU_V	0.302
Manganese	WHOL	SS1	26	27	1.93E-01	4.44E-01	1.77E+00	LCV_FISH	0.251
Manganese	WHOL	SS4	26	27	1.37E-01	2.00E-01	8.03E-02	S_CHR_V	2.492
Manganese	WHOL	SS4	26	27	1.37E-01	2.00E-01	1.10E+00	LCV_DAPH	0.182
Manganese	WHOL	SS4	26	27	1.37E-01	2.00E-01	1.10E+00	LTV_DAPH	0.182
Manganese	WHOL	SS4	26	27	1.37E-01	2.00E-01	1.27E+00	LTV_FISH	0.158
Manganese	WHOL	SS4	26	27	1.37E-01	2.00E-01	1.47E+00	S_ACU_V	0.136
Manganese	WHOL	SS4	26	27	1.37E-01	2.00E-01	1.77E+00	LCV_FISH	0.113
Manganese	WHOL	SS6	24	25	4.18E-02	6.65E-02	8.03E-02	S_CHR_V	0.828
Manganese	WHOL	SS6	24	25	4.18E-02	6.65E-02	1.10E+00	LCV_DAPH	0.060
Manganese	WHOL	SS6	24	25	4.18E-02	6.65E-02	1.10E+00	LTV_DAPH	0.060
Manganese	WHOL	SS6	24	25	4.18E-02	6.65E-02	1.27E+00	LTV_FISH	0.052
Manganese	WHOL	SS6	24	25	4.18E-02	6.65E-02	1.47E+00	S_ACU_V	0.045
Manganese	WHOL	SS6	24	25	4.18E-02	6.65E-02	1.77E+00	LCV_FISH	0.038
Mercury	FLTR	BC9.4-SS5	3	35	1.00E-04	1.20E-04	2.00E-04	LCV_FISH	0.508
Mercury	FLTR	BC9.4-SS5	3	35	1.00E-04	1.20E-04	9.00E-04	LTV_DAPH	0.134

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Mercury	FLTR	BC9.4-SS5	3	35	1.00E-04	1.20E-04	9.00E-04	LTV_FISH	0.134
Mercury	FLTR	BC9.4-SS5	3	35	1.00E-04	1.20E-04	1.00E-03	LCV_DAPH	0.122
Mercury	FLTR	BC9.4-SS5	3	35	1.00E-04	1.20E-04	1.30E-03	S_CHR_V	0.090
Mercury	FLTR	BC9.4-SS5	3	35	1.00E-04	1.20E-04	2.40E-03	NAWQ_ACU	0.049
Mercury	FLTR	BC9.4-SS5	3	35	1.00E-04	1.20E-04	5.00E-03	LCV_AQPL	0.023
Mercury	FLTR	BCK 9.40	2	33	1.00E-04	1.10E-04	2.00E-04	LCV_FISH	0.492
Mercury	FLTR	BCK 9.40	2	33	1.00E-04	1.10E-04	9.00E-04	LTV_DAPH	0.130
Mercury	FLTR	BCK 9.40	2	33	1.00E-04	1.10E-04	9.00E-04	LTV_FISH	0.130
Mercury	FLTR	BCK 9.40	2	33	1.00E-04	1.10E-04	1.00E-03	LCV_DAPH	0.118
Mercury	FLTR	BCK 9.40	2	33	1.00E-04	1.10E-04	1.30E-03	S_CHR_V	0.087
Mercury	FLTR	BCK 9.40	2	33	1.00E-04	1.10E-04	2.40E-03	NAWQ_ACU	0.047
Mercury	FLTR	BCK 9.40	2	33	1.00E-04	1.10E-04	5.00E-03	LCV_AQPL	0.023
Mercury	FLTR	NT3	7	21	1.00E-04	1.70E-04	2.00E-04	LCV_FISH	0.755
Mercury	FLTR	NT3	7	21	1.00E-04	1.70E-04	9.00E-04	LTV_DAPH	0.200
Mercury	FLTR	NT3	7	21	1.00E-04	1.70E-04	9.00E-04	LTV_FISH	0.200
Mercury	FLTR	NT3	7	21	1.00E-04	1.70E-04	1.00E-03	LCV_DAPH	0.181
Mercury	FLTR	NT3	7	21	1.00E-04	1.70E-04	1.30E-03	S_CHR_V	0.134
Mercury	FLTR	NT3	7	21	1.00E-04	1.70E-04	2.40E-03	NAWQ_ACU	0.072
Mercury	FLTR	NT3	7	21	1.00E-04	1.70E-04	5.00E-03	LCV_AQPL	0.035
Mercury	FLTR	NT6	3	21	1.00E-04	1.50E-04	2.00E-04	LCV_FISH	0.642
Mercury	FLTR	NT6	3	21	1.00E-04	1.50E-04	9.00E-04	LTV_DAPH	0.170

Table G.5 (continued)

Analyte	Media ^b	Site	Det.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Mercury	FLTR	NT6	3	21	1.00E-04	1.50E-04	9.00E-04	LTV_FISH	0.170
Mercury	FLTR	NT6	3	21	1.00E-04	1.50E-04	1.00E-03	LCV_DAPH	0.154
Mercury	FLTR	NT6	3	21	1.00E-04	1.50E-04	1.30E-03	S_CHR_V	0.114
Mercury	FLTR	NT6	3	21	1.00E-04	1.50E-04	2.40E-03	NAWQ_ACU	0.061
Mercury	FLTR	NT6	3	21	1.00E-04	1.50E-04	5.00E-03	LCV_AQPL	0.030
Mercury	FLTR	NT7	2	21	1.00E-04	1.50E-04	2.00E-04	LCV_FISH	0.642
Mercury	FLTR	NT7	2	21	1.00E-04	1.50E-04	9.00E-04	LTV_DAPH	0.170
Mercury	FLTR	NT7	2	21	1.00E-04	1.50E-04	9.00E-04	LTV_FISH	0.170
Mercury	FLTR	NT7	2	21	1.00E-04	1.50E-04	1.00E-03	LCV_DAPH	0.154
Mercury	FLTR	NT7	2	21	1.00E-04	1.50E-04	1.30E-03	S_CHR_V	0.114
Mercury	FLTR	NT7	2	21	1.00E-04	1.50E-04	2.40E-03	NAWQ_ACU	0.061
Mercury	FLTR	NT7	2	21	1.00E-04	1.50E-04	5.00E-03	LCV_AQPL	0.030
Mercury	FLTR	NT8	3	14	2.00E-04	3.40E-04	2.00E-04	LCV_FISH	1.482
Mercury	FLTR	NT8	3	14	2.00E-04	3.40E-04	9.00E-04	LTV_DAPH	0.392
Mercury	FLTR	NT8	3	14	2.00E-04	3.40E-04	9.00E-04	LTV_FISH	0.392
Mercury	FLTR	NT8	3	14	2.00E-04	3.40E-04	1.00E-03	LCV_DAPH	0.355
Mercury	FLTR	NT8	3	14	2.00E-04	3.40E-04	1.30E-03	S_CHR_V	0.262
Mercury	FLTR	NT8	3	14	2.00E-04	3.40E-04	2.40E-03	NAWQ_ACU	0.142
Mercury	FLTR	NT8	3	14	2.00E-04	3.40E-04	5.00E-03	LCV_AQPL	0.068
Mercury	FLTR	Reach 1	6	34	1.46E-04	1.90E-04	2.30E-04	LCV_FISH	0.825
Mercury	FLTR	Reach 1	6	34	1.46E-04	1.90E-04	8.70E-04	LTV_DAPH	0.218

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Mercury	FLTR	Reach 1	6	34	1.46E-04	1.90E-04	8.70E-04	LTV_FISH	0.218
Mercury	FLTR	Reach 1	6	34	1.46E-04	1.90E-04	9.60E-04	LCV_DAPH	0.198
Mercury	FLTR	Reach 1	6	34	1.46E-04	1.90E-04	1.30E-03	S_CHR_V	0.146
Mercury	FLTR	Reach 1	6	34	1.46E-04	1.90E-04	2.40E-03	NAWQ_ACU	0.079
Mercury	FLTR	Reach 1	6	34	1.46E-04	1.90E-04	5.00E-03	LCV_AQPL	0.038
Mercury	FLTR	SS1	3	25	1.00E-04	1.50E-04	2.00E-04	LCV_FISH	0.673
Mercury	FLTR	SS1	3	25	1.00E-04	1.50E-04	9.00E-04	LTV_DAPH	0.178
Mercury	FLTR	SS1	3	25	1.00E-04	1.50E-04	9.00E-04	LTV_FISH	0.178
Mercury	FLTR	SS1	3	25	1.00E-04	1.50E-04	1.00E-03	LCV_DAPH	0.161
Mercury	FLTR	SS1	3	25	1.00E-04	1.50E-04	1.30E-03	S_CHR_V	0.119
Mercury	FLTR	SS1	3	25	1.00E-04	1.50E-04	2.40E-03	NAWQ_ACU	0.064
Mercury	FLTR	SS1	3	25	1.00E-04	1.50E-04	5.00E-03	LCV_AQPL	0.031
Mercury	FLTR	SS4	3	25	1.00E-04	1.20E-04	2.00E-04	LCV_FISH	0.518
Mercury	FLTR	SS4	3	25	1.00E-04	1.20E-04	9.00E-04	LTV_DAPH	0.137
Mercury	FLTR	SS4	3	25	1.00E-04	1.20E-04	9.00E-04	LTV_FISH	0.137
Mercury	FLTR	SS4	3	25	1.00E-04	1.20E-04	1.00E-03	LCV_DAPH	0.124
Mercury	FLTR	SS4	3	25	1.00E-04	1.20E-04	1.30E-03	S_CHR_V	0.092
Mercury	FLTR	SS4	3	25	1.00E-04	1.20E-04	2.40E-03	NAWQ_ACU	0.050
Mercury	FLTR	SS4	3	25	1.00E-04	1.20E-04	5.00E-03	LCV_AQPL	0.024
Mercury	FLTR	SS5	1	25	1.00E-04	1.30E-04	2.00E-04	LCV_FISH	0.545
Mercury	FLTR	SS5	1	25	1.00E-04	1.30E-04	9.00E-04	LTV_DAPH	0.144

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Mercury	FLTR	SS5	1	25	1.00E-04	1.30E-04	9.00E-04	LTV_FISH	0.144
Mercury	FLTR	SS5	1	25	1.00E-04	1.30E-04	1.00E-03	LCV_DAPH	0.131
Mercury	FLTR	SS5	1	25	1.00E-04	1.30E-04	1.30E-03	S_CHR_V	0.096
Mercury	FLTR	SS5	1	25	1.00E-04	1.30E-04	2.40E-03	NAWQ_ACU	0.052
Mercury	FLTR	SS5	1	25	1.00E-04	1.30E-04	5.00E-03	LCV_AQPL	0.025
Mercury	WHOL	BCK 4.55	1	67	1.00E-04	1.10E-04	2.00E-04	LCV_FISH	0.478
Mercury	WHOL	BCK 4.55	1	67	1.00E-04	1.10E-04	9.00E-04	LTV_DAPH	0.126
Mercury	WHOL	BCK 4.55	1	67	1.00E-04	1.10E-04	9.00E-04	LTV_FISH	0.126
Mercury	WHOL	BCK 4.55	1	67	1.00E-04	1.10E-04	1.00E-03	LCV_DAPH	0.115
Mercury	WHOL	BCK 4.55	1	67	1.00E-04	1.10E-04	1.30E-03	S_CHR_V	0.085
Mercury	WHOL	BCK 4.55	1	67	1.00E-04	1.10E-04	2.40E-03	NAWQ_ACU	0.046
Mercury	WHOL	BCK 4.55	1	67	1.00E-04	1.10E-04	5.00E-03	LCV_AQPL	0.022
Mercury	WHOL	BCK 9.40	3	32	1.00E-04	1.10E-04	2.00E-04	LCV_FISH	0.488
Mercury	WHOL	BCK 9.40	3	32	1.00E-04	1.10E-04	9.00E-04	LTV_DAPH	0.129
Mercury	WHOL	BCK 9.40	3	32	1.00E-04	1.10E-04	9.00E-04	LTV_FISH	0.129
Mercury	WHOL	BCK 9.40	3	32	1.00E-04	1.10E-04	1.00E-03	LCV_DAPH	0.117
Mercury	WHOL	BCK 9.40	3	32	1.00E-04	1.10E-04	1.30E-03	S_CHR_V	0.086
Mercury	WHOL	BCK 9.40	3	32	1.00E-04	1.10E-04	2.40E-03	NAWQ_ACU	0.047
Mercury	WHOL	BCK 9.40	3	32	1.00E-04	1.10E-04	5.00E-03	LCV_AQPL	0.022
Mercury	WHOL	NT3	10	21	2.00E-04	2.40E-04	2.00E-04	LCV_FISH	1.042
Mercury	WHOL	NT3	10	21	2.00E-04	2.40E-04	9.00E-04	LTV_DAPH	0.276

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Mercury	WHOL	NT3	10	21	2.00E-04	2.40E-04	9.00E-04	LTV_FISH	0.276
Mercury	WHOL	NT3	10	21	2.00E-04	2.40E-04	1.00E-03	LCV_DAPH	0.250
Mercury	WHOL	NT3	10	21	2.00E-04	2.40E-04	1.30E-03	S_CHR_V	0.184
Mercury	WHOL	NT3	10	21	2.00E-04	2.40E-04	2.40E-03	NAWQ_ACU	0.100
Mercury	WHOL	NT3	10	21	2.00E-04	2.40E-04	5.00E-03	LCV_AQPL	0.048
Mercury	WHOL	NT6	3	21	1.00E-04	1.50E-04	2.00E-04	LCV_FISH	0.655
Mercury	WHOL	NT6	3	21	1.00E-04	1.50E-04	9.00E-04	LTV_DAPH	0.173
Mercury	WHOL	NT6	3	21	1.00E-04	1.50E-04	9.00E-04	LTV_FISH	0.173
Mercury	WHOL	NT6	3	21	1.00E-04	1.50E-04	1.00E-03	LCV_DAPH	0.157
Mercury	WHOL	NT6	3	21	1.00E-04	1.50E-04	1.30E-03	S_CHR_V	0.116
Mercury	WHOL	NT6	3	21	1.00E-04	1.50E-04	2.40E-03	NAWQ_ACU	0.063
Mercury	WHOL	NT6	3	21	1.00E-04	1.50E-04	5.00E-03	LCV_AQPL	0.030
Mercury	WHOL	NT7	3	21	1.00E-04	1.50E-04	2.00E-04	LCV_FISH	0.665
Mercury	WHOL	NT7	3	21	1.00E-04	1.50E-04	9.00E-04	LTV_DAPH	0.176
Mercury	WHOL	NT7	3	21	1.00E-04	1.50E-04	9.00E-04	LTV_FISH	0.176
Mercury	WHOL	NT7	3	21	1.00E-04	1.50E-04	1.00E-03	LCV_DAPH	0.159
Mercury	WHOL	NT7	3	21	1.00E-04	1.50E-04	1.30E-03	S_CHR_V	0.118
Mercury	WHOL	NT7	3	21	1.00E-04	1.50E-04	2.40E-03	NAWQ_ACU	0.064
Mercury	WHOL	NT7	3	21	1.00E-04	1.50E-04	5.00E-03	LCV_AQPL	0.031
Mercury	WHOL	NT8	3	14	1.00E-04	1.80E-04	2.00E-04	LCV_FISH	0.789
Mercury	WHOL	NT8	3	14	1.00E-04	1.80E-04	9.00E-04	LTV_DAPH	0.209

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Mercury	WHOL	NT8	3	14	1.00E-04	1.80E-04	9.00E-04	LTV_FISH	0.209
Mercury	WHOL	NT8	3	14	1.00E-04	1.80E-04	1.00E-03	LCV_DAPH	0.189
Mercury	WHOL	NT8	3	14	1.00E-04	1.80E-04	1.30E-03	S_CHR_V	0.140
Mercury	WHOL	NT8	3	14	1.00E-04	1.80E-04	2.40E-03	NAWQ_ACU	0.076
Mercury	WHOL	NT8	3	14	1.00E-04	1.80E-04	5.00E-03	LCV_AQPL	0.036
Mercury	WHOL	Reach 1	8	33	1.47E-04	1.81E-04	2.30E-04	LCV_FISH	0.787
Mercury	WHOL	Reach 1	8	33	1.47E-04	1.81E-04	8.70E-04	LTV_DAPH	0.208
Mercury	WHOL	Reach 1	8	33	1.47E-04	1.81E-04	8.70E-04	LTV_FISH	0.208
Mercury	WHOL	Reach 1	8	33	1.47E-04	1.81E-04	9.60E-04	LCV_DAPH	0.189
Mercury	WHOL	Reach 1	8	33	1.47E-04	1.81E-04	1.30E-03	S_CHR_V	0.139
Mercury	WHOL	Reach 1	8	33	1.47E-04	1.81E-04	2.40E-03	NAWQ_ACU	0.075
Mercury	WHOL	Reach 1	8	33	1.47E-04	1.81E-04	5.00E-03	LCV_AQPL	0.036
Mercury	WHOL	SSI	3	24	1.00E-04	1.40E-04	2.00E-04	LCV_FISH	0.607
Mercury	WHOL	SSI	3	24	1.00E-04	1.40E-04	9.00E-04	LTV_DAPH	0.161
Mercury	WHOL	SSI	3	24	1.00E-04	1.40E-04	9.00E-04	LTV_FISH	0.161
Mercury	WHOL	SSI	3	24	1.00E-04	1.40E-04	1.00E-03	LCV_DAPH	0.145
Mercury	WHOL	SSI	3	24	1.00E-04	1.40E-04	1.30E-03	S_CHR_V	0.107
Mercury	WHOL	SSI	3	24	1.00E-04	1.40E-04	2.40E-03	NAWQ_ACU	0.058
Mercury	WHOL	SSI	3	24	1.00E-04	1.40E-04	5.00E-03	LCV_AQPL	0.028
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	5.00E-03	LCV_AQPL	1.125
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	5.00E-03	LCV_DAPH	1.125

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	3.50E-02	LCV_FISH	0.161
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	4.50E-02	LTV_DAPH	0.125
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	6.20E-02	LTV_FISH	0.091
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	1.28E-01	LCV_NDI	0.044
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	1.60E-01	NAWQ_CHR	0.035
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	2.83E-01	NCHR_200	0.020
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	1.40E+00	NAWQ_ACU	0.004
Nickel	FLTR	BCK 9.40	2	35	4.40E-03	5.62E-03	2.55E+00	NACU_200	0.002
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	5.00E-03	LCV_AQPL	10.378
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	5.00E-03	LCV_DAPH	10.378
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	3.50E-02	LCV_FISH	1.483
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	4.50E-02	LTV_DAPH	1.153
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	6.20E-02	LTV_FISH	0.837
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	1.28E-01	LCV_NDI	0.404
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	1.60E-01	NAWQ_CHR	0.324
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	2.83E-01	NCHR_200	0.183
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	1.40E+00	NAWQ_ACU	0.037
Nickel	FLTR	Reach 1	32	38	4.05E-02	5.19E-02	2.55E+00	NACU_200	0.020
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	5.00E-03	LCV_AQPL	2.603
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	5.00E-03	LCV_DAPH	2.603
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	3.50E-02	LCV_FISH	0.372

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	4.50E-02	LTV_DAPH	0.289
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	6.20E-02	LTV_FISH	0.210
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	1.28E-01	LCV_NDI	0.101
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	1.60E-01	NAWQ_CHR	0.081
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	2.83E-01	NCHR_200	0.046
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	1.40E+00	NAWQ_ACU	0.009
Nickel	FLTR	SS1	3	27	7.50E-03	1.30E-02	2.55E+00	NACU_200	0.005
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	5.00E-03	LCV_AQPL	1.607
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	5.00E-03	LCV_DAPH	1.607
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	3.50E-02	LCV_FISH	0.230
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	4.50E-02	LTV_DAPH	0.179
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	6.20E-02	LTV_FISH	0.130
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	1.28E-01	LCV_NDI	0.063
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	1.60E-01	NAWQ_CHR	0.050
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	2.83E-01	NCHR_200	0.028
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	1.40E+00	NAWQ_ACU	0.006
Nickel	FLTR	SS4	3	27	5.80E-03	8.03E-03	2.55E+00	NACU_200	0.003
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	5.00E-03	LCV_AQPL	1.196
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	5.00E-03	LCV_DAPH	1.196
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	3.50E-02	LCV_FISH	0.171
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	4.50E-02	LTV_DAPH	0.133

Table G.5 (continued)

Analyte	Media ^b	Site	Deis.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	6.20E-02	LTV_FISH	0.096
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	1.28E-01	LCV_NDI	0.047
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	1.60E-01	NAWQ_CHR	0.037
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	2.83E-01	NCHR_200	0.021
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	1.40E+00	NAWQ_ACU	0.004
Nickel	FLTR	SS5	2	27	4.60E-03	5.98E-03	2.55E+00	NACU_200	0.002
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	5.00E-03	LCV_AQPL	1.264
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	5.00E-03	LCV_DAPH	1.264
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	3.50E-02	LCV_FISH	0.181
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	4.50E-02	LTV_DAPH	0.140
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	6.20E-02	LTV_FISH	0.102
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	1.28E-01	LCV_NDI	0.049
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	1.60E-01	NAWQ_CHR	0.040
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	2.83E-01	NCHR_200	0.022
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	1.40E+00	NAWQ_ACU	0.005
Nickel	FLTR	SS6	3	26	5.00E-03	6.32E-03	2.55E+00	NACU_200	0.002
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	5.00E-03	LCV_AQPL	1.295
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	5.00E-03	LCV_DAPH	1.295
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	3.50E-02	LCV_FISH	0.185
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	4.50E-02	LTV_DAPH	0.144
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	6.20E-02	LTV_FISH	0.104

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	1.28E-01	LCV_NDI	0.050
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	1.60E-01	NAWQ_CHR	0.040
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	2.83E-01	NCHR_200	0.023
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	1.40E+00	NAWQ_ACU	0.005
Nickel	FLTR	SS8	4	25	5.00E-03	6.47E-03	2.55E+00	NACU_200	0.003
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	5.00E-03	LCV_AQPL	1.929
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	5.00E-03	LCV_DAPH	1.929
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	3.50E-02	LCV_FISH	0.276
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	4.50E-02	LTV_DAPH	0.214
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	6.20E-02	LTV_FISH	0.156
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	1.28E-01	LCV_NDI	0.075
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	1.60E-01	NAWQ_CHR	0.060
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	2.83E-01	NCHR_200	0.034
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	1.40E+00	NAWQ_ACU	0.007
Nickel	WHOL	BC9.4-SS5	6	37	7.10E-03	9.64E-03	2.55E+00	NACU_200	0.004
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	5.00E-03	LCV_AQPL	0.914
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	5.00E-03	LCV_DAPH	0.914
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	3.50E-02	LCV_FISH	0.131
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	4.50E-02	LTV_DAPH	0.102
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	6.20E-02	LTV_FISH	0.074
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	1.28E-01	LCV_NDI	0.036

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	1.60E-01	NAWQ_CHR	0.029
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	2.83E-01	NCHR_200	0.016
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	1.40E+00	NAWQ_ACU	0.003
Nickel	WHOL	BCK 4.55	2	70	4.40E-03	4.57E-03	2.55E+00	NACU_200	0.002
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	5.00E-03	LCV_AQPL	1.183
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	5.00E-03	LCV_DAPH	1.183
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	3.50E-02	LCV_FISH	0.169
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	4.50E-02	LTV_DAPH	0.131
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	6.20E-02	LTV_FISH	0.095
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	1.28E-01	LCV_NDI	0.046
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	1.60E-01	NAWQ_CHR	0.037
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	2.83E-01	NCHR_200	0.021
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	1.40E+00	NAWQ_ACU	0.004
Nickel	WHOL	BCK 9.40	6	35	4.90E-03	5.92E-03	2.55E+00	NACU_200	0.002
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	5.00E-03	LCV_AQPL	1.255
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	5.00E-03	LCV_DAPH	1.255
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	3.50E-02	LCV_FISH	0.179
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	4.50E-02	LTV_DAPH	0.139
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	6.20E-02	LTV_FISH	0.101
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	1.28E-01	LCV_NDI	0.049
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	1.60E-01	NAWQ_CHR	0.039

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	2.83E-01	NCHR_200	0.022
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	1.40E+00	NAWQ_ACU	0.004
Nickel	WHOL	NT7	5	21	4.60E-03	6.27E-03	2.55E+00	NACU_200	0.002
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	5.00E-03	LCV_AQPL	9.385
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	5.00E-03	LCV_DAPH	9.385
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	3.50E-02	LCV_FISH	1.341
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	4.50E-02	LTV_DAPH	1.043
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	6.20E-02	LTV_FISH	0.757
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	1.28E-01	LCV_NDI	0.365
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	1.60E-01	NAWQ_CHR	0.293
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	2.83E-01	NCHR_200	0.166
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	1.40E+00	NAWQ_ACU	0.034
Nickel	WHOL	Reach 1	34	38	3.97E-02	4.69E-02	2.55E+00	NACU_200	0.018
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	5.00E-03	LCV_AQPL	2.283
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	5.00E-03	LCV_DAPH	2.283
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	3.50E-02	LCV_FISH	0.326
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	4.50E-02	LTV_DAPH	0.254
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	6.20E-02	LTV_FISH	0.184
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	1.28E-01	LCV_NDI	0.089
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	1.60E-01	NAWQ_CHR	0.071
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	2.83E-01	NCHR_200	0.040

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	1.40E+00	NAWQ_ACU	0.008
Nickel	WHOL	SS1	1	27	6.60E-03	1.14E-02	2.55E+00	NACU_200	0.004
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	5.00E-03	LCV_AQPL	1.221
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	5.00E-03	LCV_DAPH	1.221
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	3.50E-02	LCV_FISH	0.174
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	4.50E-02	LTV_DAPH	0.136
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	6.20E-02	LTV_FISH	0.098
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	1.28E-01	LCV_NDI	0.048
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	1.60E-01	NAWQ_CHR	0.038
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	2.83E-01	NCHR_200	0.022
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	1.40E+00	NAWQ_ACU	0.004
Nickel	WHOL	SS4	3	27	4.80E-03	6.10E-03	2.55E+00	NACU_200	0.002
Selenium	WHOL	Reach 1	1	23	4.24E-03	1.89E+00	5.00E-03	NAWQ_CHR	0.270
Selenium	WHOL	Reach 1	1	23	4.24E-03	4.73E-01	2.00E-02	NAWQ_ACU	0.036
Selenium	WHOL	Reach 1	1	23	4.24E-03	9.45E-03	2.50E-02	LTV_DAPH	0.378
Selenium	WHOL	Reach 1	1	23	4.24E-03	9.45E-03	4.00E-02	LTV_FISH	0.236
Selenium	WHOL	Reach 1	1	23	4.24E-03	9.45E-03	8.83E-02	LCV_FISH	0.107
Selenium	WHOL	Reach 1	1	23	4.24E-03	9.45E-03	9.17E-02	LCV_DAPH	0.103
Selenium	WHOL	Reach 1	1	23	4.24E-03	9.45E-03	1.00E-01	LCV_AQPL	0.095
Silver	FLTR	BCK 4.55	1	14	3.30E-03	3.73E-03	1.00E-04	LCV_FISH	31.103
Silver	FLTR	BCK 4.55	1	14	3.30E-03	3.73E-03	2.00E-04	LTV_FISH	18.662

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Silver	FLTR	BCK 4.55	1	14	3.30E-03	3.73E-03	4.00E-04	S_CHR_V	10.368
Silver	FLTR	BCK 4.55	1	14	3.30E-03	3.73E-03	6.00E-04	LTV_DAPH	6.665
Silver	FLTR	BCK 4.55	1	14	3.30E-03	3.73E-03	2.60E-03	LCV_DAPH	1.436
Silver	FLTR	BCK 4.55	1	14	3.30E-03	3.73E-03	4.10E-03	NAWQ_ACU	0.910
Silver	FLTR	BCK 4.55	1	14	3.30E-03	3.73E-03	1.34E-02	NACU_200	0.279
Silver	FLTR	BCK 4.55	1	14	3.30E-03	3.73E-03	3.00E-02	LCV_AQPL	0.124
Silver	FLTR	Reach 1	1	38	2.46E-03	2.75E-03	1.20E-04	LCV_FISH	22.881
Silver	FLTR	Reach 1	1	38	2.46E-03	2.75E-03	2.00E-04	LTV_FISH	13.728
Silver	FLTR	Reach 1	1	38	2.46E-03	2.75E-03	3.60E-04	S_CHR_V	7.627
Silver	FLTR	Reach 1	1	38	2.46E-03	2.75E-03	5.60E-04	LTV_DAPH	4.903
Silver	FLTR	Reach 1	1	38	2.46E-03	2.75E-03	2.60E-03	LCV_DAPH	1.056
Silver	FLTR	Reach 1	1	38	2.46E-03	2.75E-03	4.10E-03	NAWQ_ACU	0.670
Silver	FLTR	Reach 1	1	38	2.46E-03	2.75E-03	1.34E-02	NACU_200	0.205
Silver	FLTR	Reach 1	1	38	2.46E-03	2.75E-03	3.00E-02	LCV_AQPL	0.092
Silver	WHOL	BCK 4.55	1	70	3.00E-03	3.12E-03	1.00E-04	LCV_FISH	25.984
Silver	WHOL	BCK 4.55	1	70	3.00E-03	3.12E-03	2.00E-04	LTV_FISH	15.591
Silver	WHOL	BCK 4.55	1	70	3.00E-03	3.12E-03	4.00E-04	S_CHR_V	8.661
Silver	WHOL	BCK 4.55	1	70	3.00E-03	3.12E-03	6.00E-04	LTV_DAPH	5.568
Silver	WHOL	BCK 4.55	1	70	3.00E-03	3.12E-03	2.60E-03	LCV_DAPH	1.199
Silver	WHOL	BCK 4.55	1	70	3.00E-03	3.12E-03	4.10E-03	NAWQ_ACU	0.761
Silver	WHOL	BCK 4.55	1	70	3.00E-03	3.12E-03	1.34E-02	NACU_200	0.233

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Silver	WHOL	BCK 4.55	1	70	3.00E-03	3.12E-03	3.00E-02	LCV_AQPL	0.104
Silver	WHOL	Reach 1	2	38	2.52E-03	2.82E-03	1.20E-04	LCV_FISH	23.535
Silver	WHOL	Reach 1	2	38	2.52E-03	2.82E-03	2.00E-04	LTV_FISH	14.121
Silver	WHOL	Reach 1	2	38	2.52E-03	2.82E-03	3.60E-04	S_CHR_V	7.845
Silver	WHOL	Reach 1	2	38	2.52E-03	2.82E-03	5.60E-04	LTV_DAPH	5.043
Silver	WHOL	Reach 1	2	38	2.52E-03	2.82E-03	2.60E-03	LCV_DAPH	1.086
Silver	WHOL	Reach 1	2	38	2.52E-03	2.82E-03	4.10E-03	NAWQ_ACU	0.689
Silver	WHOL	Reach 1	2	38	2.52E-03	2.82E-03	1.34E-02	NACU_200	0.211
Silver	WHOL	Reach 1	2	38	2.52E-03	2.82E-03	3.00E-02	LCV_AQPL	0.094
Silver	WHOL	SS1	1	27	2.60E-03	2.96E-03	1.00E-04	LCV_FISH	24.634
Silver	WHOL	SS1	1	27	2.60E-03	2.96E-03	2.00E-04	LTV_FISH	14.781
Silver	WHOL	SS1	1	27	2.60E-03	2.96E-03	4.00E-04	S_CHR_V	8.211
Silver	WHOL	SS1	1	27	2.60E-03	2.96E-03	6.00E-04	LTV_DAPH	5.279
Silver	WHOL	SS1	1	27	2.60E-03	2.96E-03	2.60E-03	LCV_DAPH	1.137
Silver	WHOL	SS1	1	27	2.60E-03	2.96E-03	4.10E-03	NAWQ_ACU	0.721
Silver	WHOL	SS1	1	27	2.60E-03	2.96E-03	1.34E-02	NACU_200	0.221
Silver	WHOL	SS1	1	27	2.60E-03	2.96E-03	3.00E-02	LCV_AQPL	0.099
Silver	WHOL	SS4	1	27	2.60E-03	2.92E-03	1.00E-04	LCV_FISH	24.338
Silver	WHOL	SS4	1	27	2.60E-03	2.92E-03	2.00E-04	LTV_FISH	14.603
Silver	WHOL	SS4	1	27	2.60E-03	2.92E-03	4.00E-04	S_CHR_V	8.113
Silver	WHOL	SS4	1	27	2.60E-03	2.92E-03	6.00E-04	LTV_DAPH	5.215

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Silver	WHOL	SS4	1	27	2.60E-03	2.92E-03	2.60E-03	LCV_DAPH	1.123
Silver	WHOL	SS4	1	27	2.60E-03	2.92E-03	4.10E-03	NAWQ_ACU	0.712
Silver	WHOL	SS4	1	27	2.60E-03	2.92E-03	1.34E-02	NACU_200	0.218
Silver	WHOL	SS4	1	27	2.60E-03	2.92E-03	3.00E-02	LCV_AQPL	0.097
Silver	WHOL	SS6	1	25	2.60E-03	2.93E-03	1.00E-04	LCV_FISH	24.454
Silver	WHOL	SS6	1	25	2.60E-03	2.93E-03	2.00E-04	LTV_FISH	14.672
Silver	WHOL	SS6	1	25	2.60E-03	2.93E-03	4.00E-04	S_CHR_V	8.151
Silver	WHOL	SS6	1	25	2.60E-03	2.93E-03	6.00E-04	LTV_DAPH	5.240
Silver	WHOL	SS6	1	25	2.60E-03	2.93E-03	2.60E-03	LCV_DAPH	1.129
Silver	WHOL	SS6	1	25	2.60E-03	2.93E-03	4.10E-03	NAWQ_ACU	0.716
Silver	WHOL	SS6	1	25	2.60E-03	2.93E-03	1.34E-02	NACU_200	0.219
Silver	WHOL	SS6	1	25	2.60E-03	2.93E-03	3.00E-02	LCV_AQPL	0.098
Silver	WHOL	SS8	1	25	2.60E-03	3.05E-03	1.00E-04	LCV_FISH	25.429
Silver	WHOL	SS8	1	25	2.60E-03	3.05E-03	2.00E-04	LTV_FISH	15.258
Silver	WHOL	SS8	1	25	2.60E-03	3.05E-03	4.00E-04	S_CHR_V	8.477
Silver	WHOL	SS8	1	25	2.60E-03	3.05E-03	6.00E-04	LTV_DAPH	5.449
Silver	WHOL	SS8	1	25	2.60E-03	3.05E-03	2.60E-03	LCV_DAPH	1.174
Silver	WHOL	SS8	1	25	2.60E-03	3.05E-03	4.10E-03	NAWQ_ACU	0.744
Silver	WHOL	SS8	1	25	2.60E-03	3.05E-03	1.34E-02	NACU_200	0.228
Silver	WHOL	SS8	1	25	2.60E-03	3.05E-03	3.00E-02	LCV_AQPL	0.102
Strontium	FLTR	BC9.4-SS5	2	2	1.95E-01	2.61E-01	6.20E-01	S_CHR_V	0.421

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Strontium	FLTR	BC9.4-SS5	2	2	1.95E-01	2.61E-01	6.10E+00	S_ACU_V	0.043
Strontium	FLTR	BC9.4-SS5	2	2	1.95E-01	2.61E-01	4.20E+01	LCV_DAPH	0.006
Strontium	FLTR	BCK 9.40	13	13	1.75E-01	2.33E-01	6.20E-01	S_CHR_V	0.376
Strontium	FLTR	BCK 9.40	13	13	1.75E-01	2.33E-01	6.10E+00	S_ACU_V	0.038
Strontium	FLTR	BCK 9.40	13	13	1.75E-01	2.33E-01	4.20E+01	LCV_DAPH	0.006
Strontium	FLTR	Reach 1	16	16	5.56E-01	6.94E-01	6.20E-01	S_CHR_V	1.120
Strontium	FLTR	Reach 1	16	16	5.56E-01	6.94E-01	6.10E+00	S_ACU_V	0.114
Strontium	FLTR	Reach 1	16	16	5.56E-01	6.94E-01	4.20E+01	LCV_DAPH	0.017
Strontium	FLTR	SS1	14	14	5.02E-01	5.36E-01	6.20E-01	S_CHR_V	0.865
Strontium	FLTR	SS1	14	14	5.02E-01	5.36E-01	6.10E+00	S_ACU_V	0.088
Strontium	FLTR	SS1	14	14	5.02E-01	5.36E-01	4.20E+01	LCV_DAPH	0.013
Strontium	FLTR	SS4	14	14	2.41E-01	2.99E-01	6.20E-01	S_CHR_V	0.482
Strontium	FLTR	SS4	14	14	2.41E-01	2.99E-01	6.10E+00	S_ACU_V	0.049
Strontium	FLTR	SS4	14	14	2.41E-01	2.99E-01	4.20E+01	LCV_DAPH	0.007
Strontium	FLTR	SS5	14	14	1.19E-01	1.51E-01	6.20E-01	S_CHR_V	0.243
Strontium	FLTR	SS5	14	14	1.19E-01	1.51E-01	6.10E+00	S_ACU_V	0.025
Strontium	FLTR	SS5	14	14	1.19E-01	1.51E-01	4.20E+01	LCV_DAPH	0.004
Strontium	FLTR	SS6	12	12	4.38E-02	8.25E-02	6.20E-01	S_CHR_V	0.133
Strontium	FLTR	SS6	12	12	4.38E-02	8.25E-02	6.10E+00	S_ACU_V	0.014
Strontium	FLTR	SS6	12	12	4.38E-02	8.25E-02	4.20E+01	LCV_DAPH	0.002
Strontium	WHOL	BC9.4-SS5	2	2	1.95E-01	2.61E-01	6.20E-01	S_CHR_V	0.421

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Strontium	WHOL	BC9.4-SS5	2	2	1.95E-01	2.61E-01	6.10E+00	S_ACU_V	0.043
Strontium	WHOL	BC9.4-SS5	2	2	1.95E-01	2.61E-01	4.20E+01	LCV_DAPH	0.006
Strontium	WHOL	BCK 0.63	14	14	7.74E-02	8.95E-02	6.20E-01	S_CHR_V	0.144
Strontium	WHOL	BCK 0.63	14	14	7.74E-02	8.95E-02	6.10E+00	S_ACU_V	0.015
Strontium	WHOL	BCK 0.63	14	14	7.74E-02	8.95E-02	4.20E+01	LCV_DAPH	0.002
Strontium	WHOL	BCK 4.55	70	70	7.75E-02	8.31E-02	6.20E-01	S_CHR_V	0.134
Strontium	WHOL	BCK 4.55	70	70	7.75E-02	8.31E-02	6.10E+00	S_ACU_V	0.014
Strontium	WHOL	BCK 4.55	70	70	7.75E-02	8.31E-02	4.20E+01	LCV_DAPH	0.002
Strontium	WHOL	BCK 9.40	13	13	1.64E-01	1.87E-01	6.20E-01	S_CHR_V	0.301
Strontium	WHOL	BCK 9.40	13	13	1.64E-01	1.87E-01	6.10E+00	S_ACU_V	0.031
Strontium	WHOL	BCK 9.40	13	13	1.64E-01	1.87E-01	4.20E+01	LCV_DAPH	0.004
Strontium	WHOL	Reach 1	16	16	5.82E-01	7.07E-01	6.20E-01	S_CHR_V	1.140
Strontium	WHOL	Reach 1	16	16	5.82E-01	7.07E-01	6.10E+00	S_ACU_V	0.116
Strontium	WHOL	Reach 1	16	16	5.82E-01	7.07E-01	4.20E+01	LCV_DAPH	0.017
Strontium	WHOL	SS1	14	14	4.96E-01	5.28E-01	6.20E-01	S_CHR_V	0.852
Strontium	WHOL	SS1	14	14	4.96E-01	5.28E-01	6.10E+00	S_ACU_V	0.087
Strontium	WHOL	SS1	14	14	4.96E-01	5.28E-01	4.20E+01	LCV_DAPH	0.013
Strontium	WHOL	SS4	14	14	2.33E-01	2.86E-01	6.20E-01	S_CHR_V	0.461
Strontium	WHOL	SS4	14	14	2.33E-01	2.86E-01	6.10E+00	S_ACU_V	0.047
Strontium	WHOL	SS4	14	14	2.33E-01	2.86E-01	4.20E+01	LCV_DAPH	0.007
Strontium	WHOL	SS5	14	14	1.15E-01	1.45E-01	6.20E-01	S_CHR_V	0.234

Table G.5 (continued)

Analyte	Media ^a	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Strontium	WHOL	SS5	14	14	1.15E-01	1.45E-01	6.10E+00	S_ACU_V	0.024
Strontium	WHOL	SS5	14	14	1.15E-01	1.45E-01	4.20E+01	LCV_DAPH	0.003
Uranium	FLTR	BC9.4-SS5	2	2	1.39E-01	2.04E-01	1.90E-03	S_CHR_V	109.157
Uranium	FLTR	BC9.4-SS5	2	2	1.39E-01	2.04E-01	3.35E-02	S_ACU_V	6.093
Uranium	FLTR	BC9.4-SS5	2	2	1.39E-01	2.04E-01	1.42E-01	LCV_FISH	1.437
Uranium	FLTR	BC9.4-SS5	2	2	1.39E-01	2.04E-01	4.55E-01	LTV_FISH	0.449
Uranium	FLTR	BCK 0.63	14	14	2.91E-02	3.53E-02	1.90E-03	S_CHR_V	18.856
Uranium	FLTR	BCK 0.63	14	14	2.91E-02	3.53E-02	3.35E-02	S_ACU_V	1.053
Uranium	FLTR	BCK 0.63	14	14	2.91E-02	3.53E-02	1.42E-01	LCV_FISH	0.248
Uranium	FLTR	BCK 0.63	14	14	2.91E-02	3.53E-02	4.55E-01	LTV_FISH	0.078
Uranium	FLTR	BCK 4.55	14	14	3.32E-02	4.10E-02	1.90E-03	S_CHR_V	21.946
Uranium	FLTR	BCK 4.55	14	14	3.32E-02	4.10E-02	3.35E-02	S_ACU_V	1.225
Uranium	FLTR	BCK 4.55	14	14	3.32E-02	4.10E-02	1.42E-01	LCV_FISH	0.289
Uranium	FLTR	BCK 4.55	14	14	3.32E-02	4.10E-02	4.55E-01	LTV_FISH	0.090
Uranium	FLTR	BCK 9.40	13	13	1.07E-01	1.37E-01	1.90E-03	S_CHR_V	73.039
Uranium	FLTR	BCK 9.40	13	13	1.07E-01	1.37E-01	3.35E-02	S_ACU_V	4.077
Uranium	FLTR	BCK 9.40	13	13	1.07E-01	1.37E-01	1.42E-01	LCV_FISH	0.962
Uranium	FLTR	BCK 9.40	13	13	1.07E-01	1.37E-01	4.55E-01	LTV_FISH	0.300
Uranium	FLTR	Reach 1	16	16	1.36E-01	1.76E-01	1.87E-03	S_CHR_V	93.984
Uranium	FLTR	Reach 1	16	16	1.36E-01	1.76E-01	3.35E-02	S_ACU_V	5.246
Uranium	FLTR	Reach 1	16	16	1.36E-01	1.76E-01	1.42E-01	LCV_FISH	1.238

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Uranium	FLTR	Reach 1	16	16	1.36E-01	1.76E-01	4.55E-01	LTV_FISH	0.386
Uranium	FLTR	SS1	14	14	3.84E-02	4.24E-02	1.90E-03	S_CHR_V	22.655
Uranium	FLTR	SS1	14	14	3.84E-02	4.24E-02	3.35E-02	S_ACU_V	1.265
Uranium	FLTR	SS1	14	14	3.84E-02	4.24E-02	1.42E-01	LCV_FISH	0.298
Uranium	FLTR	SS1	14	14	3.84E-02	4.24E-02	4.55E-01	LTV_FISH	0.093
Uranium	FLTR	SS4	14	14	1.19E-01	1.52E-01	1.90E-03	S_CHR_V	81.167
Uranium	FLTR	SS4	14	14	1.19E-01	1.52E-01	3.35E-02	S_ACU_V	4.531
Uranium	FLTR	SS4	14	14	1.19E-01	1.52E-01	1.42E-01	LCV_FISH	1.069
Uranium	FLTR	SS4	14	14	1.19E-01	1.52E-01	4.55E-01	LTV_FISH	0.334
Uranium	FLTR	SS5	14	14	5.85E-02	7.82E-02	1.90E-03	S_CHR_V	41.796
Uranium	FLTR	SS5	14	14	5.85E-02	7.82E-02	3.35E-02	S_ACU_V	2.333
Uranium	FLTR	SS5	14	14	5.85E-02	7.82E-02	1.42E-01	LCV_FISH	0.550
Uranium	FLTR	SS5	14	14	5.85E-02	7.82E-02	4.55E-01	LTV_FISH	0.172
Uranium	FLTR	SS6	4	12	1.47E-02	4.01E-02	1.90E-03	S_CHR_V	21.442
Uranium	FLTR	SS6	4	12	1.47E-02	4.01E-02	3.35E-02	S_ACU_V	1.197
Uranium	FLTR	SS6	4	12	1.47E-02	4.01E-02	1.42E-01	LCV_FISH	0.282
Uranium	FLTR	SS6	4	12	1.47E-02	4.01E-02	4.55E-01	LTV_FISH	0.088
Uranium	FLTR	SS8	5	12	1.90E-03	3.87E-03	1.90E-03	S_CHR_V	2.068
Uranium	FLTR	SS8	5	12	1.90E-03	3.87E-03	3.35E-02	S_ACU_V	0.115
Uranium	FLTR	SS8	5	12	1.90E-03	3.87E-03	1.42E-01	LCV_FISH	0.027
Uranium	FLTR	SS8	5	12	1.90E-03	3.87E-03	4.55E-01	LTV_FISH	0.009

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Uranium	WHOL	BC9.4-SS5	2	2	1.17E-01	1.75E-01	1.90E-03	S_CHR_V	93.599
Uranium	WHOL	BC9.4-SS5	2	2	1.17E-01	1.75E-01	3.35E-02	S_ACU_V	5.225
Uranium	WHOL	BC9.4-SS5	2	2	1.17E-01	1.75E-01	1.42E-01	LCV_FISH	1.233
Uranium	WHOL	BC9.4-SS5	2	2	1.17E-01	1.75E-01	4.55E-01	LTV_FISH	0.385
Uranium	WHOL	BCK 0.63	14	14	2.92E-02	3.47E-02	1.90E-03	S_CHR_V	18.544
Uranium	WHOL	BCK 0.63	14	14	2.92E-02	3.47E-02	3.35E-02	S_ACU_V	1.035
Uranium	WHOL	BCK 0.63	14	14	2.92E-02	3.47E-02	1.42E-01	LCV_FISH	0.244
Uranium	WHOL	BCK 0.63	14	14	2.92E-02	3.47E-02	4.55E-01	LTV_FISH	0.076
Uranium	WHOL	BCK 4.55	13	14	3.13E-02	3.92E-02	1.90E-03	S_CHR_V	20.969
Uranium	WHOL	BCK 4.55	13	14	3.13E-02	3.92E-02	3.35E-02	S_ACU_V	1.171
Uranium	WHOL	BCK 4.55	13	14	3.13E-02	3.92E-02	1.42E-01	LCV_FISH	0.276
Uranium	WHOL	BCK 4.55	13	14	3.13E-02	3.92E-02	4.55E-01	LTV_FISH	0.086
Uranium	WHOL	BCK 9.40	13	13	1.03E-01	1.17E-01	1.90E-03	S_CHR_V	62.336
Uranium	WHOL	BCK 9.40	13	13	1.03E-01	1.17E-01	3.35E-02	S_ACU_V	3.480
Uranium	WHOL	BCK 9.40	13	13	1.03E-01	1.17E-01	1.42E-01	LCV_FISH	0.821
Uranium	WHOL	BCK 9.40	13	13	1.03E-01	1.17E-01	4.55E-01	LTV_FISH	0.256
Uranium	WHOL	Reach 1	16	16	1.40E-01	1.81E-01	1.87E-03	S_CHR_V	96.901
Uranium	WHOL	Reach 1	16	16	1.40E-01	1.81E-01	3.35E-02	S_ACU_V	5.409
Uranium	WHOL	Reach 1	16	16	1.40E-01	1.81E-01	1.42E-01	LCV_FISH	1.276
Uranium	WHOL	Reach 1	16	16	1.40E-01	1.81E-01	4.55E-01	LTV_FISH	0.398
Uranium	WHOL	SS1	14	14	3.66E-02	4.07E-02	1.90E-03	S_CHR_V	21.736

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Uranium	WHOL	SS1	14	14	3.66E-02	4.07E-02	3.35E-02	S_ACU_V	1.213
Uranium	WHOL	SS1	14	14	3.66E-02	4.07E-02	1.42E-01	LCV_FISH	0.286
Uranium	WHOL	SS1	14	14	3.66E-02	4.07E-02	4.55E-01	LTV_FISH	0.089
Uranium	WHOL	SS4	14	14	1.36E-01	1.74E-01	1.90E-03	S_CHR_V	92.812
Uranium	WHOL	SS4	14	14	1.36E-01	1.74E-01	3.35E-02	S_ACU_V	5.181
Uranium	WHOL	SS4	14	14	1.36E-01	1.74E-01	1.42E-01	LCV_FISH	1.222
Uranium	WHOL	SS4	14	14	1.36E-01	1.74E-01	4.55E-01	LTV_FISH	0.381
Uranium	WHOL	SS5	14	14	5.81E-02	7.69E-02	1.90E-03	S_CHR_V	41.100
Uranium	WHOL	SS5	14	14	5.81E-02	7.69E-02	3.35E-02	S_ACU_V	2.294
Uranium	WHOL	SS5	14	14	5.81E-02	7.69E-02	1.42E-01	LCV_FISH	0.541
Uranium	WHOL	SS5	14	14	5.81E-02	7.69E-02	4.55E-01	LTV_FISH	0.169
Zinc	WHOL	BC9.4-SS5	10	37	2.44E-02	3.73E-02	3.00E-02	LCV_AQPL	1.243
Zinc	WHOL	BC9.4-SS5	10	37	2.44E-02	3.73E-02	3.64E-02	LCV_FISH	1.024
Zinc	WHOL	BC9.4-SS5	10	37	2.44E-02	3.73E-02	4.67E-02	LCV_DAPH	0.798
Zinc	WHOL	BC9.4-SS5	10	37	2.44E-02	3.73E-02	4.70E-02	LTV_FISH	0.794
Zinc	WHOL	BC9.4-SS5	10	37	2.44E-02	3.73E-02	1.10E-01	NAWQ_CHR	0.339
Zinc	WHOL	BC9.4-SS5	10	37	2.44E-02	3.73E-02	1.20E-01	NAWQ_ACU	0.311
Zinc	WHOL	BC9.4-SS5	10	37	2.44E-02	3.73E-02	1.91E-01	NCHR_200	0.195
Zinc	WHOL	BC9.4-SS5	10	37	2.44E-02	3.73E-02	2.11E-01	NACU_200	0.177
Zinc	WHOL	BC9.4-SS5	10	37	2.44E-02	3.73E-02	5.24E+00	LCV_NDI	0.007
Zinc	WHOL	BCK 9.40	19	35	1.81E-02	2.94E-02	3.00E-02	LCV_AQPL	0.981

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Zinc	WHOL	BCK 9.40	19	35	1.81E-02	2.94E-02	3.64E-02	LCV_FISH	0.808
Zinc	WHOL	BCK 9.40	19	35	1.81E-02	2.94E-02	4.67E-02	LCV_DAPH	0.630
Zinc	WHOL	BCK 9.40	19	35	1.81E-02	2.94E-02	4.70E-02	LTV_FISH	0.626
Zinc	WHOL	BCK 9.40	19	35	1.81E-02	2.94E-02	1.10E-01	NAWQ_CHR	0.267
Zinc	WHOL	BCK 9.40	19	35	1.81E-02	2.94E-02	1.20E-01	NAWQ_ACU	0.245
Zinc	WHOL	BCK 9.40	19	35	1.81E-02	2.94E-02	1.91E-01	NCHR_200	0.154
Zinc	WHOL	BCK 9.40	19	35	1.81E-02	2.94E-02	2.11E-01	NACU_200	0.139
Zinc	WHOL	BCK 9.40	19	35	1.81E-02	2.94E-02	5.24E+00	LCV_NDI	0.006
Zinc	WHOL	NT7	8	21	2.44E-02	3.84E-02	3.00E-02	LCV_AQPL	1.278
Zinc	WHOL	NT7	8	21	2.44E-02	3.84E-02	3.64E-02	LCV_FISH	1.053
Zinc	WHOL	NT7	8	21	2.44E-02	3.84E-02	4.67E-02	LCV_DAPH	0.821
Zinc	WHOL	NT7	8	21	2.44E-02	3.84E-02	4.70E-02	LTV_FISH	0.816
Zinc	WHOL	NT7	8	21	2.44E-02	3.84E-02	1.10E-01	NAWQ_CHR	0.349
Zinc	WHOL	NT7	8	21	2.44E-02	3.84E-02	1.20E-01	NAWQ_ACU	0.320
Zinc	WHOL	NT7	8	21	2.44E-02	3.84E-02	1.91E-01	NCHR_200	0.201
Zinc	WHOL	NT7	8	21	2.44E-02	3.84E-02	2.11E-01	NACU_200	0.182
Zinc	WHOL	NT7	8	21	2.44E-02	3.84E-02	5.24E+00	LCV_NDI	0.007
Zinc	WHOL	SS1	16	27	1.08E-02	1.49E-02	3.00E-02	LCV_AQPL	0.498
Zinc	WHOL	SS1	16	27	1.08E-02	1.49E-02	3.64E-02	LCV_FISH	0.410
Zinc	WHOL	SS1	16	27	1.08E-02	1.49E-02	4.67E-02	LCV_DAPH	0.320
Zinc	WHOL	SS1	16	27	1.08E-02	1.49E-02	4.70E-02	LTV_FISH	0.318

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
Zinc	WHOL	SS1	16	27	1.08E-02	1.49E-02	1.10E-01	NAWQ_CHR	0.136
Zinc	WHOL	SS1	16	27	1.08E-02	1.49E-02	1.20E-01	NAWQ_ACU	0.124
Zinc	WHOL	SS1	16	27	1.08E-02	1.49E-02	1.91E-01	NCHR_200	0.078
Zinc	WHOL	SS1	16	27	1.08E-02	1.49E-02	2.11E-01	NACU_200	0.071
Zinc	WHOL	SS1	16	27	1.08E-02	1.49E-02	5.24E+00	LCV_NDI	0.003
Zinc	WHOL	SS6	12	25	1.75E-02	2.45E-02	3.00E-02	LCV_AQPL	0.815
Zinc	WHOL	SS6	12	25	1.75E-02	2.45E-02	3.64E-02	LCV_FISH	0.671
Zinc	WHOL	SS6	12	25	1.75E-02	2.45E-02	4.67E-02	LCV_DAPH	0.523
Zinc	WHOL	SS6	12	25	1.75E-02	2.45E-02	4.70E-02	LTV_FISH	0.520
Zinc	WHOL	SS6	12	25	1.75E-02	2.45E-02	1.10E-01	NAWQ_CHR	0.222
Zinc	WHOL	SS6	12	25	1.75E-02	2.45E-02	1.20E-01	NAWQ_ACU	0.204
Zinc	WHOL	SS6	12	25	1.75E-02	2.45E-02	1.91E-01	NCHR_200	0.128
Zinc	WHOL	SS6	12	25	1.75E-02	2.45E-02	2.11E-01	NACU_200	0.116
Zinc	WHOL	SS6	12	25	1.75E-02	2.45E-02	5.24E+00	LCV_NDI	0.005
1,2-Dichloroethene	WHOL	BC9.4-SS5	27	37	7.00E-03	9.72E-03	3.12E-02	S_CHR_V	0.312
1,2-Dichloroethene	WHOL	BC9.4-SS5	27	37	7.00E-03	9.72E-03	5.58E-01	S_ACU_V	0.017
1,2-Dichloroethene	WHOL	BC9.4-SS5	27	37	7.00E-03	9.72E-03	5.72E+00	LTV_FISH	0.002
1,2-Dichloroethene	WHOL	BC9.4-SS5	27	37	7.00E-03	9.72E-03	9.54E+00	LCV_FISH	0.001
1,2-Dichloroethene	WHOL	BCK 9.40	34	35	7.10E-03	8.58E-03	3.12E-02	S_CHR_V	0.275
1,2-Dichloroethene	WHOL	BCK 9.40	34	35	7.10E-03	8.58E-03	5.58E-01	S_ACU_V	0.015
1,2-Dichloroethene	WHOL	BCK 9.40	34	35	7.10E-03	8.58E-03	5.72E+00	LTV_FISH	0.002

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
1,2-Dichloroethene	WHOL	BCK 9.40	34	35	7.10E-03	8.58E-03	9.54E+00	LCV_FISH	0.001
1,2-Dichloroethene	WHOL	NT4	1	12	2.50E-03	2.53E-03	3.12E-02	S_CHR_V	0.081
1,2-Dichloroethene	WHOL	NT4	1	12	2.50E-03	2.53E-03	5.58E-01	S_ACU_V	0.005
1,2-Dichloroethene	WHOL	NT4	1	12	2.50E-03	2.53E-03	5.72E+00	LTV_FISH	0.000
1,2-Dichloroethene	WHOL	NT4	1	12	2.50E-03	2.53E-03	9.54E+00	LCV_FISH	0.000
1,2-Dichloroethene	WHOL	NT5	1	13	2.70E-03	3.04E-03	3.12E-02	S_CHR_V	0.097
1,2-Dichloroethene	WHOL	NT5	1	13	2.70E-03	3.04E-03	5.58E-01	S_ACU_V	0.005
1,2-Dichloroethene	WHOL	NT5	1	13	2.70E-03	3.04E-03	5.72E+00	LTV_FISH	0.001
1,2-Dichloroethene	WHOL	NT5	1	13	2.70E-03	3.04E-03	9.54E+00	LCV_FISH	0.000
1,2-Dichloroethene	WHOL	NT6	10	21	2.20E-03	2.40E-03	3.12E-02	S_CHR_V	0.077
1,2-Dichloroethene	WHOL	NT6	10	21	2.20E-03	2.40E-03	5.58E-01	S_ACU_V	0.004
1,2-Dichloroethene	WHOL	NT6	10	21	2.20E-03	2.40E-03	5.72E+00	LTV_FISH	0.000
1,2-Dichloroethene	WHOL	NT6	10	21	2.20E-03	2.40E-03	9.54E+00	LCV_FISH	0.000
1,2-Dichloroethene	WHOL	NT7	21	21	1.57E-01	1.87E-01	3.12E-02	S_CHR_V	5.987
1,2-Dichloroethene	WHOL	NT7	21	21	1.57E-01	1.87E-01	5.58E-01	S_ACU_V	0.335
1,2-Dichloroethene	WHOL	NT7	21	21	1.57E-01	1.87E-01	5.72E+00	LTV_FISH	0.033
1,2-Dichloroethene	WHOL	NT7	21	21	1.57E-01	1.87E-01	9.54E+00	LCV_FISH	0.020
1,2-Dichloroethene	WHOL	NT8	12	13	2.24E-01	2.80E-01	3.12E-02	S_CHR_V	8.990
1,2-Dichloroethene	WHOL	NT8	12	13	2.24E-01	2.80E-01	5.58E-01	S_ACU_V	0.503
1,2-Dichloroethene	WHOL	NT8	12	13	2.24E-01	2.80E-01	5.72E+00	LTV_FISH	0.049
1,2-Dichloroethene	WHOL	NT8	12	13	2.24E-01	2.80E-01	9.54E+00	LCV_FISH	0.029

Table G.5 (continued)

Analyte	Media ^b	Site	Dets.	Obs.	Mean	UCL ^c	BMK value	BMK name	HQ ^d
1,2-Dichloroethene	WHOL	SS1	2	27	2.50E-03	2.71E-03	3.12E-02	S_CHR_V	0.087
1,2-Dichloroethene	WHOL	SS1	2	27	2.50E-03	2.71E-03	5.58E-01	S_ACU_V	0.005
1,2-Dichloroethene	WHOL	SS1	2	27	2.50E-03	2.71E-03	5.72E+00	LTV_FISH	0.000
1,2-Dichloroethene	WHOL	SS1	2	27	2.50E-03	2.71E-03	9.54E+00	LCV_FISH	0.000
1,2-Dichloroethene	WHOL	SS4	21	27	7.70E-03	9.71E-03	3.12E-02	S_CHR_V	0.311
1,2-Dichloroethene	WHOL	SS4	21	27	7.70E-03	9.71E-03	5.58E-01	S_ACU_V	0.017
1,2-Dichloroethene	WHOL	SS4	21	27	7.70E-03	9.71E-03	5.72E+00	LTV_FISH	0.002
1,2-Dichloroethene	WHOL	SS4	21	27	7.70E-03	9.71E-03	9.54E+00	LCV_FISH	0.001
1,2-Dichloroethene	WHOL	SS5	8	27	2.30E-03	2.57E-03	3.12E-02	S_CHR_V	0.082
1,2-Dichloroethene	WHOL	SS5	8	27	2.30E-03	2.57E-03	5.58E-01	S_ACU_V	0.005
1,2-Dichloroethene	WHOL	SS5	8	27	2.30E-03	2.57E-03	5.72E+00	LTV_FISH	0.000
1,2-Dichloroethene	WHOL	SS5	8	27	2.30E-03	2.57E-03	9.54E+00	LCV_FISH	0.000

^aAll units are mg/L. Only the chemicals for which at least one quotient equaled or exceeded 1 mg/L are included. Bold indicates HQ>1

^bFLTR = filtered water samples; WHOL = unfiltered water sample.

^c95% upper confidence limit.

^dHazard quotient = UCL/benchmark value.

Table G.6. Chemical concentrations in unfiltered water sample collected December 1995 from NT-1, benchmarks, and HQs^a

Analyte	Dets.	Obs.	Concentration	BMK value	BMK name	HQ ^b	Risk in Reach 1 ^c
Barium	1	1	0.824	0.0038	S_CHR_V	216.84	Yes
Barium	1	1	0.824	0.0691	S_ACU_V	11.92	Yes
Barium	1	1	0.824	5.8	LCV_DAPH	0.14	
Beryllium	1	1	0.0007	0.0038	LTV_DAPH	0.18	
Beryllium	1	1	0.0007	0.00509	S_CHR_V	0.14	
Beryllium	1	1	0.0007	0.0053	LCV_DAPH	0.13	
Beryllium	1	1	0.0007	0.057	LCV_FISH	0.01	
Beryllium	1	1	0.0007	0.148	LTV_FISH	0.00	
Beryllium	1	1	0.0007	0.271	S_ACU_V	0.00	
Beryllium	1	1	0.0007	100	LCV_AQPL	0.00	
Cadmium	1	1	0.038	0.00015	LCV_DAPH	253.33	Yes
Cadmium	1	1	0.038	0.00075	LTV_DAPH	50.67	Yes
Cadmium	1	1	0.038	0.0011	NAWQ_CHR	34.55	Yes
Cadmium	1	1	0.038	0.0017	LCV_FISH	22.35	Yes
Cadmium	1	1	0.038	0.0018	LTV_FISH	21.11	Yes
Cadmium	1	1	0.038	0.002	LCV_AQPL	19.00	Yes
Cadmium	1	1	0.038	0.002	NCHR_200	19.00	Yes
Cadmium	1	1	0.038	0.0039	NAWQ_ACU	9.74	Yes
Cadmium	1	1	0.038	0.0086	NACU_200	4.42	Yes
Calcium	1	1	279	116	LCV_DAPH	2.41	Yes
Cobalt	1	1	0.018	0.00306	S_CHR_V	5.88	Yes
Cobalt	1	1	0.018	0.0044	LTV_DAPH	4.09	Yes
Cobalt	1	1	0.018	0.0051	LCV_DAPH	3.53	Yes
Cobalt	1	1	0.018	0.195	S_ACU_V	0.09	
Cobalt	1	1	0.018	0.29	LCV_FISH	0.06	
Cobalt	1	1	0.018	0.81	LTV_FISH	0.02	
Magnesium	1	1	37.9	82	LCV_DAPH	0.46	
Manganese	1	1	6.93	0.0803	S_CHR_V	86.30	Yes
Manganese	1	1	6.93	1.1	LCV_DAPH	6.30	Yes
Manganese	1	1	6.93	1.1	LTV_DAPH	6.30	Yes

Table G.6 (continued)

Analyte	Dets.	Obs.	Concentration	BMK value	BMK name	HQ ^b	Risk in Reach 1 ^c
Manganese	1	1	6.93	1.27	LTV_FISH	5.46	Yes
Manganese	1	1	6.93	1.47	S_ACU_V	4.71	Yes
Manganese	1	1	6.93	1.77	LCV_FISH	3.92	Yes
Nickel	1	1	0.151	0.005	LCV_AQPL	30.20	Yes
Nickel	1	1	0.151	0.005	LCV_DAPH	30.20	Yes
Nickel	1	1	0.151	0.035	LCV_FISH	4.31	Yes
Nickel	1	1	0.151	0.045	LTV_DAPH	3.36	Yes
Nickel	1	1	0.151	0.062	LTV_FISH	2.44	
Nickel	1	1	0.151	0.1284	LCV_NDI	1.18	
Nickel	1	1	0.151	0.16	NAWQ_CHR	0.94	
Nickel	1	1	0.151	0.283	NCHR_200	0.53	
Nickel	1	1	0.151	1.4	NAWQ_ACU	0.11	
Nickel	1	1	0.151	2.549	NACU_200	0.06	
Strontium	1	1	0.806	0.62	S_CHR_V	1.30	Yes
Strontium	1	1	0.806	6.1	S_ACU_V	0.13	
Strontium	1	1	0.806	42	LCV_DAPH	0.02	
Tetrachloroethene	1	1	0.019	0.125	S_CHR_V	0.15	
Tetrachloroethene	1	1	0.019	0.5	LTV_FISH	0.04	
Tetrachloroethene	1	1	0.019	0.51	LTV_DAPH	0.04	
Tetrachloroethene	1	1	0.019	0.75	LCV_DAPH	0.03	
Tetrachloroethene	1	1	0.019	0.84	LCV_FISH	0.02	
Tetrachloroethene	1	1	0.019	0.998	S_ACU_V	0.02	
Tetrachloroethene	1	1	0.019	816	LCV_AQPL	0.00	

^aAll units are mg/L. Only the chemicals for which the December 1995 concentration was greater than the Reach 1 exposure concentration and the background criterion for unfiltered water are presented. BOLD indicates HQ >1.

^bHazard Quotient = December 1995 concentration/benchmark value.

^c"Yes" indicates that the Reach 1 HQ for that benchmark was greater >1.

Table G.7. Predicted surface water concentrations, benchmarks, and HQs*

Analyte	Modeled Location (Sources)	Predicted Concentration Range			BMK name	BMK value	HQ (Max) ^a
		Minimum	Maximum				
Antimony	BCK 9.47 (ALL)	0.004	0.009		LCV_FISH	1.6	0.01
Antimony	NT-3 (BYBY)	0.03	0.08		LCV_FISH	1.6	0.05
Antimony	NT-7 (BG_A)	0.004	0.012		LCV_FISH	1.6	0.01
Arsenic	NT-8 (ALL)	0.07	0.11		NAWQ_CHR	0.19	0.58
Arsenic	NT-8 (CW)	0.02	0.04		NAWQ_CHR	0.19	0.21
Arsenic	NT-8 (WIP)	0.05	0.07		NAWQ_CHR	0.19	0.37
Chromium	NT-8 (ALL)	0.06	0.11		NAWQ_CHR	0.21	0.52
Chromium	NT-8 (CW)	0.04	0.08		NAWQ_CHR	0.21	0.38
Chromium	NT-8 (WIP)	0.02	0.03		NAWQ_CHR	0.21	0.14
Manganese	BCK 9.47 (ALL)	0.42	1.12		BCK_CRITERION	6.6	0.17
Manganese	NT-1 (S3)	1.74	5.76		BCK_CRITERION	6.6	0.87
Manganese	NT-2 (S3)	0.19	0.7		BCK_CRITERION	6.6	0.11
Manganese	NT-7 (BG_A)	0.4	1.2		BCK_CRITERION	6.6	0.18
Manganese	NT-8 (ALL)	1.98	4.07		BCK_CRITERION	6.6	0.62
Manganese	NT-8 (CW)	1.23	2.7		BCK_CRITERION	6.6	0.41
Manganese	NT-8 (WIP)	0.75	1.37		BCK_CRITERION	6.6	0.21
Strontium	NT-1 (S3)	0.25	0.87		LCV_DAPH	42	0.02
Strontium	NT-2 (S3)	2.21	8.33		LCV_DAPH	42	0.20
Thallium	BCK 9.47 (ALL)	0.002	0.004		LCV_FISH	0.057	0.07
Thallium	NT-8 (ALL)	0.02	0.04		LCV_FISH	0.057	0.70
Thallium	NT-8 (CW)	0.02	0.04		LCV_FISH	0.057	0.70
1,1,1-Trichloroethane	NT-7 (BG_A)	0.065	0.4359		LCV_DAPH	1.77	0.25
1,1,1-Trichloroethane	NT-8 (ALL)	0.46124	1.0789		LCV_DAPH	1.77	0.61
1,1,1-Trichloroethane	NT-8 (CW)	0.3818	0.84		LCV_DAPH	1.77	0.47
1,1,1-Trichloroethane	NT-8 (WIP)	0.0794	0.2389		LCV_DAPH	1.77	0.13
1,1,2,2-Tetrachloroethane	NT-3 (BYBY)	0	0.00015		LCV_FISH	2.4	0.00
1,1,2-Trichloroethane	NT-7 (BG_A)	0.0016	0.0067		LCV_FISH	9.4	0.00

Table G.7 (continued)

Analyte	Modeled Location (Sources)	Predicted Concentration Range		BMK name	BMK value	HQ (Max) ^a
		Minimum	Maximum			
1,1,2-Trichloroethane	NT-8 (ALL)	0.00446	0.01124	LCV_FISH	9.4	0.00
1,1,2-Trichloroethane	NT-8 (WIP)	0.00446	0.01124	LCV_FISH	9.4	0.00
1,1-Dichloroethene	BCK 9.47 (ALL)	0.0011	0.0149	LCV_FISH	2.8	0.01
1,1-Dichloroethene	NT-3 (BYBY)	0	0.00308	LCV_FISH	2.8	0.00
1,1-Dichloroethene	NT-7 (BG_A)	0	0.0163	LCV_FISH	2.8	0.01
1,1-Dichloroethene	NT-8 (ALL)	0.01161	0.13764	LCV_FISH	2.8	0.05
1,1-Dichloroethene	NT-8 (WIP)	0.0116	0.1376	LCV_FISH	2.8	0.05
1,2-Dichloroethane	BCK 9.47 (ALL)	0.025	0.0554	LCV_DAPH	15.2	0.00
1,2-Dichloroethane	NT-7 (BG_A)	0.00067	0.0046	LCV_DAPH	15.2	0.00
1,2-Dichloroethane	NT-8 (ALL)	0.25733	0.56865	LCV_DAPH	15.2	0.04
1,2-Dichloroethane	NT-8 (CW)	0.2545	0.56	LCV_DAPH	15.2	0.04
1,2-Dichloroethane	NT-8 (WIP)	0.00278	0.00865	LCV_DAPH	15.2	0.00
1,2-Dichloroethene	NT-3 (BYBY)	0.01928	0.04948	LCV_FISH	9.538	0.01
1,2-Dichloroethene	NT-7 (BG_A)	0.057	0.179	LCV_FISH	9.538	0.02
1,2-Dichloroethene	NT-8 (WIP)	0.11	0.2537	LCV_FISH	9.538	0.03
Benzene	BCK 9.47 (ALL)	0.06659	0.2228	LCV_FISH	8.25	0.03
Benzene	NT-7 (BG_A)	0.0021	0.0179	LCV_FISH	8.25	0.00
Benzene	NT-8 (ALL)	0.6864	2.2837	LCV_FISH	8.25	0.28
Benzene	NT-8 (CW)	0.0048	0.0106	LCV_FISH	8.25	0.00
Benzene	NT-8 (WIP)	0.682	2.273	LCV_FISH	8.25	0.28
Carbon tetrachloride	BCK 9.47 (ALL)	0.00004	0.00689	LCV_FISH	1.97	0.00
Carbon tetrachloride	NT-7 (BG_A)	0	0.0899	LCV_FISH	1.97	0.05
Carbon tetrachloride	NT-8 (ALL)	0.00044	0.00285	LCV_FISH	1.97	0.00
Carbon tetrachloride	NT-8 (WIP)	0.00044	0.00285	LCV_FISH	1.97	0.00
Chloroform	NT-7 (BG_A)	0.0413	0.202	LCV_FISH	1.24	0.16
Chloroform	NT-8 (ALL)	0.02026	0.05703	LCV_FISH	1.24	0.05

Table G.7 (continued)

Analyte	Modeled Location (Sources)	Predicted Concentration Range		BMK name	BMK value	HQ (Max) ^a
		Minimum	Maximum			
Chloroform	NT-8 (WIP)	0.0203	0.057	LCV_FISH	1.24	0.05
Methylene chloride	BCK 9.47 (ALL)	0.00098	0.01091	LCV_DAPH	42.667	0.00
Methylene chloride	NT-3 (BYBY)	0	0.0147	LCV_DAPH	42.667	0.00
Methylene chloride	NT-7 (BG_A)	0	0.00226	LCV_DAPH	42.667	0.00
Methylene chloride	NT-8 (ALL)	0.00986	0.09136	LCV_DAPH	42.667	0.00
Methylene chloride	NT-8 (CW)	0.0043	0.0094	LCV_DAPH	42.667	0.00
Methylene chloride	NT-8 (WIP)	0.00558	0.082	LCV_DAPH	42.667	0.00
trans-1,2-Dichloroethene	BCK 9.47 (ALL)	0.162	0.386	LCV_FISH	42.667	0.00
trans-1,2-Dichloroethene	NT-7 (BG_A)	0.542	1.619	LCV_FISH	9.538	0.04
trans-1,2-Dichloroethene	NT-8 (ALL)	1.2648	2.7541	LCV_FISH	9.538	0.17
trans-1,2-Dichloroethene	NT-8 (CW)	0.1636	0.36	LCV_FISH	9.538	0.29
trans-1,2-Dichloroethene	NT-8 (WIP)	1.101	2.394	LCV_FISH	9.538	0.04
Trichloroethene	BCK 9.47 (ALL)	0.0093	0.0423	LCV_DAPH	9.538	0.25
Trichloroethene	NT-3 (BYBY)	0.01325	0.0506	LCV_DAPH	7.257	0.01
Trichloroethene	NT-7 (BG_A)	0.0736	0.4242	LCV_DAPH	7.257	0.01
Trichloroethene	NT-8 (ALL)	0.02381	0.05743	LCV_DAPH	7.257	0.06
Trichloroethene	NT-8 (CW)	0.0136	0.03	LCV_DAPH	7.257	0.01
Trichloroethene	NT-8 (WIP)	0.0102	0.0274	LCV_DAPH	7.257	0.00
Vinyl chloride	BCK 9.47 (ALL)	0.02808	0.06598	LCV_FISH	7.257	0.00
Vinyl chloride	NT-3 (BYBY)	0.00115	0.0031	LCV_FISH	28.879	0.00
Vinyl chloride	NT-7 (BG_A)	0.0345	0.1118	LCV_FISH	28.879	0.00
Vinyl chloride	NT-8 (ALL)	0.2626	0.59338	LCV_FISH	28.879	0.00
Vinyl chloride	NT-8 (CW)	0.2091	0.46	LCV_FISH	28.879	0.02
Vinyl chloride	NT-8 (WIP)	0.0535	0.1334	LCV_FISH	28.879	0.02

^aAll units are mg/L. Only the chemicals for which all HQs were less than 1 are presented.^bHazard Quotient = Maximum predicted concentration/benchmark value.

Table G.8. Summary of the characterization of future risks to aquatic biota based on predicted maximum surface water concentrations^a

Location	Likelihood of Effects (predicted time range) ^b		Future Risks
	Possible	Expected	
NT-1	Mercury (40-100)	Cadmium (40-200) Calcium (35-100) Nickel (40-100) Uranium (40-150)	Increase - peak exposures expected in ~50-150 years.
NT-2	Barium (40-100)	Calcium (75-400)	Increase - peak exposures expected in ~50-350 years.
NT-3	Mercury (steady-state)	Cadmium (steady-state) Nickel (steady-state) Uranium (steady-state)	Unchanged.
NT-7	Tetrachloroethene (20-200)	Beryllium (>1000) Cadmium (>1000) Copper (>1000) Cyanide (10-100) Lead (>1000) Lithium (>1000) Nickel (>1000) Uranium (>1000)	Increase - slowly over next 1000 years for most chemicals.
NT-8	Cadmium (>1000)	Boron (steady-state) Beryllium (>1000) Copper (>1000) Cyanide (10-100) Lead (>1000) Lithium (>1000) Nickel (>1000) Uranium (>1000) Total PCBs (steady-state) Bis(2-ethylhexyl)-phthalate (steady-state)	Increase - slowly over next 1000 years for most chemicals.
Bear Creek above NT-1	Not Applicable	Not Applicable	Decrease - exposures not expected to meet RBRGOs for 30 - 40 years.
Bear Creek Between BCK 9.47 and NT-1	Not Predicted	Not Predicted	Not Predicted - but cannot be assumed to decrease given increased inputs from NT-1 and NT-2.
Bear Creek at BCK 9.47	Beryllium (Not Predicted) Copper (Not Predicted)	Cadmium (Not Predicted) Cyanide (Not Predicted) Lithium (Not Predicted) Uranium (Not Predicted)	Increase - peak times could not be estimated as modeled.

^abased on model results and evaluations presented in Appendix E.

^btime range is estimated number of years, from start of waste operations, to reach peak concentrations.

**Table G.9. Exposure concentrations, benchmark values for small fish,
and the HQs for radionuclides detected in surface water^a**

Site	Radionuclides	Media ^b	Det.	Obs.	Mean	UCL ^c	Benchmark value ^d	HQ
BC9.4-SS5	Technetium-99	WHOL	1	10	17.99	32.98	9687857	0.00
BC9.4-SS5	Thorium-228	WHOL	1	6	0.02	0.03	1365	0.00
BC9.4-SS5	Thorium-230	WHOL	2	6	0.07	0.11	2064	0.00
BC9.4-SS5	Uranium-233/234	WHOL	34	35	14.19	16.28	20213	0.01
BC9.4-SS5	Uranium-235	WHOL	9	35	0.44	0.58	21833	0.00
BC9.4-SS5	Uranium-238	WHOL	34	35	31.42	35.25	22725	0.02
							WHOL Total	0.03
BC9.4-SS5	Uranium-233/234	FLTR	35	35	13.18	15.26	20213	0.01
BC9.4-SS5	Uranium-235	FLTR	6	35	0.49	0.66	21833	0.00
BC9.4-SS5	Uranium-238	FLTR	35	35	29.40	33.89	22725	0.00
							FLTR Total	0.00
BCK 9.40	Technetium-99	WHOL	1	7	29.79	56.05	9687857	0.00
BCK 9.40	Thorium-228	WHOL	1	3	0.04	0.13	1365	0.00
BCK 9.40	Thorium-230	WHOL	1	3	0.08	0.26	2064	0.00
BCK 9.40	Uranium-233/234	WHOL	21	22	17.90	20.58	20213	0.00
BCK 9.40	Uranium-235	WHOL	6	22	0.63	0.82	21833	0.00
BCK 9.40	Uranium-238	WHOL	21	22	38.47	44.12	22725	0.00
							WHOL Total	0.00
BCK 9.40	Uranium-233/234	FLTR	22	22	17.36	20.00	20213	0.00
BCK 9.40	Uranium-235	FLTR	5	22	0.61	0.85	21833	0.00
BCK 9.40	Uranium-238	FLTR	22	22	36.39	41.72	22725	0.00
							FLTR Total	0.00
NT2	Technetium-99	WHOL	2	2	205.50	739.01	9687857	0.00
NT2	Uranium-233/234	WHOL	1	21	1.37	3.38	20213	0.00
NT2	Uranium-238	WHOL	1	21	2.52	6.57	22725	0.00
							WHOL Total	0.00
NT2	Uranium-233/234	FLTR	1	21	0.21	0.31	20213	0.00
NT2	Uranium-238	FLTR	1	21	0.18	0.32	22725	0.00
							FLTR Total	0.00
NT3	Strontium-90	WHOL	3	11	0.54	0.86	346570	0.00
NT3	Thorium-228	WHOL	4	11	0.09	0.14	1365	0.00
NT3	Thorium-230	WHOL	6	11	1.92	5.11	2064	0.00
NT3	Thorium-232	WHOL	7	11	0.26	0.55	2389	0.00

Table G.9 (continued)

Site	Radionuclides	Media ^a	Det.	Obs.	Mean	UCL ^c	Benchmark value ^d	HQ
NT3	Uranium-233/234	WHOL	18	19	123.92	150.95	20213	0.01
NT3	Uranium-235	WHOL	17	19	6.26	8.18	21833	0.00
NT3	Uranium-238	WHOL	18	19	288.71	355.49	22725	0.02
							WHOL Total	0.03
NT3	Uranium-233/234	FLTR	20	20	134.83	170.49	20213	0.01
NT3	Uranium-235	FLTR	19	20	15.87	26.56	21833	0.00
NT3	Uranium-238	FLTR	20	20	310.75	390.63	22725	0.02
							FLTR Total	0.03
NT4	Uranium-233/234	WHOL	1	12	0.43	0.66	20213	0.00
NT4	Uranium-238	WHOL	1	12	0.48	0.82	22725	0.00
							WHOL Total	0.00
NT4	Uranium-233/234	FLTR	2	12	0.39	0.64	20213	0.00
NT4	Uranium-238	FLTR	1	12	0.39	0.66	22725	0.00
							FLTR Total	0.00
NT5	Uranium-233/234	WHOL	1	13	2.85	7.71	20213	0.00
NT5	Uranium-235	WHOL	1	13	0.39	1.07	21833	0.00
NT5	Uranium-238	WHOL	1	13	5.60	15.36	22725	0.00
							WHOL Total	0.00
NT6	Thorium-228	WHOL	1	3	0.06	0.16	1365	0.00
NT6	Uranium-233/234	WHOL	21	21	3.56	4.27	20213	0.00
NT6	Uranium-235	WHOL	1	21	0.16	0.30	21833	0.00
NT6	Uranium-238	WHOL	21	21	6.83	8.42	22725	0.00
							WHOL Total	0.00
NT6	Uranium-233/234	FLTR	17	21	3.11	4.01	20213	0.00
NT6	Uranium-238	FLTR	20	21	6.60	8.47	22725	0.00
							FLTR Total	0.00
NT7	Plutonium-238	WHOL	1	2	0.08	0.29	5845	0.00
NT7	Thorium-228	WHOL	1	3	0.13	0.47	1365	0.00
NT7	Thorium-230	WHOL	2	3	0.19	0.54	2064	0.00
NT7	Thorium-232	WHOL	1	3	0.13	0.50	2389	0.00
NT7	Uranium-233/234	WHOL	21	21	7.63	10.14	20213	0.00
NT7	Uranium-235	WHOL	4	21	0.34	0.54	21833	0.00
NT7	Uranium-238	WHOL	21	21	12.54	16.78	22725	0.00

Table G.9 (continued)

Site	Radionuclides	Media ^b	Det.	Obs.	Mean	UCL ^c	Benchmark value ^d	HQ
							WHOL Total	0.00
NT7	Uranium-233/234	FLTR	20	21	7.32	10.59	20213	0.00
NT7	Uranium-235	FLTR	1	21	0.19	0.28	21833	0.00
NT7	Uranium-238	FLTR	20	21	12.92	19.91	22725	0.00
							FLTR Total	0.00
NT8	Potassium-40	WHOL	1	2	73.50	430.23	3804	0.11
NT8	Thorium-228	WHOL	2	5	0.14	0.32	1365	0.00
NT8	Thorium-230	WHOL	4	5	0.31	0.53	2064	0.00
NT8	Thorium-232	WHOL	2	5	0.12	0.24	2389	0.00
NT8	Uranium-233/234	WHOL	14	14	15.99	22.02	20213	0.00
NT8	Uranium-235	WHOL	3	14	0.81	1.56	21833	0.00
NT8	Uranium-238	WHOL	14	14	63.31	114.79	22725	0.01
							WHOL Total	0.12
NT8	Uranium-233/234	FLTR	12	12	14.39	18.10	20213	0.00
NT8	Uranium-235	FLTR	3	12	0.57	0.87	21833	0.00
NT8	Uranium-238	FLTR	12	12	34.52	38.91	22725	0.00
							FLTR Total	0.00
Reach 1	Strontium-90	WHOL	7	11	0.99	1.34	346570	0.00
Reach 1	Technetium-99	WHOL	8	9	237.97	327.04	9687857	0.00
Reach 1	Thorium-228	WHOL	5	10	0.10	0.14	1365	0.00
Reach 1	Thorium-230	WHOL	3	10	0.08	0.12	2064	0.00
Reach 1	Thorium-232	WHOL	3	10	0.05	0.08	2389	0.00
Reach 1	Uranium-233/234	WHOL	21	22	32.01	37.91	20213	0.00
Reach 1	Uranium-235	WHOL	16	22	1.81	2.33	21833	0.00
Reach 1	Uranium-238	WHOL	21	22	69.12	83.08	22725	0.00
							WHOL Total	0.01
Reach 1	Uranium-233/234	FLTR	22	22	38.11	48.51	20213	0.00
Reach 1	Uranium-235	FLTR	18	22	2.29	3.00	21833	0.00
Reach 1	Uranium-238	FLTR	22	22	82.25	107.42	22725	0.00
							FLTR Total	0.01
SS1	Uranium-233/234	WHOL	13	13	8.95	9.68	20213	0.00
SS1	Uranium-238	WHOL	13	13	8.80	9.51	22725	0.00
							WHOL Total	0.00

Table G.9 (continued)

Site	Radionuclides	Media ^a	Det.	Obs.	Mean	UCL ^c	Benchmark value ^d	HQ
SS1	Uranium-233/234	FLTR	13	13	11.14	15.64	20213	0.00
SS1	Uranium-235	FLTR	1	13	0.31	0.57	21833	0.00
SS1	Uranium-238	FLTR	13	13	15.01	26.05	22725	0.00
							FLTR Total	0.00
SS4	Technetium-99	WHOL	2	3	121.98	273.22	9687857	0.00
SS4	Thorium-230	WHOL	1	3	0.05	0.14	2064	0.00
SS4	Uranium-233/234	WHOL	13	13	27.26	31.40	20213	0.00
SS4	Uranium-235	WHOL	10	13	1.51	2.06	21833	0.00
SS4	Uranium-238	WHOL	13	13	57.59	67.58	22725	0.00
							WHOL Total	0.00
SS4	Uranium-233/234	FLTR	13	13	28.98	31.23	20213	0.00
SS4	Uranium-235	FLTR	8	13	1.36	1.85	21833	0.00
SS4	Uranium-238	FLTR	13	13	59.45	63.86	22725	0.00
							FLTR Total	0.00
SS5	Thorium-230	WHOL	1	3	0.10	0.27	2064	0.00
SS5	Uranium-233/234	WHOL	13	13	13.97	16.29	20213	0.00
SS5	Uranium-235	WHOL	3	13	0.64	1.06	21833	0.00
SS5	Uranium-238	WHOL	13	13	26.71	32.24	22725	0.00
							WHOL Total	0.00
SS5	Uranium-233/234	FLTR	13	13	13.37	14.73	20213	0.00
SS5	Uranium-235	FLTR	1	13	0.37	0.50	21833	0.00
SS5	Uranium-238	FLTR	13	13	26.59	29.33	22725	0.00
							FLTR Total	0.00
SS6	Uranium-233/234	WHOL	8	14	2.58	5.71	20213	0.00
SS6	Uranium-235	WHOL	1	14	0.17	0.43	21833	0.00
SS6	Uranium-238	WHOL	10	14	4.65	10.87	22725	0.00
							WHOL Total	0.00
SS6	Uranium-233/234	FLTR	5	14	0.65	0.88	20213	0.00
SS6	Uranium-238	FLTR	7	14	0.99	1.31	22725	0.00
							FLTR Total	0.00

^aAll measured concentrations and benchmark values are per pCi/L.

^bFLTR = filtered water samples; WHOL = unfiltered water samples.

^c95% upper confidence limit.

^dAqueous concentrations resulting in a total dose rate to small fish of 1 rad/d (benchmark value) for each detected isotope.

Table G.10. Summary of the risk characterization for the fish communities in Bear Creek and tributaries NT-2 through NT-8

Exposure area	Evidence	Result	Explanation
Reach 1	Biological surveys	-	Species richness and total density of fish community has increased since 1989 and is comparable to reference communities.
		-	Tennessee dace has successfully colonized this reach. Densities at the uppermost site are comparable to the reference streams, though the high year-to-year variability may obscure subtle differences. Observed differences are likely to be due to low stream flow, especially at BCK 11.83.
	Toxicity tests	+	Survival and reproduction of <i>Ceriodaphnia dubia</i> continue to be drastically reduced. Calcium and manganese concentrations were significantly correlated with these responses.
	Body burdens	-	Mercury and PCB concentrations for whole fish are less than all body burden benchmarks.
	Media analyses	+	Calcium, cadmium, and uranium concentrations are likely to be toxic. Nickel is likely to be toxic to sensitive species. Toxicity is possible, but not likely, from barium and copper.
	Weight of evidence	-	The fish community does not appear to be significantly degraded due to contaminant concentrations. The surveyed fish community is apparently less sensitive than <i>Ceriodaphnia</i> to the elevated chemical concentrations.
		-	The Tennessee dace population does not appear to be reduced by a contaminant effect: highest densities occur at the most highly contaminated site (BCK 12.36). Lower densities at BCK 11.83 are likely due to intermittent stream flow.
Reach 2	Biological surveys	-	Species richness and total density of fish community is comparable to reference communities. Habitat quality (i.e., intermittent flow and siltation) and the weir at BCK 4.55 are probably limiting factors.
		-	Densities of Tennessee dace at several sites are low relative to reference streams, but this appears to be due to low stream flow and/or siltation, especially at BCKs 11.09 and 9.91.

Table G.10 (continued)

Exposure area	Evidence	Result	Explanation
Reach 3	Toxicity tests	-	100% mortality of <i>Ceriodaphnia dubia</i> in water from furthest upstream site (BCK 11.09) was observed once in 1991. Significant effects have not been observed since then, or at other sites in this reach. Hence this is considered to be not representative of current conditions in this reach.
	Body burdens	N/A	Body burdens were not measured.
	Media analyses	+	Cadmium concentrations are likely to be toxic at BCK 9.4. Toxicity also is possible, but not likely, from barium, boron, copper, iron, nickel, and uranium.
	Weight of evidence	-	The fish community does not appear to be significantly degraded due to a contaminant effect.
		-	The Tennessee dace population does not appear to be reduced by a contaminant effect. Low stream flow and siltation are probably limiting factors.
		-	Species richness and total density of fish community are comparable to reference communities.
	Biological surveys	-	Tennessee dace densities are within the range of densities observed at reference sites, though high year-to-year variability may obscure subtle differences. Siltation has been identified as a possible problem at BCK 7.87.
		-	Significant toxic effects have not been observed in this reach.
	Toxicity tests	-	Significant toxicity is not expected. Mercury concentrations are below all benchmarks and PCB concentrations exceeded only one very low screening value.
	Body burdens	-	Significant toxicity is not expected. Mercury concentrations are below all benchmarks and PCB concentrations exceeded only one very low screening value.
	Media analyses	-	None of the COPECs occur at concentrations likely to be toxic. Toxicity is possible, but not likely, from copper, iron, nickel, and uranium.

Table G.10 (continued)

Exposure area	Evidence	Result	Explanation
Reach 4	Weight of evidence	-	The fish community does not appear to be significantly degraded due to a contaminant effect.
		-	The Tennessee dace population does not appear to be reduced by a contaminant effect. Habitat quality is probably a limiting factors.
	Biological surveys	-	Species richness and total density of fish community are comparable to reference communities.
		N/A	Tennessee dace are not expected to inhabit this reach.
	Toxicity tests	N/A	Toxicity tests were not conducted.
	Body burdens	±	Mercury and PCB concentrations in rock bass fillets suggest that toxicity to sensitive species is possible, but unlikely. Increasing mercury concentrations suggest that risks may increase in the future.
NT-2	Media analyses	-	None of the COPECs occur at concentrations likely to be toxic. Toxicity is possible, but not likely, from copper, iron, nickel, and uranium.
	Weight of evidence	-	The fish community does not appear to be significantly impacted in this reach.
		-	The Tennessee dace is not expected to use this reach.
	Biological surveys	N/A	The fish community was not surveyed.
	Toxicity tests	+	<i>Ceriodaphnia dubia</i> reproduction was reduced by 37% in one of two tests, though survival was 100% in both tests. Calcium concentrations were significantly correlated with this response. Fathead minnows were not significantly affected. However, the intensity and frequency of effects was higher for Reach 1.
	Body burdens	N/A	Body Burdens were not measured.
	Media analyses	+	Calcium concentrations are likely to be toxic. Toxicity also is possible, but not likely, from barium. However, there were more COPECs at higher concentrations in Reach 1.

Table G.10 (continued)

Exposure area	Evidence	Result	Explanation
NT-3	Weight of evidence	-	Given that the fish community in Reach 1 is not at risk, it is highly unlikely that the fish using NT-2 are at risk. Also, the fish in NT-2 are functionally part of the community in Reach 1, because NT-2 is too small to support a distinct fish community.
	Biological surveys	N/A	The fish community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Body burdens	N/A	Body Burdens were not measured.
	Media analyses	+	Toxicity is possible, but not likely, from the observed concentrations of lithium.
NT-4	Weight of evidence	-	The toxicity tests are considered to best represent the actual risks to fish and none of the COPECs are likely to be toxic.
	Biological surveys	N/A	The fish community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Body burdens	N/A	Body Burdens were not measured.
	Media analyses	-	None of the COPECs occurred at concentrations likely to be toxic.
NT-5	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to fish and none of the COPECs are likely to be toxic.
	Biological surveys	N/A	The fish community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Body burdens	N/A	Body Burdens were not measured.
	Media analyses	-	None of the COPECs occurred at concentrations likely to be toxic.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to fish and none of the COPECs are likely to be toxic.

Table G.10 (continued)

Exposure area	Evidence	Result	Explanation
NT-6	Biological surveys	N/A	The fish community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Body burdens	N/A	Body Burdens were not measured.
	Media analyses	-	None of the COPECs occurred at concentrations likely to be toxic.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to fish and none of the COPECs are likely to be toxic.
NT-7	Biological surveys	N/A	The fish community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Body burdens	N/A	Body Burdens were not measured
	Media analyses	-	Toxicity is possible, but not likely, from the observed concentrations of lithium.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to fish and none of the COPECs are likely to be toxic.
NT-8	Biological surveys	N/A	The fish community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Body burdens	N/A	Body Burdens were not measured.
	Media analyses	-	Toxicity is possible, but not likely, from the observed concentrations of lithium and mercury.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to fish and none of the COPECs are likely to be toxic.

+ indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.

- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.

± indicates that the evidence is too ambiguous to interpret.

Table G.11. Summary of the risk characterization for the benthic invertebrate communities in Bear Creek, tributaries NT-2 through NT-8, and seeps SS-1, SS-4, SS-5, SS-6, and SS-8

Exposure area	Evidence	Result	Explanation
Reach 1	Biological surveys	+	The community has improved, but is still severely degraded. Total and EPT richness continue to be lower than reference streams. The snail <i>Elimia</i> is still absent from the uppermost site (BCK 12.36). The absence of mayflies (<i>Ephemeroptera</i>) is suggestive of metals toxicity.
	Toxicity tests	+	Survival and reproduction of <i>Ceriodaphnia dubia</i> continue to be drastically reduced. Calcium and manganese concentrations were significantly correlated with these responses.
	Media analyses	+	Calcium, cadmium, and uranium concentrations are likely to be toxic. Nickel is likely to be toxic to sensitive species. Toxicity is possible, but not likely, from barium and copper.
	Weight of evidence	+	Reach 1 water appears to pose a significant risk to the benthic invertebrate community from high concentrations of calcium, cadmium, manganese, nickel, and uranium.
Reach 2	Biological surveys	+	Community has improved, but is still moderately degraded. Total and EPT richness and abundance are generally lower than reference streams. The very low mayfly (<i>Ephemeroptera</i>) density and richness is suggestive of metals toxicity.
	Toxicity tests	-	100% mortality of <i>Ceriodaphnia dubia</i> in water from the farthest upstream site (BCK 11.09) was observed once in 1991. Significant effects have not been observed since then, or at other sites in this reach. Hence this is not considered to be representative of current conditions in this reach.
	Media analyses	+	Cadmium concentrations are likely to be toxic at BCK 9.4. Toxicity also is possible, but not likely, from barium, boron, copper, iron, nickel, and uranium.
	Weight of evidence	+	Reach 2 water appears to pose a significant risk to the benthic invertebrate community from high concentrations of cadmium.

Table G.11 (continued)

Exposure area	Evidence	Result	Explanation
Reach 3	Biological surveys	+	Community has improved, but is still moderately degraded above BCK 3.25. Total and EPT richness and abundance are generally lower than reference streams. The very low mayfly (<i>Ephemeroptera</i>) density and richness is suggestive of metals toxicity. Habitat quality is likely a contributing factor at BCK 7.87.
	Toxicity tests	-	Significant toxic effects have not been observed in this reach.
	Media analyses	-	None of the COPECs occur at concentrations likely to be toxic. Toxicity is possible, but not likely, from copper, iron, nickel, and uranium.
	Weight of evidence	-	Although the benthic invertebrate communities just below BCK 9.4 and at BCK 7.87 are generally less rich and abundant than references, none of the COPECs are likely to be toxic, the water has never been shown to be toxic, and siltation at BCK 7.87 has degraded the habitat.
Reach 4	Biological surveys	-	The benthic invertebrate community is comparable to reference communities.
	Toxicity tests	N/A	Toxicity tests were not conducted.
	Media analyses	-	None of the COPECs occur at concentrations likely to be toxic. Toxicity is possible, but not likely, from copper, iron, nickel, and uranium.
	Weight of evidence	-	The benthic invertebrate community does not appear to be significantly degraded in this reach.
NT-2	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	+	<i>Ceriodaphnia dubia</i> reproduction was reduced by 37% in one of two tests, though survival was 100% in both tests. Calcium concentrations were significantly correlated with this response. Fathead minnows were not significantly affected.
	Media analyses	+	Calcium concentrations are likely to be toxic. Toxicity also is possible, but not likely, from barium.
	Weight of evidence	+	Toxicity tests results indicate that chronic toxicity to sensitive species during base flow conditions is likely. The most probable contributor to toxicity is calcium.

Table G.11 (continued)

Exposure area	Evidence	Result	Explanation
NT-3	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Media analyses	-	Toxicity is possible, but not likely, from the observed concentrations of lithium.
	Weight of evidence	-	The toxicity tests are considered to best represent the actual risks to benthic invertebrates and none of the COPECs are likely to be toxic.
NT-4	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Media analyses	-	None of the COPECs occurred at concentrations likely to be toxic.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to benthic invertebrates and none of the COPECs are likely to be toxic.
NT-5	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Media analyses	-	None of the COPECs occurred at concentrations likely to be toxic.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to benthic invertebrates and none of the COPECs are likely to be toxic.
NT-6	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Media analyses	-	None of the COPECs occurred at concentrations likely to be toxic.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to benthic invertebrates and none of the COPECs are likely to be toxic.
NT-7	Biological surveys	N/A	The benthic invertebrate community was not surveyed.

Table G.11 (continued)

Exposure area	Evidence	Result	Explanation
NT-8	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Media analyses	-	Toxicity is possible, but not likely, from the observed concentrations of lithium.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to benthic invertebrates and none of the COPECs are likely to be toxic.
	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Media analyses	-	Toxicity is possible, but not likely, from the observed concentrations of lithium and mercury.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to benthic invertebrates and none of the COPECs are likely to be toxic.
SS-1	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	+	<i>Ceriodaphnia dubia</i> survival was reduced by 40% in May 1994 and reproduction was reduced by 52% and 45% in May and August of 1994, respectively. Fathead minnow survival was reduced by 30% in May 1994.
	Media analyses	+	Calcium, cadmium, and nickel concentrations are likely to be toxic. Toxicity also is possible, but not likely, from barium, copper, iron, nickel, and manganese.
	Weight of evidence	+	SS-1 water appears to pose a significant risk to benthic invertebrates from high concentrations of calcium, cadmium, and nickel.
SS-4	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	+	<i>Ceriodaphnia dubia</i> reproduction was reduced by 29% in August 1994. Fathead minnow survival was reduced by 21% in August 1994.
	Media analyses	-	Toxicity is possible, but not likely, from the observed concentrations of lithium, barium, nickel, and uranium.

Table G.11 (continued)

Exposure area	Evidence	Result	Explanation
SS-5	Weight of evidence	+	The toxicity tests are considered to represent the actual risks to benthic invertebrates. Although the evidence is weak, lithium, barium, nickel, or uranium may be the cause of toxicity.
	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Media analyses	-	Toxicity is possible, but not likely, from the observed concentrations of copper and nickel.
SS-6	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to benthic invertebrates and none of the COPECs are likely to be toxic.
	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Media analyses	-	Toxicity is possible, but not likely, from the observed concentrations of copper, nickel, and uranium.
SS-8	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to benthic invertebrates and none of the COPECs are likely to be toxic.
	Biological surveys	N/A	The benthic invertebrate community was not surveyed.
	Toxicity tests	-	<i>Ceriodaphnia dubia</i> and fathead minnows were not significantly affected during the two tests conducted using water from this site.
	Media analyses	-	Toxicity is possible, but not likely, from the observed concentrations of copper and nickel.
	Weight of evidence	-	The toxicity tests are considered to represent the actual risks to benthic invertebrates and none of the COPECs are likely to be toxic.

+ indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.

- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.

± indicates that the evidence is too ambiguous to interpret.

Table G.12. Descriptions of the ecotoxicological screening benchmarks for benthic biota exposed to contaminated sediments*

Benchmark	Abbreviation	Description
Effects Range—Low	ER_L	The tenth percentile of estuarine sediment concentrations reported to be associated with some level of toxic effects.
Effects Range—Median	ER_M	The fiftieth percentile of estuarine sediment concentrations reported to be associated with some level of toxic effects.
Region IV Benchmark	REG_IV	The higher of two values, the EPA Contract Laboratory Program Practical Quantification Limit (CLP PQL) and the Effects Value which is the lower of the ER-L and the Florida NOEL.
Threshold Effect Level	TEL	The geometric mean of the fifteenth percentile of reported concentrations which were associated with some level of effects and the fiftieth percentile of reported concentrations which were associated with no adverse effects. All data are for marine and estuarine sediments.
Probable Effect Level	PEL	The geometric mean of the fiftieth percentile of reported concentrations which were associated with some level of effects and the eighty-fifth percentile of reported concentrations which were associated with no adverse effects. All data are for marine and estuarine sediments.
National Sediment Quality Criteria	EPASQC_A	Sediment quality criteria based on toxicity in water expressed as chronic water quality criteria (recalculated after adding some benthic species) and partitioning of the contaminant between organic matter (1% of sediment by weight) and pore water. Sediment quality criteria were adjusted to the site-specific percent total organic matter content.
Equilibrium Partitioning Benchmark	EQPSQB_A	Benchmarks derived in the same manner as sediment quality criteria except that the expression of aqueous toxicity is the chronic NAWQC or the Secondary Chronic Value, and Site-specific percent organic matter is used.
Ontario Ministry of the Environment Lowest Effect Level	LEL_MOE	Concentrations determined by the Ontario MOE to constitute thresholds for toxic effects in Ontario sediments.
Ontario Ministry of the Environment Severe Effect Level	SEL_MOE	Concentrations determined by the Ontario MOE to constitute thresholds for severe toxic effects in Ontario sediments.

Table G.12 (continued)

Benchmark	Abbreviation	Description
Region V Benchmark for non-polluted sediments	REG_V_L	A concentration determined to constitute background for sediments in Illinois.
Region V Benchmark for heavily polluted sediments	REG_V_M	A concentration determined to constitute the upper bound of moderately polluted sediments relative to background sediments in Illinois.
Apparent Effect Threshold	AET	A concentration above which toxic effects occurred at all sites in Puget Sound.

*More details are presented by Hull and Suter (1994), Long et al (1995), MacDonald (1994), and Region IV (1994). The last five benchmarks are used only when none of the first seven are available.

Table G.13. Results of screening of chemicals that exceed background criteria in whole sediments against benchmarks for COPECs

Chemical	COPEC	Reason for inclusion or rejection
Antimony	YES	Exceeds the ER-L, but not the REG_IV or the ER-M, at SD 4.
Arsenic	YES	Exceeds the TEL, REG_IV, and ER-L at SDs 1, 2, 4, 7, 9, and 10-14. Does not exceed the PEL or ER-M at any site.
Barium	YES	Exceeds the REG_V_L and REG_V_M background values at SDs 2, 3, 4, 7, 8, and 14.
Cadmium	YES	Exceeds the TEL, REG_IV, and ER-L at SDs 1, 2, 4, 7, 10, 11, and 14. Exceeds the PEL and/or the ER-M at SDs 2, 4, 7, 10, 11, and 14.
Chromium	YES	Exceeds the REG_IV at SDs 4, 7, 11, and 14; the TEL at 4, 7, and 11; and the ER-L at 4 and 11. Exceeds the PEL and ER-M at SD 4 only.
Copper	YES	Exceeds the TEL at SDs 1, 2, 4, 7, 12, and 13 and the REG_IV and ER-L at 1 and 4. Exceeds the PEL at SD 4, but does not exceed the ER-M at any site.
Iron	YES	Exceeds the LEL_MOE and SEL_MOE at SDs 4, 8, 11, and 14.
Lead	YES	Exceeds the REG_IV and/or the TEL at SDs 1, 2, 4, 7, 8, and 10-14 and the ER-L at 4, 12, 13, and 14, but is less than the PEL and ER-M at all sites.
Manganese	YES	Exceeds the LEL_MOE and SEL_MOE at SDs 2, 3, 4, 7, 8, 10, 11, and 14.
Mercury	YES	Exceeds the REG_IV, TEL, ER-L, PEL, and ER-M at SDs 2 and 4. All other detected concentrations were less than background.
Nickel	YES	Exceeds the TEL, REG_IV and ER-L at SDs 1, 2, 3, 7-14 and the PEL and/or ER-M at 2, 4, 7, 11, and 14.
Silver	YES	Exceeds the TEL, ER-L, PEL, and REG_IV at SD 4, but is less than the ER-M at all sites.
Zinc	YES	Exceeds the REG_IV at SDs 1-4, 7, and 11-14; the TEL and ER-L at 2 and 4; and the PEL at 4. Does not exceed the ER-M at any site.
4,4'-DDD	YES	Exceeds the TEL, but not the PEL or EQPSQB_A, at SDs 8 and 10. Detected below benchmarks at SDs 7, 11, and 17.
4,4'-DDE	YES	Exceeds the TEL, and ER-L but not the PEL or ER-M, at SDs 8 and 10. Detected below benchmarks at SDs 1-5, and 13-17.
4,4'-DDT	YES	Exceeds the TEL and ER-L, but not the REG_IV, PEL, ER-M, or EQPSQB_A, at SD 8. Detected below benchmarks at SDs 1, 3, 7, 13, and 15.
Acenaphthene	YES	Exceeds the TEL, ER-L, and PEL, but not the REG_IV, ER-M, or EPASQC_A, at SD 4. Not detected at any other sites.

Table G.13 (continued)

Chemical	COPEC	Reason for inclusion or rejection
Anthracene	YES	Exceeds the EQPSQB_A, TEL, ER-L, PEL, REG_IV, and ER-M at SD 4. Not detected at any other sites.
Benzo(a)anthracene	YES	Exceeds the TEL at SDs 2, 4, 11, 12, 14, 16, and 17; the EQPSQB_A at 2, 4, 11, and 16; and the ER-L, REG_IV, PEL, and ER-M at SD 4.
Benzo(a)pyrene	YES	Exceeds the EQPSQB_A at SDs 4 and 11; the TEL at 2, 4, and 11; and the REG_IV, ER-L, PEL, and ER-M at 4.
Bis(2-ethylhexyl)phthalate	YES	Exceeds the TEL, but not the PEL or EQPSQB_A, at SD 2. Detected below benchmarks at five other sites.
Chlordane	YES	Exceeds the ER-L, REG_IV, and/or TEL at SDs 1, 2, 4, 5, 7, 10, 13, 17, and 18. Exceeds the PEL, but not the ER-M or EQPSQB_A, at SD 4.
Chrysene	YES	Exceeds the TEL at SDs 2, 4, and 11 and the REG_IV, ER-L, PEL, and ER-M at SD 4.
Dibenz(a,h)anthracene	YES	Exceeds the TEL, ER-L, PEL, ER-M, and REG_IV at SD 4. Not detected at any other sites.
Dieldrin	YES	Exceeds the ER-L and TEL at SDs 4 and 8 and the REG_IV, PEL, and ER-M at SD 8. Does not exceed the ER-M at SD 4 and was not detected at any other sites.
Endrin	YES	Exceeds the ER-L and REG_IV at all sites where it was detected (i.e., SDs 1-3, 5-8, 10, and 12-18) but did not exceed the ER-M at any site. Marginally exceeds the EPASQC_A at SDs 1 and 10.
Fluoranthene	YES	Exceeds the TEL at SDs 2, 4, 11, 12, and 16 and the REG_IV, ER-L, PEL, and ER-M at 4. Does not exceed the EPASQC_A at any site.
Fluorene	YES	Exceeds the ER-L, TEL, and PEL, but not the REG_IV or ER-M, at SD 4. Not detected at any other sites.
Naphthalene	YES	Exceeds the TEL, but not the ER-L, REG_IV, PEL, EQPSQB_A, or ER-M, at SD 4. Not detected at any other sites.
PAHs, Total	YES	Exceeds the TEL, REG_IV, and ER-L at all sites where PAHs were detected (i.e., SDs 2, 4, 7, 11, 12, 14-17, and SP 4). Exceeds the PEL and ER-M at SD 4 only.
PCB-1254	YES	Exceeds the ER-L, ER-M, and EQPSQB_A, at SDs 4, 10, and 11. Detected below benchmarks at SD 18.
PCB-1260	YES	Exceeds the ER-L at all sites where it was detected (i.e., SDs 2, 4-9, 11, and 14-17). Exceeds the ER-M at 4, 8, 9, and 11. Does not exceed the EQPSQB_A at any site.
Phenanthrene	YES	Exceeds the TEL at SDs 2, 4, and 11 and the ER-L, ER-M, REG_IV, PEL, and EPASQC_A at 4.
Pyrene	YES	Exceeds the TEL at SDs 2, 4, 11, and 16 and the REG_IV, ER-L, PEL, and ER-M at 4.

Table G.14. Measured chemical concentrations in whole sediment samples, benchmarks, and the HQs for sediment COPECs^a

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Antimony	SD04	4.60E+00	2.00E+00	ER_L	2.300
Antimony	SD04	4.60E+00	1.20E+01	REG_IV	0.383
Antimony	SD04	4.60E+00	2.50E+01	ER_M	0.184
Arsenic	SD01	1.74E+01	6.00E+00	LEL_MOE	2.900
Arsenic	SD01	1.74E+01	7.24E+00	SED_TEL	2.403
Arsenic	SD01	1.74E+01	8.00E+00	REG_IV	2.175
Arsenic	SD01	1.74E+01	8.20E+00	ER_L	2.122
Arsenic	SD01	1.74E+01	4.16E+01	SED_PEL	0.418
Arsenic	SD01	1.74E+01	7.00E+01	ER_M	0.249
Arsenic	SD02	1.21E+01	6.00E+00	LEL_MOE	2.017
Arsenic	SD02	1.21E+01	7.24E+00	SED_TEL	1.671
Arsenic	SD02	1.21E+01	8.00E+00	REG_IV	1.513
Arsenic	SD02	1.21E+01	8.20E+00	ER_L	1.476
Arsenic	SD02	1.21E+01	4.16E+01	SED_PEL	0.291
Arsenic	SD02	1.21E+01	7.00E+01	ER_M	0.173
Arsenic	SD04	1.52E+01	6.00E+00	LEL_MOE	2.533
Arsenic	SD04	1.52E+01	7.24E+00	SED_TEL	2.099
Arsenic	SD04	1.52E+01	8.00E+00	REG_IV	1.900
Arsenic	SD04	1.52E+01	8.20E+00	ER_L	1.854
Arsenic	SD04	1.52E+01	4.16E+01	SED_PEL	0.365
Arsenic	SD04	1.52E+01	7.00E+01	ER_M	0.217
Arsenic	SD07	1.39E+01	6.00E+00	LEL_MOE	2.317
Arsenic	SD07	1.39E+01	7.24E+00	SED_TEL	1.920
Arsenic	SD07	1.39E+01	8.00E+00	REG_IV	1.738
Arsenic	SD07	1.39E+01	8.20E+00	ER_L	1.695
Arsenic	SD07	1.39E+01	4.16E+01	SED_PEL	0.334
Arsenic	SD07	1.39E+01	7.00E+01	ER_M	0.199
Arsenic	SD08	9.20E+00	6.00E+00	LEL_MOE	1.533
Arsenic	SD08	9.20E+00	7.24E+00	SED_TEL	1.271
Arsenic	SD08	9.20E+00	8.00E+00	REG_IV	1.150
Arsenic	SD08	9.20E+00	8.20E+00	ER_L	1.122

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Arsenic	SD08	9.20E+00	4.16E+01	SED_PEL	0.221
Arsenic	SD08	9.20E+00	7.00E+01	ER_M	0.131
Arsenic	SD10	9.30E+00	6.00E+00	LEL_MOE	1.550
Arsenic	SD10	9.30E+00	7.24E+00	SED_TEL	1.285
Arsenic	SD10	9.30E+00	8.00E+00	REG_IV	1.163
Arsenic	SD10	9.30E+00	8.20E+00	ER_L	1.134
Arsenic	SD10	9.30E+00	4.16E+01	SED_PEL	0.224
Arsenic	SD10	9.30E+00	7.00E+01	ER_M	0.133
Arsenic	SD11	1.75E+01	6.00E+00	LEL_MOE	2.917
Arsenic	SD11	1.75E+01	7.24E+00	SED_TEL	2.417
Arsenic	SD11	1.75E+01	8.00E+00	REG_IV	2.188
Arsenic	SD11	1.75E+01	8.20E+00	ER_L	2.134
Arsenic	SD11	1.75E+01	4.16E+01	SED_PEL	0.421
Arsenic	SD11	1.75E+01	7.00E+01	ER_M	0.250
Arsenic	SD12	1.05E+01	6.00E+00	LEL_MOE	1.750
Arsenic	SD12	1.05E+01	7.24E+00	SED_TEL	1.450
Arsenic	SD12	1.05E+01	8.00E+00	REG_IV	1.313
Arsenic	SD12	1.05E+01	8.20E+00	ER_L	1.280
Arsenic	SD12	1.05E+01	4.16E+01	SED_PEL	0.252
Arsenic	SD12	1.05E+01	7.00E+01	ER_M	0.150
Arsenic	SD13	1.60E+01	6.00E+00	LEL_MOE	2.667
Arsenic	SD13	1.60E+01	7.24E+00	SED_TEL	2.210
Arsenic	SD13	1.60E+01	8.00E+00	REG_IV	2.000
Arsenic	SD13	1.60E+01	8.20E+00	ER_L	1.951
Arsenic	SD13	1.60E+01	4.16E+01	SED_PEL	0.385
Arsenic	SD13	1.60E+01	7.00E+01	ER_M	0.229
Arsenic	SD14	1.32E+01	6.00E+00	LEL_MOE	2.200
Arsenic	SD14	1.32E+01	7.24E+00	SED_TEL	1.823
Arsenic	SD14	1.32E+01	8.00E+00	REG_IV	1.650
Arsenic	SD14	1.32E+01	8.20E+00	ER_L	1.610
Arsenic	SD14	1.32E+01	4.16E+01	SED_PEL	0.317
Arsenic	SD14	1.32E+01	7.00E+01	ER_M	0.189

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Barium	SD02	5.17E+02	2.00E+01	REG_V_L	25.850
Barium	SD02	5.17E+02	6.00E+01	REG_V_M	8.617
Barium	SD03	2.22E+02	2.00E+01	REG_V_L	11.100
Barium	SD03	2.22E+02	6.00E+01	REG_V_M	3.700
Barium	SD04	2.24E+02	2.00E+01	REG_V_L	11.200
Barium	SD04	2.24E+02	6.00E+01	REG_V_M	3.733
Barium	SD07	2.51E+02	2.00E+01	REG_V_L	12.550
Barium	SD07	2.51E+02	6.00E+01	REG_V_M	4.183
Barium	SD08	5.71E+02	2.00E+01	REG_V_L	28.550
Barium	SD08	5.71E+02	6.00E+01	REG_V_M	9.517
Barium	SD14	5.27E+02	2.00E+01	REG_V_L	26.350
Barium	SD14	5.27E+02	6.00E+01	REG_V_M	8.783
Cadmium	SD01	4.00E+00	6.00E-01	LEL_MOE	6.667
Cadmium	SD01	4.00E+00	6.76E-01	SED_TEL	5.917
Cadmium	SD01	4.00E+00	1.00E+00	REG_IV	4.000
Cadmium	SD01	4.00E+00	1.20E+00	ER_L	3.333
Cadmium	SD01	4.00E+00	4.21E+00	SED_PEL	0.950
Cadmium	SD01	4.00E+00	9.60E+00	ER_M	0.417
Cadmium	SD02	2.17E+01	6.00E-01	LEL_MOE	36.167
Cadmium	SD02	2.17E+01	6.76E-01	SED_TEL	32.101
Cadmium	SD02	2.17E+01	1.00E+00	REG_IV	21.700
Cadmium	SD02	2.17E+01	1.20E+00	ER_L	18.083
Cadmium	SD02	2.17E+01	4.21E+00	SED_PEL	5.154
Cadmium	SD02	2.17E+01	9.60E+00	ER_M	2.260
Cadmium	SD04	9.20E+00	6.00E-01	LEL_MOE	15.333
Cadmium	SD04	9.20E+00	6.76E-01	SED_TEL	13.609
Cadmium	SD04	9.20E+00	1.00E+00	REG_IV	9.200
Cadmium	SD04	9.20E+00	1.20E+00	ER_L	7.667
Cadmium	SD04	9.20E+00	4.21E+00	SED_PEL	2.185
Cadmium	SD04	9.20E+00	9.60E+00	ER_M	0.958
Cadmium	SD07	1.06E+01	6.00E-01	LEL_MOE	17.667
Cadmium	SD07	1.06E+01	6.76E-01	SED_TEL	15.680

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Cadmium	SD07	1.06E+01	1.00E+00	REG_IV	10.600
Cadmium	SD07	1.06E+01	1.20E+00	ER_L	8.833
Cadmium	SD07	1.06E+01	4.21E+00	SED_PEL	2.518
Cadmium	SD07	1.06E+01	9.60E+00	ER_M	1.104
Cadmium	SD10	4.50E+00	6.00E-01	LEL_MOE	7.500
Cadmium	SD10	4.50E+00	6.76E-01	SED_TEL	6.657
Cadmium	SD10	4.50E+00	1.00E+00	REG_IV	4.500
Cadmium	SD10	4.50E+00	1.20E+00	ER_L	3.750
Cadmium	SD10	4.50E+00	4.21E+00	SED_PEL	1.069
Cadmium	SD10	4.50E+00	9.60E+00	ER_M	0.469
Cadmium	SD11	5.10E+00	6.00E-01	LEL_MOE	8.500
Cadmium	SD11	5.10E+00	6.76E-01	SED_TEL	7.544
Cadmium	SD11	5.10E+00	1.00E+00	REG_IV	5.100
Cadmium	SD11	5.10E+00	1.20E+00	ER_L	4.250
Cadmium	SD11	5.10E+00	4.21E+00	SED_PEL	1.211
Cadmium	SD11	5.10E+00	9.60E+00	ER_M	0.531
Cadmium	SD14	1.62E+01	6.00E-01	LEL_MOE	27.000
Cadmium	SD14	1.62E+01	6.76E-01	SED_TEL	23.964
Cadmium	SD14	1.62E+01	1.00E+00	REG_IV	16.200
Cadmium	SD14	1.62E+01	1.20E+00	ER_L	13.500
Cadmium	SD14	1.62E+01	4.21E+00	SED_PEL	3.848
Cadmium	SD14	1.62E+01	9.60E+00	ER_M	1.688
Cadmium	SD15	5.30E-01	6.00E-01	LEL_MOE	0.883
Cadmium	SD15	5.30E-01	6.76E-01	SED_TEL	0.784
Cadmium	SD15	5.30E-01	1.00E+00	REG_IV	0.530
Cadmium	SD15	5.30E-01	1.20E+00	ER_L	0.442
Cadmium	SD15	5.30E-01	4.21E+00	SED_PEL	0.126
Cadmium	SD15	5.30E-01	9.60E+00	ER_M	0.055
Chromium	SD01	2.84E+01	3.30E+01	REG_IV	0.861
Chromium	SD01	2.84E+01	5.23E+01	SED_TEL	0.543
Chromium	SD01	2.84E+01	8.10E+01	ER_L	0.351
Chromium	SD01	2.84E+01	1.60E+02	SED_PEL	0.178

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Chromium	SD01	2.84E+01	3.70E+02	ER_M	0.077
Chromium	SD02	2.65E+01	3.30E+01	REG_IV	0.803
Chromium	SD02	2.65E+01	5.23E+01	SED_TEL	0.507
Chromium	SD02	2.65E+01	8.10E+01	ER_L	0.327
Chromium	SD02	2.65E+01	1.60E+02	SED_PEL	0.166
Chromium	SD02	2.65E+01	3.70E+02	ER_M	0.072
Chromium	SD04	1.04E+03	3.30E+01	REG_IV	31.515
Chromium	SD04	1.04E+03	5.23E+01	SED_TEL	19.885
Chromium	SD04	1.04E+03	8.10E+01	ER_L	12.840
Chromium	SD04	1.04E+03	1.60E+02	SED_PEL	6.500
Chromium	SD04	1.04E+03	3.70E+02	ER_M	2.811
Chromium	SD07	6.49E+01	3.30E+01	REG_IV	1.967
Chromium	SD07	6.49E+01	5.23E+01	SED_TEL	1.241
Chromium	SD07	6.49E+01	8.10E+01	ER_L	0.801
Chromium	SD07	6.49E+01	1.60E+02	SED_PEL	0.406
Chromium	SD07	6.49E+01	3.70E+02	ER_M	0.175
Chromium	SD08	2.38E+01	3.30E+01	REG_IV	0.721
Chromium	SD08	2.38E+01	5.23E+01	SED_TEL	0.455
Chromium	SD08	2.38E+01	8.10E+01	ER_L	0.294
Chromium	SD08	2.38E+01	1.60E+02	SED_PEL	0.149
Chromium	SD08	2.38E+01	3.70E+02	ER_M	0.064
Chromium	SD09	2.68E+01	3.30E+01	REG_IV	0.812
Chromium	SD09	2.68E+01	5.23E+01	SED_TEL	0.512
Chromium	SD09	2.68E+01	8.10E+01	ER_L	0.331
Chromium	SD09	2.68E+01	1.60E+02	SED_PEL	0.168
Chromium	SD09	2.68E+01	3.70E+02	ER_M	0.072
Chromium	SD10	2.78E+01	3.30E+01	REG_IV	0.842
Chromium	SD10	2.78E+01	5.23E+01	SED_TEL	0.532
Chromium	SD10	2.78E+01	8.10E+01	ER_L	0.343
Chromium	SD10	2.78E+01	1.60E+02	SED_PEL	0.174
Chromium	SD10	2.78E+01	3.70E+02	ER_M	0.075
Chromium	SD11	1.30E+02	3.30E+01	REG_IV	3.939

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Chromium	SD11	1.30E+02	5.23E+01	SED_TEL	2.486
Chromium	SD11	1.30E+02	8.10E+01	ER_L	1.605
Chromium	SD11	1.30E+02	1.60E+02	SED_PEL	0.813
Chromium	SD11	1.30E+02	3.70E+02	ER_M	0.351
Chromium	SD14	3.41E+01	3.30E+01	REG_IV	1.033
Chromium	SD14	3.41E+01	5.23E+01	SED_TEL	0.652
Chromium	SD14	3.41E+01	8.10E+01	ER_L	0.421
Chromium	SD14	3.41E+01	1.60E+02	SED_PEL	0.213
Chromium	SD14	3.41E+01	3.70E+02	ER_M	0.092
Copper	SD01	3.46E+01	1.87E+01	SED_TEL	1.850
Copper	SD01	3.46E+01	2.80E+01	REG_IV	1.236
Copper	SD01	3.46E+01	3.40E+01	ER_L	1.018
Copper	SD01	3.46E+01	1.08E+02	SED_PEL	0.320
Copper	SD01	3.46E+01	2.70E+02	ER_M	0.128
Copper	SD02	2.77E+01	1.87E+01	SED_TEL	1.481
Copper	SD02	2.77E+01	2.80E+01	REG_IV	0.989
Copper	SD02	2.77E+01	3.40E+01	ER_L	0.815
Copper	SD02	2.77E+01	1.08E+02	SED_PEL	0.256
Copper	SD02	2.77E+01	2.70E+02	ER_M	0.103
Copper	SD04	2.41E+02	1.87E+01	SED_TEL	12.888
Copper	SD04	2.41E+02	2.80E+01	REG_IV	8.607
Copper	SD04	2.41E+02	3.40E+01	ER_L	7.088
Copper	SD04	2.41E+02	1.08E+02	SED_PEL	2.231
Copper	SD04	2.41E+02	2.70E+02	ER_M	0.893
Copper	SD07	2.13E+01	1.87E+01	SED_TEL	1.139
Copper	SD07	2.13E+01	2.80E+01	REG_IV	0.761
Copper	SD07	2.13E+01	3.40E+01	ER_L	0.626
Copper	SD07	2.13E+01	1.08E+02	SED_PEL	0.197
Copper	SD07	2.13E+01	2.70E+02	ER_M	0.079
Copper	SD09	1.21E+01	1.87E+01	SED_TEL	0.647
Copper	SD09	1.21E+01	2.80E+01	REG_IV	0.432
Copper	SD09	1.21E+01	3.40E+01	ER_L	0.356

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Copper	SD09	1.21E+01	1.08E+02	SED_PEL	0.112
Copper	SD09	1.21E+01	2.70E+02	ER_M	0.045
Copper	SD10	1.19E+01	1.87E+01	SED_TEL	0.636
Copper	SD10	1.19E+01	2.80E+01	REG_IV	0.425
Copper	SD10	1.19E+01	3.40E+01	ER_L	0.350
Copper	SD10	1.19E+01	1.08E+02	SED_PEL	0.110
Copper	SD10	1.19E+01	2.70E+02	ER_M	0.044
Copper	SD11	1.34E+01	1.87E+01	SED_TEL	0.717
Copper	SD11	1.34E+01	2.80E+01	REG_IV	0.479
Copper	SD11	1.34E+01	3.40E+01	ER_L	0.394
Copper	SD11	1.34E+01	1.08E+02	SED_PEL	0.124
Copper	SD11	1.34E+01	2.70E+02	ER_M	0.050
Copper	SD12	2.54E+01	1.87E+01	SED_TEL	1.358
Copper	SD12	2.54E+01	2.80E+01	REG_IV	0.907
Copper	SD12	2.54E+01	3.40E+01	ER_L	0.747
Copper	SD12	2.54E+01	1.08E+02	SED_PEL	0.235
Copper	SD12	2.54E+01	2.70E+02	ER_M	0.094
Copper	SD13	2.06E+01	1.87E+01	SED_TEL	1.102
Copper	SD13	2.06E+01	2.80E+01	REG_IV	0.736
Copper	SD13	2.06E+01	3.40E+01	ER_L	0.606
Copper	SD13	2.06E+01	1.08E+02	SED_PEL	0.191
Copper	SD13	2.06E+01	2.70E+02	ER_M	0.076
Copper	SD14	1.44E+01	1.87E+01	SED_TEL	0.770
Copper	SD14	1.44E+01	2.80E+01	REG_IV	0.514
Copper	SD14	1.44E+01	3.40E+01	ER_L	0.424
Copper	SD14	1.44E+01	1.08E+02	SED_PEL	0.133
Copper	SD14	1.44E+01	2.70E+02	ER_M	0.053
Iron	SD04	5.35E+04	3.00E+04	LEL_MOE	1.783
Iron	SD04	5.35E+04	4.00E+04	SEL_MOE	1.338
Iron	SD08	5.09E+04	3.00E+04	LEL_MOE	1.697
Iron	SD08	5.09E+04	4.00E+04	SEL_MOE	1.273
Iron	SD11	4.28E+04	3.00E+04	LEL_MOE	1.427

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Iron	SD11	4.28E+04	4.00E+04	SEL_MOE	1.070
Iron	SD14	6.14E+04	3.00E+04	LEL_MOE	2.047
Iron	SD14	6.14E+04	4.00E+04	SEL_MOE	1.535
Lead	SD01	3.19E+01	2.10E+01	REG_IV	1.519
Lead	SD01	3.19E+01	3.02E+01	SED_TEL	1.056
Lead	SD01	3.19E+01	4.70E+01	ER_L	0.679
Lead	SD01	3.19E+01	1.12E+02	SED_PEL	0.285
Lead	SD01	3.19E+01	2.18E+02	ER_M	0.146
Lead	SD02	3.11E+01	2.10E+01	REG_IV	1.481
Lead	SD02	3.11E+01	3.02E+01	SED_TEL	1.030
Lead	SD02	3.11E+01	4.70E+01	ER_L	0.662
Lead	SD02	3.11E+01	1.12E+02	SED_PEL	0.278
Lead	SD02	3.11E+01	2.18E+02	ER_M	0.143
Lead	SD04	1.07E+02	2.10E+01	REG_IV	5.095
Lead	SD04	1.07E+02	3.02E+01	SED_TEL	3.543
Lead	SD04	1.07E+02	4.70E+01	ER_L	2.277
Lead	SD04	1.07E+02	1.12E+02	SED_PEL	0.955
Lead	SD04	1.07E+02	2.18E+02	ER_M	0.491
Lead	SD07	3.86E+01	2.10E+01	REG_IV	1.838
Lead	SD07	3.86E+01	3.02E+01	SED_TEL	1.278
Lead	SD07	3.86E+01	4.70E+01	ER_L	0.821
Lead	SD07	3.86E+01	1.12E+02	SED_PEL	0.345
Lead	SD07	3.86E+01	2.18E+02	ER_M	0.177
Lead	SD08	2.50E+01	2.10E+01	REG_IV	1.190
Lead	SD08	2.50E+01	3.02E+01	SED_TEL	0.828
Lead	SD08	2.50E+01	4.70E+01	ER_L	0.532
Lead	SD08	2.50E+01	1.12E+02	SED_PEL	0.223
Lead	SD08	2.50E+01	2.18E+02	ER_M	0.115
Lead	SD09	1.63E+01	2.10E+01	REG_IV	0.776
Lead	SD09	1.63E+01	3.02E+01	SED_TEL	0.540
Lead	SD09	1.63E+01	4.70E+01	ER_L	0.347
Lead	SD09	1.63E+01	1.12E+02	SED_PEL	0.146

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Lead	SD09	1.63E+01	2.18E+02	ER_M	0.075
Lead	SD10	2.60E+01	2.10E+01	REG_IV	1.238
Lead	SD10	2.60E+01	3.02E+01	SED_TEL	0.861
Lead	SD10	2.60E+01	4.70E+01	ER_L	0.553
Lead	SD10	2.60E+01	1.12E+02	SED_PEL	0.232
Lead	SD10	2.60E+01	2.18E+02	ER_M	0.119
Lead	SD11	3.09E+01	2.10E+01	REG_IV	1.471
Lead	SD11	3.09E+01	3.02E+01	SED_TEL	1.023
Lead	SD11	3.09E+01	4.70E+01	ER_L	0.657
Lead	SD11	3.09E+01	1.12E+02	SED_PEL	0.276
Lead	SD11	3.09E+01	2.18E+02	ER_M	0.142
Lead	SD12	5.94E+01	2.10E+01	REG_IV	2.829
Lead	SD12	5.94E+01	3.02E+01	SED_TEL	1.967
Lead	SD12	5.94E+01	4.70E+01	ER_L	1.264
Lead	SD12	5.94E+01	1.12E+02	SED_PEL	0.530
Lead	SD12	5.94E+01	2.18E+02	ER_M	0.272
Lead	SD13	5.44E+01	2.10E+01	REG_IV	2.590
Lead	SD13	5.44E+01	3.02E+01	SED_TEL	1.801
Lead	SD13	5.44E+01	4.70E+01	ER_L	1.157
Lead	SD13	5.44E+01	1.12E+02	SED_PEL	0.486
Lead	SD13	5.44E+01	2.18E+02	ER_M	0.250
Lead	SD14	5.08E+01	2.10E+01	REG_IV	2.419
Lead	SD14	5.08E+01	3.02E+01	SED_TEL	1.682
Lead	SD14	5.08E+01	4.70E+01	ER_L	1.081
Lead	SD14	5.08E+01	1.12E+02	SED_PEL	0.454
Lead	SD14	5.08E+01	2.18E+02	ER_M	0.233
Lead	SD16	1.72E+01	2.10E+01	REG_IV	0.819
Lead	SD16	1.72E+01	3.02E+01	SED_TEL	0.570
Lead	SD16	1.72E+01	4.70E+01	ER_L	0.366
Lead	SD16	1.72E+01	1.12E+02	SED_PEL	0.154
Lead	SD16	1.72E+01	2.18E+02	ER_M	0.079
Manganese	SD02	5.66E+03	4.60E+02	LEL_MOE	12.304

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Manganese	SD02	5.66E+03	1.11E+03	SEL_MOE	5.099
Manganese	SD03	1.83E+03	4.60E+02	LEL_MOE	3.978
Manganese	SD03	1.83E+03	1.11E+03	SEL_MOE	1.649
Manganese	SD04	1.90E+03	4.60E+02	LEL_MOE	4.130
Manganese	SD04	1.90E+03	1.11E+03	SEL_MOE	1.712
Manganese	SD07	3.96E+03	4.60E+02	LEL_MOE	8.609
Manganese	SD07	3.96E+03	1.11E+03	SEL_MOE	3.568
Manganese	SD08	9.28E+03	4.60E+02	LEL_MOE	20.174
Manganese	SD08	9.28E+03	1.11E+03	SEL_MOE	8.360
Manganese	SD10	2.18E+03	4.60E+02	LEL_MOE	4.739
Manganese	SD10	2.18E+03	1.11E+03	SEL_MOE	1.964
Manganese	SD11	2.76E+03	4.60E+02	LEL_MOE	6.000
Manganese	SD11	2.76E+03	1.11E+03	SEL_MOE	2.486
Manganese	SD14	7.32E+03	4.60E+02	LEL_MOE	15.913
Manganese	SD14	7.32E+03	1.11E+03	SEL_MOE	6.595
Mercury	SD02	3.00E+00	1.00E-01	REG_IV	30.000
Mercury	SD02	3.00E+00	1.30E-01	SED_TEL	23.077
Mercury	SD02	3.00E+00	1.50E-01	ER_L	20.000
Mercury	SD02	3.00E+00	6.96E-01	SED_PEL	4.310
Mercury	SD02	3.00E+00	7.10E-01	ER_M	4.225
Mercury	SD04	6.90E+00	1.00E-01	REG_IV	69.000
Mercury	SD04	6.90E+00	1.30E-01	SED_TEL	53.077
Mercury	SD04	6.90E+00	1.50E-01	ER_L	46.000
Mercury	SD04	6.90E+00	6.96E-01	SED_PEL	9.914
Mercury	SD04	6.90E+00	7.10E-01	ER_M	9.718
Nickel	SD01	2.74E+01	1.59E+01	SED_TEL	1.723
Nickel	SD01	2.74E+01	2.09E+01	REG_IV	1.311
Nickel	SD01	2.74E+01	2.10E+01	ER_L	1.305
Nickel	SD01	2.74E+01	4.28E+01	SED_PEL	0.640
Nickel	SD01	2.74E+01	5.16E+01	ER_M	0.531
Nickel	SD02	1.60E+02	1.59E+01	SED_TEL	10.063
Nickel	SD02	1.60E+02	2.09E+01	REG_IV	7.656

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Nickel	SD02	1.60E+02	2.10E+01	ER_L	7.619
Nickel	SD02	1.60E+02	4.28E+01	SED_PEL	3.738
Nickel	SD02	1.60E+02	5.16E+01	ER_M	3.101
Nickel	SD03	2.43E+01	1.59E+01	SED_TEL	1.528
Nickel	SD03	2.43E+01	2.09E+01	REG_IV	1.163
Nickel	SD03	2.43E+01	2.10E+01	ER_L	1.157
Nickel	SD03	2.43E+01	4.28E+01	SED_PEL	0.568
Nickel	SD03	2.43E+01	5.16E+01	ER_M	0.471
Nickel	SD04	9.61E+01	1.59E+01	SED_TEL	6.044
Nickel	SD04	9.61E+01	2.09E+01	REG_IV	4.598
Nickel	SD04	9.61E+01	2.10E+01	ER_L	4.576
Nickel	SD04	9.61E+01	4.28E+01	SED_PEL	2.245
Nickel	SD04	9.61E+01	5.16E+01	ER_M	1.862
Nickel	SD07	6.21E+01	1.59E+01	SED_TEL	3.906
Nickel	SD07	6.21E+01	2.09E+01	REG_IV	2.971
Nickel	SD07	6.21E+01	2.10E+01	ER_L	2.957
Nickel	SD07	6.21E+01	4.28E+01	SED_PEL	1.451
Nickel	SD07	6.21E+01	5.16E+01	ER_M	1.203
Nickel	SD08	2.83E+01	1.59E+01	SED_TEL	1.780
Nickel	SD08	2.83E+01	2.09E+01	REG_IV	1.354
Nickel	SD08	2.83E+01	2.10E+01	ER_L	1.348
Nickel	SD08	2.83E+01	4.28E+01	SED_PEL	0.661
Nickel	SD08	2.83E+01	5.16E+01	ER_M	0.548
Nickel	SD09	2.49E+01	1.59E+01	SED_TEL	1.566
Nickel	SD09	2.49E+01	2.09E+01	REG_IV	1.191
Nickel	SD09	2.49E+01	2.10E+01	ER_L	1.186
Nickel	SD09	2.49E+01	4.28E+01	SED_PEL	0.582
Nickel	SD09	2.49E+01	5.16E+01	ER_M	0.483
Nickel	SD10	4.16E+01	1.59E+01	SED_TEL	2.616
Nickel	SD10	4.16E+01	2.09E+01	REG_IV	1.990
Nickel	SD10	4.16E+01	2.10E+01	ER_L	1.981
Nickel	SD10	4.16E+01	4.28E+01	SED_PEL	0.972

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Nickel	SD10	4.16E+01	5.16E+01	ER_M	0.806
Nickel	SD11	4.68E+01	1.59E+01	SED_TEL	2.943
Nickel	SD11	4.68E+01	2.09E+01	REG_IV	2.239
Nickel	SD11	4.68E+01	2.10E+01	ER_L	2.229
Nickel	SD11	4.68E+01	4.28E+01	SED_PEL	1.093
Nickel	SD11	4.68E+01	5.16E+01	ER_M	0.907
Nickel	SD12	2.16E+01	1.59E+01	SED_TEL	1.358
Nickel	SD12	2.16E+01	2.09E+01	REG_IV	1.033
Nickel	SD12	2.16E+01	2.10E+01	ER_L	1.029
Nickel	SD12	2.16E+01	4.28E+01	SED_PEL	0.505
Nickel	SD12	2.16E+01	5.16E+01	ER_M	0.419
Nickel	SD13	2.19E+01	1.59E+01	SED_TEL	1.377
Nickel	SD13	2.19E+01	2.09E+01	REG_IV	1.048
Nickel	SD13	2.19E+01	2.10E+01	ER_L	1.043
Nickel	SD13	2.19E+01	4.28E+01	SED_PEL	0.512
Nickel	SD13	2.19E+01	5.16E+01	ER_M	0.424
Nickel	SD14	9.54E+01	1.59E+01	SED_TEL	6.000
Nickel	SD14	9.54E+01	2.09E+01	REG_IV	4.565
Nickel	SD14	9.54E+01	2.10E+01	ER_L	4.543
Nickel	SD14	9.54E+01	4.28E+01	SED_PEL	2.229
Nickel	SD14	9.54E+01	5.16E+01	ER_M	1.849
Silver	SD02	2.90E-01	7.33E-01	SED_TEL	0.396
Silver	SD02	2.90E-01	1.00E+00	ER_L	0.290
Silver	SD02	2.90E-01	1.77E+00	SED_PEL	0.164
Silver	SD02	2.90E-01	2.00E+00	REG_IV	0.145
Silver	SD02	2.90E-01	3.70E+00	ER_M	0.078
Silver	SD04	2.80E+00	7.33E-01	SED_TEL	3.820
Silver	SD04	2.80E+00	1.00E+00	ER_L	2.800
Silver	SD04	2.80E+00	1.77E+00	SED_PEL	1.582
Silver	SD04	2.80E+00	2.00E+00	REG_IV	1.400
Silver	SD04	2.80E+00	3.70E+00	ER_M	0.757
Silver	SD08	3.60E-01	7.33E-01	SED_TEL	0.491

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Silver	SD08	3.60E-01	1.00E+00	ER_L	0.360
Silver	SD08	3.60E-01	1.77E+00	SED_PEL	0.203
Silver	SD08	3.60E-01	2.00E+00	REG_IV	0.180
Silver	SD08	3.60E-01	3.70E+00	ER_M	0.097
Silver	SD14	3.00E-01	7.33E-01	SED_TEL	0.409
Silver	SD14	3.00E-01	1.00E+00	ER_L	0.300
Silver	SD14	3.00E-01	1.77E+00	SED_PEL	0.169
Silver	SD14	3.00E-01	2.00E+00	REG_IV	0.150
Silver	SD14	3.00E-01	3.70E+00	ER_M	0.081
Zinc	SD01	1.15E+02	6.80E+01	REG_IV	1.691
Zinc	SD01	1.15E+02	1.24E+02	SED_TEL	0.927
Zinc	SD01	1.15E+02	1.50E+02	ER_L	0.767
Zinc	SD01	1.15E+02	2.71E+02	SED_PEL	0.424
Zinc	SD01	1.15E+02	4.10E+02	ER_M	0.280
Zinc	SD02	2.02E+02	6.80E+01	REG_IV	2.971
Zinc	SD02	2.02E+02	1.24E+02	SED_TEL	1.629
Zinc	SD02	2.02E+02	1.50E+02	ER_L	1.347
Zinc	SD02	2.02E+02	2.71E+02	SED_PEL	0.745
Zinc	SD02	2.02E+02	4.10E+02	ER_M	0.493
Zinc	SD03	7.14E+01	6.80E+01	REG_IV	1.050
Zinc	SD03	7.14E+01	1.24E+02	SED_TEL	0.576
Zinc	SD03	7.14E+01	1.50E+02	ER_L	0.476
Zinc	SD03	7.14E+01	2.71E+02	SED_PEL	0.263
Zinc	SD03	7.14E+01	4.10E+02	ER_M	0.174
Zinc	SD04	4.08E+02	6.80E+01	REG_IV	6.000
Zinc	SD04	4.08E+02	1.24E+02	SED_TEL	3.290
Zinc	SD04	4.08E+02	1.50E+02	ER_L	2.720
Zinc	SD04	4.08E+02	2.71E+02	SED_PEL	1.506
Zinc	SD04	4.08E+02	4.10E+02	ER_M	0.995
Zinc	SD06	5.49E+01	6.80E+01	REG_IV	0.807
Zinc	SD06	5.49E+01	1.24E+02	SED_TEL	0.443
Zinc	SD06	5.49E+01	1.50E+02	ER_L	0.366

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Zinc	SD06	5.49E+01	2.71E+02	SED_PEL	0.203
Zinc	SD06	5.49E+01	4.10E+02	ER_M	0.134
Zinc	SD07	7.22E+01	6.80E+01	REG_IV	1.062
Zinc	SD07	7.22E+01	1.24E+02	SED_TEL	0.582
Zinc	SD07	7.22E+01	1.50E+02	ER_L	0.481
Zinc	SD07	7.22E+01	2.71E+02	SED_PEL	0.266
Zinc	SD07	7.22E+01	4.10E+02	ER_M	0.176
Zinc	SD08	4.80E+01	6.80E+01	REG_IV	0.706
Zinc	SD08	4.80E+01	1.24E+02	SED_TEL	0.387
Zinc	SD08	4.80E+01	1.50E+02	ER_L	0.320
Zinc	SD08	4.80E+01	2.71E+02	SED_PEL	0.177
Zinc	SD08	4.80E+01	4.10E+02	ER_M	0.117
Zinc	SD09	6.74E+01	6.80E+01	REG_IV	0.991
Zinc	SD09	6.74E+01	1.24E+02	SED_TEL	0.544
Zinc	SD09	6.74E+01	1.50E+02	ER_L	0.449
Zinc	SD09	6.74E+01	2.71E+02	SED_PEL	0.249
Zinc	SD09	6.74E+01	4.10E+02	ER_M	0.164
Zinc	SD10	5.36E+01	6.80E+01	REG_IV	0.788
Zinc	SD10	5.36E+01	1.24E+02	SED_TEL	0.432
Zinc	SD10	5.36E+01	1.50E+02	ER_L	0.357
Zinc	SD10	5.36E+01	2.71E+02	SED_PEL	0.198
Zinc	SD10	5.36E+01	4.10E+02	ER_M	0.131
Zinc	SD11	7.38E+01	6.80E+01	REG_IV	1.085
Zinc	SD11	7.38E+01	1.24E+02	SED_TEL	0.595
Zinc	SD11	7.38E+01	1.50E+02	ER_L	0.492
Zinc	SD11	7.38E+01	2.71E+02	SED_PEL	0.272
Zinc	SD11	7.38E+01	4.10E+02	ER_M	0.180
Zinc	SD12	8.98E+01	6.80E+01	REG_IV	1.321
Zinc	SD12	8.98E+01	1.24E+02	SED_TEL	0.724
Zinc	SD12	8.98E+01	1.50E+02	ER_L	0.599
Zinc	SD12	8.98E+01	2.71E+02	SED_PEL	0.331

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Zinc	SD12	8.98E+01	4.10E+02	ER_M	0.219
Zinc	SD13	1.15E+02	6.80E+01	REG_IV	1.691
Zinc	SD13	1.15E+02	1.24E+02	SED_TEL	0.927
Zinc	SD13	1.15E+02	1.50E+02	ER_L	0.767
Zinc	SD13	1.15E+02	2.71E+02	SED_PEL	0.424
Zinc	SD13	1.15E+02	4.10E+02	ER_M	0.280
Zinc	SD14	7.14E+01	6.80E+01	REG_IV	1.050
Zinc	SD14	7.14E+01	1.24E+02	SED_TEL	0.576
Zinc	SD14	7.14E+01	1.50E+02	ER_L	0.476
Zinc	SD14	7.14E+01	2.71E+02	SED_PEL	0.263
Zinc	SD14	7.14E+01	4.10E+02	ER_M	0.174
4,4'-DDD	SD07	1.20E-04	1.22E-03	SED_TEL	0.098
4,4'-DDD	SD07	1.20E-04	7.81E-03	SED_PEL	0.015
4,4'-DDD	SD07	1.20E-04	4.54E-02	EQPSQB_A	0.003
4,4'-DDD	SD08	1.40E-03	1.22E-03	SED_TEL	1.148
4,4'-DDD	SD08	1.40E-03	7.81E-03	SED_PEL	0.179
4,4'-DDD	SD08	1.40E-03	7.81E-02	EQPSQB_A	0.018
4,4'-DDD	SD10	1.30E-03	1.22E-03	SED_TEL	1.066
4,4'-DDD	SD10	1.30E-03	7.81E-03	SED_PEL	0.166
4,4'-DDD	SD10	1.30E-03	2.71E-02	EQPSQB_A	0.048
4,4'-DDD	SD11	4.40E-04	1.22E-03	SED_TEL	0.361
4,4'-DDD	SD11	4.40E-04	7.81E-03	SED_PEL	0.056
4,4'-DDD	SD11	4.40E-04	2.14E-02	EQPSQB_A	0.021
4,4'-DDD	SD17	3.30E-04	1.22E-03	SED_TEL	0.270
4,4'-DDD	SD17	3.30E-04	7.81E-03	SED_PEL	0.042
4,4'-DDD	SD17	3.30E-04	5.48E-02	EQPSQB_A	0.006
4,4'-DDE	SD01	1.40E-04	2.07E-03	SED_TEL	0.068
4,4'-DDE	SD01	1.40E-04	2.20E-03	ER_L	0.064
4,4'-DDE	SD01	1.40E-04	3.74E-01	SED_PEL	0.000
4,4'-DDE	SD01	1.40E-04	2.70E-02	ER_M	0.005
4,4'-DDE	SD02	4.10E-04	2.07E-03	SED_TEL	0.198

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
4,4'-DDE	SD02	4.10E-04	2.20E-03	ER_L	0.186
4,4'-DDE	SD02	4.10E-04	3.74E-01	SED_PEL	0.001
4,4'-DDE	SD02	4.10E-04	2.70E-02	ER_M	0.015
4,4'-DDE	SD03	3.10E-04	2.07E-03	SED_TEL	0.150
4,4'-DDE	SD03	3.10E-04	2.20E-03	ER_L	0.141
4,4'-DDE	SD03	3.10E-04	3.74E-01	SED_PEL	0.001
4,4'-DDE	SD03	3.10E-04	2.70E-02	ER_M	0.011
4,4'-DDE	SD04	8.30E-04	2.07E-03	SED_TEL	0.401
4,4'-DDE	SD04	8.30E-04	2.20E-03	ER_L	0.377
4,4'-DDE	SD04	8.30E-04	3.74E-01	SED_PEL	0.002
4,4'-DDE	SD04	8.30E-04	2.70E-02	ER_M	0.031
4,4'-DDE	SD05	4.40E-04	2.07E-03	SED_TEL	0.213
4,4'-DDE	SD05	4.40E-04	2.20E-03	ER_L	0.200
4,4'-DDE	SD05	4.40E-04	3.74E-01	SED_PEL	0.001
4,4'-DDE	SD05	4.40E-04	2.70E-02	ER_M	0.016
4,4'-DDE	SD08	4.30E-03	2.07E-03	SED_TEL	2.077
4,4'-DDE	SD08	4.30E-03	2.20E-03	ER_L	1.955
4,4'-DDE	SD08	4.30E-03	3.74E-01	SED_PEL	0.011
4,4'-DDE	SD08	4.30E-03	2.70E-02	ER_M	0.159
4,4'-DDE	SD10	6.20E-03	2.07E-03	SED_TEL	2.995
4,4'-DDE	SD10	6.20E-03	2.20E-03	ER_L	2.818
4,4'-DDE	SD10	6.20E-03	3.74E-01	SED_PEL	0.017
4,4'-DDE	SD10	6.20E-03	2.70E-02	ER_M	0.230
4,4'-DDE	SD13	3.60E-04	2.07E-03	SED_TEL	0.174
4,4'-DDE	SD13	3.60E-04	2.20E-03	ER_L	0.164
4,4'-DDE	SD13	3.60E-04	3.74E-01	SED_PEL	0.001
4,4'-DDE	SD13	3.60E-04	2.70E-02	ER_M	0.013
4,4'-DDE	SD14	8.00E-05	2.07E-03	SED_TEL	0.039
4,4'-DDE	SD14	8.00E-05	2.20E-03	ER_L	0.036
4,4'-DDE	SD14	8.00E-05	3.74E-01	SED_PEL	0.000
4,4'-DDE	SD14	8.00E-05	2.70E-02	ER_M	0.003

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
4,4'-DDE	SD15	1.40E-04	2.07E-03	SED_TEL	0.068
4,4'-DDE	SD15	1.40E-04	2.20E-03	ER_L	0.064
4,4'-DDE	SD15	1.40E-04	3.74E-01	SED_PEL	0.000
4,4'-DDE	SD15	1.40E-04	2.70E-02	ER_M	0.005
4,4'-DDE	SD16	8.30E-05	2.07E-03	SED_TEL	0.040
4,4'-DDE	SD16	8.30E-05	2.20E-03	ER_L	0.038
4,4'-DDE	SD16	8.30E-05	3.74E-01	SED_PEL	0.000
4,4'-DDE	SD16	8.30E-05	2.70E-02	ER_M	0.003
4,4'-DDE	SD17	6.20E-04	2.07E-03	SED_TEL	0.300
4,4'-DDE	SD17	6.20E-04	2.20E-03	ER_L	0.282
4,4'-DDE	SD17	6.20E-04	3.74E-01	SED_PEL	0.002
4,4'-DDE	SD17	6.20E-04	2.70E-02	ER_M	0.023
4,4'-DDT	SD01	9.90E-05	1.19E-03	SED_TEL	0.083
4,4'-DDT	SD01	9.90E-05	1.60E-03	ER_L	0.062
4,4'-DDT	SD01	9.90E-05	3.30E-03	REG_IV	0.030
4,4'-DDT	SD01	9.90E-05	4.77E-03	SED_PEL	0.021
4,4'-DDT	SD01	9.90E-05	2.70E-02	ER_M	0.004
4,4'-DDT	SD01	9.90E-05	1.64E-01	EQPSQB_A	0.001
4,4'-DDT	SD03	4.00E-04	1.19E-03	SED_TEL	0.336
4,4'-DDT	SD03	4.00E-04	1.60E-03	ER_L	0.250
4,4'-DDT	SD03	4.00E-04	3.30E-03	REG_IV	0.121
4,4'-DDT	SD03	4.00E-04	4.77E-03	SED_PEL	0.084
4,4'-DDT	SD03	4.00E-04	2.70E-02	ER_M	0.015
4,4'-DDT	SD03	4.00E-04	4.47E-01	EQPSQB_A	0.001
4,4'-DDT	SD07	5.60E-04	1.19E-03	SED_TEL	0.471
4,4'-DDT	SD07	5.60E-04	1.60E-03	ER_L	0.350
4,4'-DDT	SD07	5.60E-04	3.30E-03	REG_IV	0.170
4,4'-DDT	SD07	5.60E-04	4.77E-03	SED_PEL	0.117
4,4'-DDT	SD07	5.60E-04	2.70E-02	ER_M	0.021
4,4'-DDT	SD07	5.60E-04	5.36E-01	EQPSQB_A	0.001
4,4'-DDT	SD08	2.80E-03	1.19E-03	SED_TEL	2.353

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
4,4'-DDT	SD08	2.80E-03	1.60E-03	ER_L	1.750
4,4'-DDT	SD08	2.80E-03	3.30E-03	REG_IV	0.848
4,4'-DDT	SD08	2.80E-03	4.77E-03	SED_PEL	0.587
4,4'-DDT	SD08	2.80E-03	2.70E-02	ER_M	0.104
4,4'-DDT	SD08	2.80E-03	9.24E-01	EQPSQB_A	0.003
4,4'-DDT	SD13	4.30E-04	1.19E-03	SED_TEL	0.361
4,4'-DDT	SD13	4.30E-04	1.60E-03	ER_L	0.269
4,4'-DDT	SD13	4.30E-04	3.30E-03	REG_IV	0.130
4,4'-DDT	SD13	4.30E-04	4.77E-03	SED_PEL	0.090
4,4'-DDT	SD13	4.30E-04	2.70E-02	ER_M	0.016
4,4'-DDT	SD13	4.30E-04	2.71E+00	EQPSQB_A	0.000
4,4'-DDT	SD15	4.80E-04	1.19E-03	SED_TEL	0.403
4,4'-DDT	SD15	4.80E-04	1.60E-03	ER_L	0.300
4,4'-DDT	SD15	4.80E-04	3.30E-03	REG_IV	0.145
4,4'-DDT	SD15	4.80E-04	4.77E-03	SED_PEL	0.101
4,4'-DDT	SD15	4.80E-04	2.70E-02	ER_M	0.018
4,4'-DDT	SD15	4.80E-04	4.10E-01	EQPSQB_A	0.001
Acenaphthene	SD04	1.90E-01	6.71E-03	SED_TEL	28.316
Acenaphthene	SD04	1.90E-01	1.60E-02	ER_L	11.875
Acenaphthene	SD04	1.90E-01	8.89E-02	SED_PEL	2.137
Acenaphthene	SD04	1.90E-01	3.30E-01	REG_IV	0.576
Acenaphthene	SD04	1.90E-01	5.00E-01	ER_M	0.380
Acenaphthene	SD04	1.90E-01	2.72E+00	EPASQC_A	0.070
Anthracene	SD04	1.10E+00	6.27E-04	EQPSQB_A	1754.38
Anthracene	SD04	1.10E+00	4.69E-02	SED_TEL	6
Anthracene	SD04	1.10E+00	8.50E-02	ER_L	23.454
Anthracene	SD04	1.10E+00	2.45E-01	SED_PEL	12.941
Anthracene	SD04	1.10E+00	3.30E-01	REG_IV	4.490
Anthracene	SD04	1.10E+00	1.10E+00	ER_M	3.333
Benzo(a)anthracene	SD02	1.80E-01	7.48E-02	SED_TEL	1.000
Benzo(a)anthracene	SD02	1.80E-01	1.58E-01	EQPSQB_A	2.406
					1.142

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Benzo(a)anthracene	SD02	1.80E-01	3.30E-01	REG_IV	0.545
Benzo(a)anthracene	SD02	1.80E-01	6.93E-01	SED_PEL	0.260
Benzo(a)anthracene	SD02	1.80E-01	1.60E+00	ER_M	0.113
Benzo(a)anthracene	SD04	5.80E+00	7.48E-02	SED_TEL	77.540
Benzo(a)anthracene	SD04	5.80E+00	2.26E-01	EQPSQB_A	25.696
Benzo(a)anthracene	SD04	5.80E+00	3.30E-01	REG_IV	17.576
Benzo(a)anthracene	SD04	5.80E+00	6.93E-01	SED_PEL	8.369
Benzo(a)anthracene	SD04	5.80E+00	1.60E+00	ER_M	3.625
Benzo(a)anthracene	SD11	1.40E-01	3.67E-02	EQPSQB_A	3.813
Benzo(a)anthracene	SD11	1.40E-01	7.48E-02	SED_TEL	1.872
Benzo(a)anthracene	SD11	1.40E-01	3.30E-01	REG_IV	0.424
Benzo(a)anthracene	SD11	1.40E-01	6.93E-01	SED_PEL	0.202
Benzo(a)anthracene	SD11	1.40E-01	1.60E+00	ER_M	0.088
Benzo(a)anthracene	SD12	1.00E-01	7.48E-02	SED_TEL	1.337
Benzo(a)anthracene	SD12	1.00E-01	2.59E-01	EQPSQB_A	0.386
Benzo(a)anthracene	SD12	1.00E-01	3.30E-01	REG_IV	0.303
Benzo(a)anthracene	SD12	1.00E-01	6.93E-01	SED_PEL	0.144
Benzo(a)anthracene	SD12	1.00E-01	1.60E+00	ER_M	0.063
Benzo(a)anthracene	SD14	9.00E-02	7.48E-02	SED_TEL	1.203
Benzo(a)anthracene	SD14	9.00E-02	1.34E-01	EQPSQB_A	0.672
Benzo(a)anthracene	SD14	9.00E-02	3.30E-01	REG_IV	0.273
Benzo(a)anthracene	SD14	9.00E-02	6.93E-01	SED_PEL	0.130
Benzo(a)anthracene	SD14	9.00E-02	1.60E+00	ER_M	0.056
Benzo(a)anthracene	SD15	3.80E-02	5.94E-02	EQPSQB_A	0.640
Benzo(a)anthracene	SD15	3.80E-02	7.48E-02	SED_TEL	0.508
Benzo(a)anthracene	SD15	3.80E-02	3.30E-01	REG_IV	0.115
Benzo(a)anthracene	SD15	3.80E-02	6.93E-01	SED_PEL	0.055
Benzo(a)anthracene	SD15	3.80E-02	1.60E+00	ER_M	0.024
Benzo(a)anthracene	SD16	1.10E-01	6.37E-02	EQPSQB_A	1.726
Benzo(a)anthracene	SD16	1.10E-01	7.48E-02	SED_TEL	1.471
Benzo(a)anthracene	SD16	1.10E-01	3.30E-01	REG_IV	0.333
Benzo(a)anthracene	SD16	1.10E-01	6.93E-01	SED_PEL	0.159

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Benzo(a)anthracene	SD16	1.10E-01	1.60E+00	ER_M	0.069
Benzo(a)anthracene	SD17	8.20E-02	7.48E-02	SED_TEL	1.096
Benzo(a)anthracene	SD17	8.20E-02	9.40E-02	EQPSQB_A	0.873
Benzo(a)anthracene	SD17	8.20E-02	3.30E-01	REG_IV	0.248
Benzo(a)anthracene	SD17	8.20E-02	6.93E-01	SED_PEL	0.118
Benzo(a)anthracene	SD17	8.20E-02	1.60E+00	ER_M	0.051
Benzo(a)pyrene	SD02	1.90E-01	8.88E-02	SED_TEL	2.140
Benzo(a)pyrene	SD02	1.90E-01	2.04E-01	EQPSQB_A	0.930
Benzo(a)pyrene	SD02	1.90E-01	3.30E-01	REG_IV	0.576
Benzo(a)pyrene	SD02	1.90E-01	4.30E-01	ER_L	0.442
Benzo(a)pyrene	SD02	1.90E-01	7.63E-01	SED_PEL	0.249
Benzo(a)pyrene	SD02	1.90E-01	1.60E+00	ER_M	0.119
Benzo(a)pyrene	SD04	4.80E+00	8.88E-02	SED_TEL	54.054
Benzo(a)pyrene	SD04	4.80E+00	2.93E-01	EQPSQB_A	16.405
Benzo(a)pyrene	SD04	4.80E+00	3.30E-01	REG_IV	14.545
Benzo(a)pyrene	SD04	4.80E+00	4.30E-01	ER_L	11.163
Benzo(a)pyrene	SD04	4.80E+00	7.63E-01	SED_PEL	6.291
Benzo(a)pyrene	SD04	4.80E+00	1.60E+00	ER_M	3.000
Benzo(a)pyrene	SD07	2.60E-02	8.88E-02	SED_TEL	0.293
Benzo(a)pyrene	SD07	2.60E-02	1.01E-01	EQPSQB_A	0.258
Benzo(a)pyrene	SD07	2.60E-02	3.30E-01	REG_IV	0.079
Benzo(a)pyrene	SD07	2.60E-02	4.30E-01	ER_L	0.060
Benzo(a)pyrene	SD07	2.60E-02	7.63E-01	SED_PEL	0.034
Benzo(a)pyrene	SD07	2.60E-02	1.60E+00	ER_M	0.016
Benzo(a)pyrene	SD11	1.10E-01	4.76E-02	EQPSQB_A	2.311
Benzo(a)pyrene	SD11	1.10E-01	8.88E-02	SED_TEL	1.239
Benzo(a)pyrene	SD11	1.10E-01	3.30E-01	REG_IV	0.333
Benzo(a)pyrene	SD11	1.10E-01	4.30E-01	ER_L	0.256
Benzo(a)pyrene	SD11	1.10E-01	7.63E-01	SED_PEL	0.144
Benzo(a)pyrene	SD11	1.10E-01	1.60E+00	ER_M	0.069
Benzo(a)pyrene	SD14	6.50E-02	8.88E-02	SED_TEL	0.732
Benzo(a)pyrene	SD14	6.50E-02	1.74E-01	EQPSQB_A	0.374

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Benzo(a)pyrene	SD14	6.50E-02	3.30E-01	REG_IV	0.197
Benzo(a)pyrene	SD14	6.50E-02	4.30E-01	ER_L	0.151
Benzo(a)pyrene	SD14	6.50E-02	7.63E-01	SED_PEL	0.085
Benzo(a)pyrene	SD14	6.50E-02	1.60E+00	ER_M	0.041
Benzo(a)pyrene	SD15	4.50E-02	7.70E-02	EQPSQB_A	0.584
Benzo(a)pyrene	SD15	4.50E-02	8.88E-02	SED_TEL	0.507
Benzo(a)pyrene	SD15	4.50E-02	3.30E-01	REG_IV	0.136
Benzo(a)pyrene	SD15	4.50E-02	4.30E-01	ER_L	0.105
Benzo(a)pyrene	SD15	4.50E-02	7.63E-01	SED_PEL	0.059
Benzo(a)pyrene	SD15	4.50E-02	1.60E+00	ER_M	0.028
Benzo(a)pyrene	SD16	7.90E-02	8.26E-02	EQPSQB_A	0.956
Benzo(a)pyrene	SD16	7.90E-02	8.88E-02	SED_TEL	0.890
Benzo(a)pyrene	SD16	7.90E-02	3.30E-01	REG_IV	0.239
Benzo(a)pyrene	SD16	7.90E-02	4.30E-01	ER_L	0.184
Benzo(a)pyrene	SD16	7.90E-02	7.63E-01	SED_PEL	0.104
Benzo(a)pyrene	SD16	7.90E-02	1.60E+00	ER_M	0.049
Bis(2-ethylhexyl)phthalate	SD02	9.20E-01	1.82E-01	SED_TEL	5.055
Bis(2-ethylhexyl)phthalate	SD02	9.20E-01	2.65E+00	SED_PEL	0.348
Bis(2-ethylhexyl)phthalate	SD02	9.20E-01	1.30E+06	EQPSQB_A	0.000
Bis(2-ethylhexyl)phthalate	SD06	7.40E-02	1.82E-01	SED_TEL	0.407
Bis(2-ethylhexyl)phthalate	SD06	7.40E-02	2.65E+00	SED_PEL	0.028
Bis(2-ethylhexyl)phthalate	SD06	7.40E-02	6.76E+05	EQPSQB_A	0.000
Bis(2-ethylhexyl)phthalate	SD07	4.90E-02	1.82E-01	SED_TEL	0.269
Bis(2-ethylhexyl)phthalate	SD07	4.90E-02	2.65E+00	SED_PEL	0.019
Bis(2-ethylhexyl)phthalate	SD07	4.90E-02	6.41E+05	EQPSQB_A	0.000
Bis(2-ethylhexyl)phthalate	SD09	1.20E-01	1.82E-01	SED_TEL	0.659
Bis(2-ethylhexyl)phthalate	SD09	1.20E-01	2.65E+00	SED_PEL	0.045
Bis(2-ethylhexyl)phthalate	SD09	1.20E-01	7.39E+05	EQPSQB_A	0.000
Bis(2-ethylhexyl)phthalate	SD14	1.30E-01	1.82E-01	SED_TEL	0.714
Bis(2-ethylhexyl)phthalate	SD14	1.30E-01	2.65E+00	SED_PEL	0.049
Bis(2-ethylhexyl)phthalate	SD14	1.30E-01	1.10E+06	EQPSQB_A	0.000

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Bis(2-ethylhexyl)phthalate	SD15	3.20E-02	1.82E-01	SED_TEL	0.176
Bis(2-ethylhexyl)phthalate	SD15	3.20E-02	2.65E+00	SED_PEL	0.012
Bis(2-ethylhexyl)phthalate	SD15	3.20E-02	4.90E+05	EQPSQB_A	0.000
Bis(2-ethylhexyl)phthalate	SD17	6.40E-02	1.82E-01	SED_TEL	0.352
Bis(2-ethylhexyl)phthalate	SD17	6.40E-02	2.65E+00	SED_PEL	0.024
Bis(2-ethylhexyl)phthalate	SD17	6.40E-02	7.74E+05	EQPSQB_A	0.000
Chlordane, total	SD01	2.78E-03	5.00E-04	ER_L	5.560
Chlordane, total	SD01	2.78E-03	1.70E-03	REG_IV	1.635
Chlordane, total	SD01	2.78E-03	2.26E-03	SED_TEL	1.230
Chlordane, total	SD01	2.78E-03	4.79E-03	SED_PEL	0.580
Chlordane, total	SD01	2.78E-03	6.00E-03	ER_M	0.463
Chlordane, total	SD01	2.78E-03	9.61E-02	EQPSQB_A	0.029
Chlordane, total	SD02	7.90E-04	5.00E-04	ER_L	1.580
Chlordane, total	SD02	7.90E-04	1.70E-03	REG_IV	0.465
Chlordane, total	SD02	7.90E-04	2.26E-03	SED_TEL	0.350
Chlordane, total	SD02	7.90E-04	4.79E-03	SED_PEL	0.165
Chlordane, total	SD02	7.90E-04	6.00E-03	ER_M	0.132
Chlordane, total	SD02	7.90E-04	6.38E-01	EQPSQB_A	0.001
Chlordane, total	SD04	5.30E-03	5.00E-04	ER_L	10.600
Chlordane, total	SD04	5.30E-03	1.70E-03	REG_IV	3.118
Chlordane, total	SD04	5.30E-03	2.26E-03	SED_TEL	2.345
Chlordane, total	SD04	5.30E-03	4.79E-03	SED_PEL	1.106
Chlordane, total	SD04	5.30E-03	6.00E-03	ER_M	0.883
Chlordane, total	SD04	5.30E-03	9.13E-01	EQPSQB_A	0.006
Chlordane, total	SD05	3.33E-03	5.00E-04	ER_L	6.660
Chlordane, total	SD05	3.33E-03	1.70E-03	REG_IV	1.959
Chlordane, total	SD05	3.33E-03	2.26E-03	SED_TEL	1.473
Chlordane, total	SD05	3.33E-03	4.79E-03	SED_PEL	0.695
Chlordane, total	SD05	3.33E-03	6.00E-03	ER_M	0.555
Chlordane, total	SD05	3.33E-03	2.84E-01	EQPSQB_A	0.012
Chlordane, total	SD07	2.53E-03	5.00E-04	ER_L	5.060
Chlordane, total	SD07	2.53E-03	1.70E-03	REG_IV	1.488

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Chlordane, total	SD07	2.53E-03	2.26E-03	SED_TEL	1.119
Chlordane, total	SD07	2.53E-03	4.79E-03	SED_PEL	0.528
Chlordane, total	SD07	2.53E-03	6.00E-03	ER_M	0.422
Chlordane, total	SD07	2.53E-03	3.15E-01	EQPSQB_A	0.008
Chlordane, total	SD10	2.98E-03	5.00E-04	ER_L	5.960
Chlordane, total	SD10	2.98E-03	1.70E-03	REG_IV	1.753
Chlordane, total	SD10	2.98E-03	2.26E-03	SED_TEL	1.319
Chlordane, total	SD10	2.98E-03	4.79E-03	SED_PEL	0.622
Chlordane, total	SD10	2.98E-03	6.00E-03	ER_M	0.497
Chlordane, total	SD10	2.98E-03	1.88E-01	EQPSQB_A	0.016
Chlordane, total	SD13	5.80E-04	5.00E-04	ER_L	1.160
Chlordane, total	SD13	5.80E-04	1.70E-03	REG_IV	0.341
Chlordane, total	SD13	5.80E-04	2.26E-03	SED_TEL	0.257
Chlordane, total	SD13	5.80E-04	4.79E-03	SED_PEL	0.121
Chlordane, total	SD13	5.80E-04	6.00E-03	ER_M	0.097
Chlordane, total	SD13	5.80E-04	1.59E+00	EQPSQB_A	0.000
Chlordane, total	SD14	1.91E-04	5.00E-04	ER_L	0.382
Chlordane, total	SD14	1.91E-04	1.70E-03	REG_IV	0.112
Chlordane, total	SD14	1.91E-04	2.26E-03	SED_TEL	0.085
Chlordane, total	SD14	1.91E-04	4.79E-03	SED_PEL	0.040
Chlordane, total	SD14	1.91E-04	6.00E-03	ER_M	0.032
Chlordane, total	SD14	1.91E-04	5.42E-01	EQPSQB_A	0.000
Chlordane, total	SD15	1.59E-04	5.00E-04	ER_L	0.318
Chlordane, total	SD15	1.59E-04	1.70E-03	REG_IV	0.094
Chlordane, total	SD15	1.59E-04	2.26E-03	SED_TEL	0.070
Chlordane, total	SD15	1.59E-04	4.79E-03	SED_PEL	0.033
Chlordane, total	SD15	1.59E-04	6.00E-03	ER_M	0.027
Chlordane, total	SD15	1.59E-04	2.40E-01	EQPSQB_A	0.001
Chlordane, total	SD17	3.25E-03	5.00E-04	ER_L	6.500
Chlordane, total	SD17	3.25E-03	1.70E-03	REG_IV	1.912
Chlordane, total	SD17	3.25E-03	2.26E-03	SED_TEL	1.438
Chlordane, total	SD17	3.25E-03	4.79E-03	SED_PEL	0.678

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Chlordane, total	SD17	3.25E-03	6.00E-03	ER_M	0.542
Chlordane, total	SD17	3.25E-03	3.80E-01	EQPSQB_A	0.009
Chlordane, total	SD18	2.74E-03	5.00E-04	ER_L	5.480
Chlordane, total	SD18	2.74E-03	1.70E-03	REG_IV	1.612
Chlordane, total	SD18	2.74E-03	2.26E-03	SED_TEL	1.212
Chlordane, total	SD18	2.74E-03	4.79E-03	SED_PEL	0.572
Chlordane, total	SD18	2.74E-03	6.00E-03	ER_M	0.457
Chlordane, total	SD18	2.74E-03	4.37E-01	EQPSQB_A	0.006
Chrysene	SD02	1.70E-01	1.08E-01	SED_TEL	1.574
Chrysene	SD02	1.70E-01	3.30E-01	REG_IV	0.515
Chrysene	SD02	1.70E-01	3.80E-01	ER_L	0.447
Chrysene	SD02	1.70E-01	8.46E-01	SED_PEL	0.201
Chrysene	SD02	1.70E-01	2.80E+00	ER_M	0.061
Chrysene	SD04	5.80E+00	1.08E-01	SED_TEL	53.704
Chrysene	SD04	5.80E+00	3.30E-01	REG_IV	17.576
Chrysene	SD04	5.80E+00	3.80E-01	ER_L	15.263
Chrysene	SD04	5.80E+00	8.46E-01	SED_PEL	6.856
Chrysene	SD04	5.80E+00	2.80E+00	ER_M	2.071
Chrysene	SD11	1.50E-01	1.08E-01	SED_TEL	1.389
Chrysene	SD11	1.50E-01	3.30E-01	REG_IV	0.455
Chrysene	SD11	1.50E-01	3.80E-01	ER_L	0.395
Chrysene	SD11	1.50E-01	8.46E-01	SED_PEL	0.177
Chrysene	SD11	1.50E-01	2.80E+00	ER_M	0.054
Chrysene	SD12	9.80E-02	1.08E-01	SED_TEL	0.907
Chrysene	SD12	9.80E-02	3.30E-01	REG_IV	0.297
Chrysene	SD12	9.80E-02	3.80E-01	ER_L	0.258
Chrysene	SD12	9.80E-02	8.46E-01	SED_PEL	0.116
Chrysene	SD12	9.80E-02	2.80E+00	ER_M	0.035
Chrysene	SD14	6.50E-02	1.08E-01	SED_TEL	0.602
Chrysene	SD14	6.50E-02	3.30E-01	REG_IV	0.197
Chrysene	SD14	6.50E-02	3.80E-01	ER_L	0.171
Chrysene	SD14	6.50E-02	8.46E-01	SED_PEL	0.077

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Chrysene	SD14	6.50E-02	2.80E+00	ER_M	0.023
Chrysene	SD15	3.60E-02	1.08E-01	SED_TEL	0.333
Chrysene	SD15	3.60E-02	3.30E-01	REG_IV	0.109
Chrysene	SD15	3.60E-02	3.80E-01	ER_L	0.095
Chrysene	SD15	3.60E-02	8.46E-01	SED_PEL	0.043
Chrysene	SD15	3.60E-02	2.80E+00	ER_M	0.013
Chrysene	SD16	9.70E-02	1.08E-01	SED_TEL	0.898
Chrysene	SD16	9.70E-02	3.30E-01	REG_IV	0.294
Chrysene	SD16	9.70E-02	3.80E-01	ER_L	0.255
Chrysene	SD16	9.70E-02	8.46E-01	SED_PEL	0.115
Chrysene	SD16	9.70E-02	2.80E+00	ER_M	0.035
Dibenz(a,h)anthracene	SD04	3.50E-01	6.22E-03	SED_TEL	56.270
Dibenz(a,h)anthracene	SD04	3.50E-01	6.30E-02	ER_L	5.556
Dibenz(a,h)anthracene	SD04	3.50E-01	1.35E-01	SED_PEL	2.593
Dibenz(a,h)anthracene	SD04	3.50E-01	2.60E-01	ER_M	1.346
Dibenz(a,h)anthracene	SD04	3.50E-01	3.30E-01	REG_IV	1.061
Dieldrin	SD04	3.00E-03	2.00E-05	ER_L	150.000
Dieldrin	SD04	3.00E-03	7.15E-04	SED_TEL	4.196
Dieldrin	SD04	3.00E-03	3.30E-03	REG_IV	0.909
Dieldrin	SD04	3.00E-03	4.30E-03	SED_PEL	0.698
Dieldrin	SD04	3.00E-03	8.00E-03	ER_M	0.375
Dieldrin	SD04	3.00E-03	2.30E-01	EPASQC_A	0.013
Dieldrin	SD08	1.20E-02	2.00E-05	ER_L	600.000
Dieldrin	SD08	1.20E-02	7.15E-04	SED_TEL	16.783
Dieldrin	SD08	1.20E-02	3.30E-03	REG_IV	3.636
Dieldrin	SD08	1.20E-02	4.30E-03	SED_PEL	2.791
Dieldrin	SD08	1.20E-02	8.00E-03	ER_M	1.500
Dieldrin	SD08	1.20E-02	1.36E-01	EPASQC_A	0.088
Endrin, total	SD01	1.07E-02	2.00E-05	ER_L	535.500
Endrin, total	SD01	1.07E-02	3.30E-03	REG_IV	3.245
Endrin, total	SD01	1.07E-02	9.24E-03	EPASQC_A	1.159
Endrin, total	SD01	1.07E-02	4.50E-02	ER_M	0.238

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Endrin, total	SD02	2.19E-02	2.00E-05	ER_L	1095.000
Endrin, total	SD02	2.19E-02	3.30E-03	REG_IV	6.636
Endrin, total	SD02	2.19E-02	4.50E-02	ER_M	0.487
Endrin, total	SD02	2.19E-02	6.13E-02	EPASQC_A	0.357
Endrin, total	SD03	6.11E-03	2.00E-05	ER_L	305.500
Endrin, total	SD03	6.11E-03	3.30E-03	REG_IV	1.852
Endrin, total	SD03	6.11E-03	2.52E-02	EPASQC_A	0.242
Endrin, total	SD03	6.11E-03	4.50E-02	ER_M	0.136
Endrin, total	SD05	1.49E-02	2.00E-05	ER_L	745.000
Endrin, total	SD05	1.49E-02	3.30E-03	REG_IV	4.515
Endrin, total	SD05	1.49E-02	2.73E-02	EPASQC_A	0.546
Endrin, total	SD05	1.49E-02	4.50E-02	ER_M	0.331
Endrin, total	SD06	6.44E-03	2.00E-05	ER_L	322.000
Endrin, total	SD06	6.44E-03	3.30E-03	REG_IV	1.952
Endrin, total	SD06	6.44E-03	3.19E-02	EPASQC_A	0.202
Endrin, total	SD06	6.44E-03	4.50E-02	ER_M	0.143
Endrin, total	SD07	1.23E-02	2.00E-05	ER_L	615.000
Endrin, total	SD07	1.23E-02	3.30E-03	REG_IV	3.727
Endrin, total	SD07	1.23E-02	3.02E-02	EPASQC_A	0.407
Endrin, total	SD07	1.23E-02	4.50E-02	ER_M	0.273
Endrin, total	SD08	1.50E-02	2.00E-05	ER_L	750.000
Endrin, total	SD08	1.50E-02	3.30E-03	REG_IV	4.545
Endrin, total	SD08	1.50E-02	4.50E-02	ER_M	0.333
Endrin, total	SD08	1.50E-02	5.21E-02	EPASQC_A	0.288
Endrin, total	SD10	1.84E-02	2.00E-05	ER_L	920.000
Endrin, total	SD10	1.84E-02	3.30E-03	REG_IV	5.576
Endrin, total	SD10	1.84E-02	1.81E-02	EPASQC_A	1.019
Endrin, total	SD10	1.84E-02	4.50E-02	ER_M	0.409
Endrin, total	SD12	9.48E-03	2.00E-05	ER_L	474.000
Endrin, total	SD12	9.48E-03	3.30E-03	REG_IV	2.873
Endrin, total	SD12	9.48E-03	4.50E-02	ER_M	0.211

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Endrin, total	SD12	9.48E-03	1.01E-01	EPASQC_A	0.094
Endrin, total	SD13	1.38E-02	2.00E-05	ER_L	690.500
Endrin, total	SD13	1.38E-02	3.30E-03	REG_IV	4.185
Endrin, total	SD13	1.38E-02	4.50E-02	ER_M	0.307
Endrin, total	SD13	1.38E-02	1.53E-01	EPASQC_A	0.090
Endrin, total	SD14	1.19E-02	2.00E-05	ER_L	595.000
Endrin, total	SD14	1.19E-02	3.30E-03	REG_IV	3.606
Endrin, total	SD14	1.19E-02	4.50E-02	ER_M	0.264
Endrin, total	SD14	1.19E-02	5.21E-02	EPASQC_A	0.228
Endrin, total	SD15	1.19E-02	2.00E-05	ER_L	595.000
Endrin, total	SD15	1.19E-02	3.30E-03	REG_IV	3.606
Endrin, total	SD15	1.19E-02	2.31E-02	EPASQC_A	0.515
Endrin, total	SD15	1.19E-02	4.50E-02	ER_M	0.264
Endrin, total	SD16	1.14E-02	2.00E-05	ER_L	570.000
Endrin, total	SD16	1.14E-02	3.30E-03	REG_IV	3.455
Endrin, total	SD16	1.14E-02	2.48E-02	EPASQC_A	0.460
Endrin, total	SD16	1.14E-02	4.50E-02	ER_M	0.253
Endrin, total	SD17	1.71E-02	2.00E-05	ER_L	855.000
Endrin, total	SD17	1.71E-02	3.30E-03	REG_IV	5.182
Endrin, total	SD17	1.71E-02	3.65E-02	EPASQC_A	0.468
Endrin, total	SD17	1.71E-02	4.50E-02	ER_M	0.380
Endrin, total	SD18	9.81E-03	2.00E-05	ER_L	490.500
Endrin, total	SD18	9.81E-03	3.30E-03	REG_IV	2.973
Endrin, total	SD18	9.81E-03	4.20E-02	EPASQC_A	0.234
Endrin, total	SD18	9.81E-03	4.50E-02	ER_M	0.218
Fluoranthene	SD02	2.30E-01	1.13E-01	SED_TEL	2.035
Fluoranthene	SD02	2.30E-01	3.80E-01	REG_IV	0.605
Fluoranthene	SD02	2.30E-01	6.00E-01	ER_L	0.383
Fluoranthene	SD02	2.30E-01	1.49E+00	SED_PEL	0.154
Fluoranthene	SD02	2.30E-01	5.10E+00	ER_M	0.045
Fluoranthene	SD02	2.30E-01	9.05E+00	EPASQC_A	0.025
Fluoranthene	SD04	1.20E+01	1.13E-01	SED_TEL	106.195

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Fluoranthene	SD04	1.20E+01	3.80E-01	REG_IV	31.579
Fluoranthene	SD04	1.20E+01	6.00E-01	ER_L	20.000
Fluoranthene	SD04	1.20E+01	1.49E+00	SED_PEL	8.032
Fluoranthene	SD04	1.20E+01	5.10E+00	ER_M	2.353
Fluoranthene	SD04	1.20E+01	1.30E+01	EPASQC_A	0.926
Fluoranthene	SD07	4.50E-02	1.13E-01	SED_TEL	0.398
Fluoranthene	SD07	4.50E-02	3.80E-01	REG_IV	0.118
Fluoranthene	SD07	4.50E-02	6.00E-01	ER_L	0.075
Fluoranthene	SD07	4.50E-02	1.49E+00	SED_PEL	0.030
Fluoranthene	SD07	4.50E-02	4.46E+00	EPASQC_A	0.010
Fluoranthene	SD07	4.50E-02	5.10E+00	ER_M	0.009
Fluoranthene	SD11	2.60E-01	1.13E-01	SED_TEL	2.301
Fluoranthene	SD11	2.60E-01	3.80E-01	REG_IV	0.684
Fluoranthene	SD11	2.60E-01	6.00E-01	ER_L	0.433
Fluoranthene	SD11	2.60E-01	1.49E+00	SED_PEL	0.174
Fluoranthene	SD11	2.60E-01	2.11E+00	EPASQC_A	0.123
Fluoranthene	SD11	2.60E-01	5.10E+00	ER_M	0.051
Fluoranthene	SD12	1.50E-01	1.13E-01	SED_TEL	1.327
Fluoranthene	SD12	1.50E-01	3.80E-01	REG_IV	0.395
Fluoranthene	SD12	1.50E-01	6.00E-01	ER_L	0.250
Fluoranthene	SD12	1.50E-01	1.49E+00	SED_PEL	0.100
Fluoranthene	SD12	1.50E-01	5.10E+00	ER_M	0.029
Fluoranthene	SD12	1.50E-01	1.49E+01	EPASQC_A	0.010
Fluoranthene	SD14	1.10E-01	1.13E-01	SED_TEL	0.973
Fluoranthene	SD14	1.10E-01	3.80E-01	REG_IV	0.289
Fluoranthene	SD14	1.10E-01	6.00E-01	ER_L	0.183
Fluoranthene	SD14	1.10E-01	1.49E+00	SED_PEL	0.074
Fluoranthene	SD14	1.10E-01	5.10E+00	ER_M	0.022
Fluoranthene	SD14	1.10E-01	7.69E+00	EPASQC_A	0.014
Fluoranthene	SD15	6.20E-02	1.13E-01	SED_TEL	0.549
Fluoranthene	SD15	6.20E-02	3.80E-01	REG_IV	0.163
Fluoranthene	SD15	6.20E-02	6.00E-01	ER_L	0.103

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Fluoranthene	SD15	6.20E-02	1.49E+00	SED_PEL	0.041
Fluoranthene	SD15	6.20E-02	3.41E+00	EPASQC_A	0.018
Fluoranthene	SD15	6.20E-02	5.10E+00	ER_M	0.012
Fluoranthene	SD16	1.90E-01	1.13E-01	SED_TEL	1.681
Fluoranthene	SD16	1.90E-01	3.80E-01	REG_IV	0.500
Fluoranthene	SD16	1.90E-01	6.00E-01	ER_L	0.317
Fluoranthene	SD16	1.90E-01	1.49E+00	SED_PEL	0.127
Fluoranthene	SD16	1.90E-01	3.66E+00	EPASQC_A	0.052
Fluoranthene	SD16	1.90E-01	5.10E+00	ER_M	0.037
Fluoranthene	SD17	1.10E-01	1.13E-01	SED_TEL	0.973
Fluoranthene	SD17	1.10E-01	3.80E-01	REG_IV	0.289
Fluoranthene	SD17	1.10E-01	6.00E-01	ER_L	0.183
Fluoranthene	SD17	1.10E-01	1.49E+00	SED_PEL	0.074
Fluoranthene	SD17	1.10E-01	5.10E+00	ER_M	0.022
Fluoranthene	SD17	1.10E-01	5.39E+00	EPASQC_A	0.020
Fluorene	SD04	2.90E-01	1.90E-02	ER_L	15.263
Fluorene	SD04	2.90E-01	2.12E-02	SED_TEL	13.679
Fluorene	SD04	2.90E-01	1.44E-01	SED_PEL	2.014
Fluorene	SD04	2.90E-01	3.30E-01	REG_IV	0.879
Fluorene	SD04	2.90E-01	5.40E-01	ER_M	0.537
Naphthalene	SD04	8.80E-02	3.46E-02	SED_TEL	2.543
Naphthalene	SD04	8.80E-02	1.60E-01	ER_L	0.550
Naphthalene	SD04	8.80E-02	3.30E-01	REG_IV	0.267
Naphthalene	SD04	8.80E-02	3.91E-01	SED_PEL	0.225
Naphthalene	SD04	8.80E-02	8.51E-01	EQPSQB_A	0.103
Naphthalene	SD04	8.80E-02	2.10E+00	ER_M	0.042
PAH, total	SD02	8.05E+00	1.68E+00	SED_TEL	4.780
PAH, total	SD02	8.05E+00	2.90E+00	REG_IV	2.776
PAH, total	SD02	8.05E+00	4.03E+00	ER_L	1.999
PAH, total	SD02	8.05E+00	1.68E+01	SED_PEL	0.480
PAH, total	SD02	8.05E+00	4.48E+01	ER_M	0.180
PAH, total	SD04	6.75E+01	1.68E+00	SED_TEL	40.100

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
PAH, total	SD04	6.75E+01	2.90E+00	REG_IV	23.286
PAH, total	SD04	6.75E+01	4.03E+00	ER_L	16.769
PAH, total	SD04	6.75E+01	1.68E+01	SED_PEL	4.027
PAH, total	SD04	6.75E+01	4.48E+01	ER_M	1.508
PAH, total	SD07	6.47E+00	1.68E+00	SED_TEL	3.842
PAH, total	SD07	6.47E+00	2.90E+00	REG_IV	2.231
PAH, total	SD07	6.47E+00	4.03E+00	ER_L	1.607
PAH, total	SD07	6.47E+00	1.68E+01	SED_PEL	0.386
PAH, total	SD07	6.47E+00	4.48E+01	ER_M	0.144
PAH, total	SD11	5.67E+00	1.68E+00	SED_TEL	3.368
PAH, total	SD11	5.67E+00	2.90E+00	REG_IV	1.956
PAH, total	SD11	5.67E+00	4.03E+00	ER_L	1.408
PAH, total	SD11	5.67E+00	1.68E+01	SED_PEL	0.338
PAH, total	SD11	5.67E+00	4.48E+01	ER_M	0.127
PAH, total	SD12	8.89E+00	1.68E+00	SED_TEL	5.281
PAH, total	SD12	8.89E+00	2.90E+00	REG_IV	3.067
PAH, total	SD12	8.89E+00	4.03E+00	ER_L	2.208
PAH, total	SD12	8.89E+00	1.68E+01	SED_PEL	0.530
PAH, total	SD12	8.89E+00	4.48E+01	ER_M	0.199
PAH, total	SD14	6.05E+00	1.68E+00	SED_TEL	3.590
PAH, total	SD14	6.05E+00	2.90E+00	REG_IV	2.084
PAH, total	SD14	6.05E+00	4.03E+00	ER_L	1.501
PAH, total	SD14	6.05E+00	1.68E+01	SED_PEL	0.360
PAH, total	SD14	6.05E+00	4.48E+01	ER_M	0.135
PAH, total	SD15	5.66E+00	1.68E+00	SED_TEL	3.361
PAH, total	SD15	5.66E+00	2.90E+00	REG_IV	1.952
PAH, total	SD15	5.66E+00	4.03E+00	ER_L	1.406
PAH, total	SD15	5.66E+00	1.68E+01	SED_PEL	0.338
PAH, total	SD15	5.66E+00	4.48E+01	ER_M	0.126
PAH, total	SD16	4.96E+00	1.68E+00	SED_TEL	2.948
PAH, total	SD16	4.96E+00	2.90E+00	REG_IV	1.712
PAH, total	SD16	4.96E+00	4.03E+00	ER_L	1.233

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
PAH, total	SD16	4.96E+00	1.68E+01	SED_PEL	0.296
PAH, total	SD16	4.96E+00	4.48E+01	ER_M	0.111
PAH, total	SD17	8.41E+00	1.68E+00	SED_TEL	4.992
PAH, total	SD17	8.41E+00	2.90E+00	REG_IV	2.899
PAH, total	SD17	8.41E+00	4.03E+00	ER_L	2.088
PAH, total	SD17	8.41E+00	1.68E+01	SED_PEL	0.501
PAH, total	SD17	8.41E+00	4.48E+01	ER_M	0.188
PCB-1254	SD04	7.10E-01	2.30E-02	ER_L	30.870
PCB-1254	SD04	7.10E-01	1.80E-01	ER_M	3.944
PCB-1254	SD04	7.10E-01	3.55E-01	EQPSQB_A	1.998
PCB-1254	SD10	1.20E+00	2.30E-02	ER_L	52.174
PCB-1254	SD10	1.20E+00	7.31E-02	EQPSQB_A	16.416
PCB-1254	SD10	1.20E+00	1.80E-01	ER_M	6.667
PCB-1254	SD11	2.80E-01	2.30E-02	ER_L	12.174
PCB-1254	SD11	2.80E-01	5.78E-02	EQPSQB_A	4.844
PCB-1254	SD11	2.80E-01	1.80E-01	ER_M	1.556
PCB-1254	SD18	1.70E-02	2.30E-02	ER_L	0.739
PCB-1254	SD18	1.70E-02	1.70E-01	EQPSQB_A	0.100
PCB-1254	SD18	1.70E-02	1.80E-01	ER_M	0.094
PCB-1260	SD02	1.20E-01	2.30E-02	ER_L	5.217
PCB-1260	SD02	1.20E-01	1.80E-01	ER_M	0.667
PCB-1260	SD02	1.20E-01	1.60E+03	EQPSQB_A	0.000
PCB-1260	SD04	4.70E-01	2.30E-02	ER_L	20.435
PCB-1260	SD04	4.70E-01	1.80E-01	ER_M	2.611
PCB-1260	SD04	4.70E-01	2.30E+03	EQPSQB_A	0.000
PCB-1260	SD05	9.80E-02	2.30E-02	ER_L	4.261
PCB-1260	SD05	9.80E-02	1.80E-01	ER_M	0.544
PCB-1260	SD05	9.80E-02	7.14E+02	EQPSQB_A	0.000
PCB-1260	SD06	2.50E-02	2.30E-02	ER_L	1.087
PCB-1260	SD06	2.50E-02	1.80E-01	ER_M	0.139
PCB-1260	SD06	2.50E-02	8.35E+02	EQPSQB_A	0.000
PCB-1260	SD07	5.90E-02	2.30E-02	ER_L	2.565

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
PCB-1260	SD07	5.90E-02	1.80E-01	ER_M	0.328
PCB-1260	SD07	5.90E-02	7.91E+02	EQPSQB_A	0.000
PCB-1260	SD08	4.30E-01	2.30E-02	ER_L	18.696
PCB-1260	SD08	4.30E-01	1.80E-01	ER_M	2.389
PCB-1260	SD08	4.30E-01	1.36E+03	EQPSQB_A	0.000
PCB-1260	SD09	2.50E+00	2.30E-02	ER_L	108.696
PCB-1260	SD09	2.50E+00	1.80E-01	ER_M	13.889
PCB-1260	SD09	2.50E+00	9.12E+02	EQPSQB_A	0.003
PCB-1260	SD11	2.40E-01	2.30E-02	ER_L	10.435
PCB-1260	SD11	2.40E-01	1.80E-01	ER_M	1.333
PCB-1260	SD11	2.40E-01	3.74E+02	EQPSQB_A	0.001
PCB-1260	SD14	2.40E-02	2.30E-02	ER_L	1.043
PCB-1260	SD14	2.40E-02	1.80E-01	ER_M	0.133
PCB-1260	SD14	2.40E-02	1.36E+03	EQPSQB_A	0.000
PCB-1260	SD15	3.80E-02	2.30E-02	ER_L	1.652
PCB-1260	SD15	3.80E-02	1.80E-01	ER_M	0.211
PCB-1260	SD15	3.80E-02	6.04E+02	EQPSQB_A	0.000
PCB-1260	SD16	3.90E-02	2.30E-02	ER_L	1.696
PCB-1260	SD16	3.90E-02	1.80E-01	ER_M	0.217
PCB-1260	SD16	3.90E-02	6.48E+02	EQPSQB_A	0.000
PCB-1260	SD17	1.10E-01	2.30E-02	ER_L	4.783
PCB-1260	SD17	1.10E-01	1.80E-01	ER_M	0.611
PCB-1260	SD17	1.10E-01	9.56E+02	EQPSQB_A	0.000
Phenanthrene	SD02	1.00E-01	8.67E-02	SED_TEL	1.153
Phenanthrene	SD02	1.00E-01	2.40E-01	ER_L	0.417
Phenanthrene	SD02	1.00E-01	3.30E-01	REG_IV	0.303
Phenanthrene	SD02	1.00E-01	5.44E-01	SED_PEL	0.184
Phenanthrene	SD02	1.00E-01	1.50E+00	ER_M	0.067
Phenanthrene	SD02	1.00E-01	2.63E+00	EPASQC_A	0.038
Phenanthrene	SD04	6.90E+00	8.67E-02	SED_TEL	79.585
Phenanthrene	SD04	6.90E+00	2.40E-01	ER_L	28.750
Phenanthrene	SD04	6.90E+00	3.30E-01	REG_IV	20.909

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Phenanthrene	SD04	6.90E+00	5.44E-01	SED_PEL	12.684
Phenanthrene	SD04	6.90E+00	1.50E+00	ER_M	0.067
Phenanthrene	SD04	6.90E+00	3.76E+00	EPASQC_A	1.834
Phenanthrene	SD11	1.50E-01	8.67E-02	SED_TEL	1.730
Phenanthrene	SD11	1.50E-01	2.40E-01	ER_L	0.625
Phenanthrene	SD11	1.50E-01	3.30E-01	REG_IV	0.455
Phenanthrene	SD11	1.50E-01	5.44E-01	SED_PEL	0.276
Phenanthrene	SD11	1.50E-01	6.12E-01	EPASQC_A	0.245
Phenanthrene	SD11	1.50E-01	1.50E+00	ER_M	0.067
Phenanthrene	SD12	8.50E-02	8.67E-02	SED_TEL	0.980
Phenanthrene	SD12	8.50E-02	2.40E-01	ER_L	0.354
Phenanthrene	SD12	8.50E-02	3.30E-01	REG_IV	0.258
Phenanthrene	SD12	8.50E-02	5.44E-01	SED_PEL	0.156
Phenanthrene	SD12	8.50E-02	1.50E+00	ER_M	0.067
Phenanthrene	SD12	8.50E-02	4.32E+00	EPASQC_A	0.020
Phenanthrene	SD14	8.50E-02	8.67E-02	SED_TEL	0.980
Phenanthrene	SD14	8.50E-02	2.40E-01	ER_L	0.354
Phenanthrene	SD14	8.50E-02	3.30E-01	REG_IV	0.258
Phenanthrene	SD14	8.50E-02	5.44E-01	SED_PEL	0.156
Phenanthrene	SD14	8.50E-02	1.50E+00	ER_M	0.067
Phenanthrene	SD14	8.50E-02	2.23E+00	EPASQC_A	0.038
Phenanthrene	SD16	7.20E-02	8.67E-02	SED_TEL	0.830
Phenanthrene	SD16	7.20E-02	2.40E-01	ER_L	0.300
Phenanthrene	SD16	7.20E-02	3.30E-01	REG_IV	0.218
Phenanthrene	SD16	7.20E-02	5.44E-01	SED_PEL	0.132
Phenanthrene	SD16	7.20E-02	1.06E+00	EPASQC_A	0.068
Phenanthrene	SD16	7.20E-02	1.50E+00	ER_M	0.067
Pyrene	SD02	2.20E-01	1.53E-01	SED_TEL	1.438
Pyrene	SD02	2.20E-01	3.30E-01	REG_IV	0.667
Pyrene	SD02	2.20E-01	6.60E-01	ER_L	0.333
Pyrene	SD02	2.20E-01	1.40E+00	SED_PEL	0.157
Pyrene	SD02	2.20E-01	2.60E+00	ER_M	0.085

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Pyrene	SD04	8.60E+00	1.53E-01	SED_TEL	56.209
Pyrene	SD04	8.60E+00	3.30E-01	REG_IV	26.061
Pyrene	SD04	8.60E+00	6.60E-01	ER_L	13.030
Pyrene	SD04	8.60E+00	1.40E+00	SED_PEL	6.152
Pyrene	SD04	8.60E+00	2.60E+00	ER_M	3.308
Pyrene	SD07	4.40E-02	1.53E-01	SED_TEL	0.288
Pyrene	SD07	4.40E-02	3.30E-01	REG_IV	0.133
Pyrene	SD07	4.40E-02	6.60E-01	ER_L	0.067
Pyrene	SD07	4.40E-02	1.40E+00	SED_PEL	0.031
Pyrene	SD07	4.40E-02	2.60E+00	ER_M	0.017
Pyrene	SD11	2.40E-01	1.53E-01	SED_TEL	1.569
Pyrene	SD11	2.40E-01	3.30E-01	REG_IV	0.727
Pyrene	SD11	2.40E-01	6.60E-01	ER_L	0.364
Pyrene	SD11	2.40E-01	1.40E+00	SED_PEL	0.172
Pyrene	SD11	2.40E-01	2.60E+00	ER_M	0.092
Pyrene	SD12	1.40E-01	1.53E-01	SED_TEL	0.915
Pyrene	SD12	1.40E-01	3.30E-01	REG_IV	0.424
Pyrene	SD12	1.40E-01	6.60E-01	ER_L	0.212
Pyrene	SD12	1.40E-01	1.40E+00	SED_PEL	0.100
Pyrene	SD12	1.40E-01	2.60E+00	ER_M	0.054
Pyrene	SD14	1.20E-01	1.53E-01	SED_TEL	0.784
Pyrene	SD14	1.20E-01	3.30E-01	REG_IV	0.364
Pyrene	SD14	1.20E-01	6.60E-01	ER_L	0.182
Pyrene	SD14	1.20E-01	1.40E+00	SED_PEL	0.086
Pyrene	SD14	1.20E-01	2.60E+00	ER_M	0.046
Pyrene	SD15	6.10E-02	1.53E-01	SED_TEL	0.399
Pyrene	SD15	6.10E-02	3.30E-01	REG_IV	0.185
Pyrene	SD15	6.10E-02	6.60E-01	ER_L	0.092
Pyrene	SD15	6.10E-02	1.40E+00	SED_PEL	0.044
Pyrene	SD15	6.10E-02	2.60E+00	ER_M	0.023
Pyrene	SD16	1.80E-01	1.53E-01	SED_TEL	1.176
Pyrene	SD16	1.80E-01	3.30E-01	REG_IV	0.545

Table G.14 (continued)

Analyte	Site	Concentration	BMK value	BMK name	HQ ^b
Pyrene	SD16	1.80E-01	6.60E-01	ER_L	0.273
Pyrene	SD16	1.80E-01	1.40E+00	SED_PEL	0.129
Pyrene	SD16	1.80E-01	2.60E+00	ER_M	0.069
Pyrene	SD17	1.00E-01	1.53E-01	SED_TEL	0.654
Pyrene	SD17	1.00E-01	3.30E-01	REG_IV	0.303
Pyrene	SD17	1.00E-01	6.60E-01	ER_L	0.152
Pyrene	SD17	1.00E-01	1.40E+00	SED_PEL	0.072
Pyrene	SD17	1.00E-01	2.60E+00	ER_M	0.038

^aAll concentrations are mg/kg. Only the chemicals for which at least one quotient equaled or exceeded 1 are included.

^bHazard quotient = concentration/benchmark value. Bold indicates HQ>1.

Table G.15. Measured radionuclide concentrations in whole sediment samples, benchmark values for small invertebrates, and the HQs for detected radionuclides*

Site	Radionuclides	Det.	Obs.	Concentration	Benchmark value ^b	HQ ^c
SD01	Thorium-228	1	1	0.9	17450	0.00
SD01	Thorium-230	1	1	0.73	306208	0.00
SD01	Thorium-232	1	1	0.74	25440	0.00
SD01	Uranium-234	1	1	4.68	9093	0.00
SD01	Uranium-235	1	1	0.22	9207	0.00
SD01	Uranium-238	1	1	7.35	8351	0.00
SD01 Total						0.00
SD02	Americium-241	1	1	0.06	4076	0.00
SD02	Cesium-137	1	1	0.18	23627	0.00
SD02	Technetium-99	1	1	8.74	14532	0.00
SD02	Thorium-228	1	1	1.45	17450	0.00
SD02	Thorium-230	1	1	1.03	306208	0.00
SD02	Thorium-232	1	1	0.99	25440	0.00
SD02	Uranium-234	1	1	16.77	9093	0.00
SD02	Uranium-235	1	1	0.73	9207	0.00
SD02	Uranium-238	1	1	27.38	8351	0.00
SD02 Total						0.01
SD03	Cesium-137	1	1	0.09	23627	0.00
SD03	Thorium-228	1	1	1.6	17450	0.00
SD03	Thorium-230	1	1	0.79	306208	0.00
SD03	Thorium-232	1	1	1	25440	0.00
SD03	Uranium-234	1	1	1.18	9093	0.00
SD03	Uranium-235	1	1	0.05	9207	0.00
SD03	Uranium-238	1	1	1.27	8351	0.00
SD03 Total						0.00
SD04	Cesium-137	1	1	0.16	23627	0.00
SD04	Thorium-228	1	1	0.62	17450	0.00
SD04	Thorium-230	1	1	0.49	306208	0.00
SD04	Thorium-232	1	1	0.52	25440	0.00
SD04	Uranium-234	1	1	25.36	9093	0.00
SD04	Uranium-235	1	1	1.24	9207	0.00
SD04	Uranium-238	1	1	34.39	8351	0.00
SD04 Total						0.01
SD05	Cesium-137	1	1	0.11	23627	0.00
SD05	Thorium-228	1	1	1.35	17450	0.00
SD05	Thorium-230	1	1	0.82	306208	0.00
SD05	Thorium-232	1	1	1.16	25440	0.00
SD05	Uranium-234	1	1	1.82	9093	0.00
SD05	Uranium-235	1	1	0.04	9207	0.00
SD05	Uranium-238	1	1	2.04	8251	0.00
SD05 Total						0.00
SD06	Cesium-137	1	1	0.13	23627	0.00

Table G.15 (continued)

Site	Radionuclides	Det.	Obs.	Concentration	Benchmark value ^b	HQ ^c
SD06	Thorium-228	1	1	0.93	17450	0.00
SD06	Thorium-230	1	1	0.64	306208	0.00
SD06	Thorium-232	1	1	0.76	25440	0.00
SD06	Uranium-234	1	1	1.42	9093	0.00
SD06	Uranium-235	1	1	0.04	9207	0.00
SD06	Uranium-238	1	1	1.62	8351	0.00
SD06 Total						0.00
SD07	Cesium-137	1	1	0.08	23627	0.00
SD07	Thorium-228	1	1	1.02	17450	0.00
SD07	Thorium-230	1	1	0.79	306208	0.00
SD07	Thorium-232	1	1	0.81	25440	0.00
SD07	Uranium-234	1	1	8.53	9093	0.00
SD07	Uranium-235	1	1	0.46	9207	0.00
SD07	Uranium-238	1	1	14.83	8351	0.00
SD07 Total						0.00
SD08	Cesium-137	1	1	0.18	23627	0.00
SD08	Thorium-228	1	1	1.55	17450	0.00
SD08	Thorium-230	1	1	0.87	306208	0.00
SD08	Thorium-232	1	1	1.05	25440	0.00
SD08	Uranium-234	1	1	7.22	9093	0.00
SD08	Uranium-235	1	1	0.34	9207	0.00
SD08	Uranium-238	1	1	13.32	8351	0.00
SD08 Total						0.00
SD09	Americium-241	1	1	0.07	4076	0.00
SD09	Cesium-137	1	1	0.18	23627	0.00
SD09	Technetium-99	1	1	5.43	14532	0.00
SD09	Thorium-228	1	1	1.35	17450	0.00
SD09	Thorium-230	1	1	0.63	306208	0.00
SD09	Thorium-232	1	1	0.77	25440	0.00
SD09	Uranium-234	1	1	11.07	9093	0.00
SD09	Uranium-235	1	1	0.89	9207	0.00
SD09	Uranium-238	1	1	21.56	8351	0.00
SD09 Total						0.00
SD10	Americium-241	1	1	0.07	17450	0.00
SD10	Thorium-228	1	1	1.23	306208	0.00
SD10	Thorium-230	1	1	0.69	25440	0.00
SD10	Thorium-232	1	1	0.88	9093	0.00
SD10	Uranium-234	1	1	5.75	9207	0.00
SD10	Uranium-235	1	1	0.23	8351	0.00
SD10	Uranium-238	1	1	9.36	4076	0.00
SD10 Total						0.00
SD11	Cesium-137	1	1	0.07	23627	0.00

Table G.15 (continued)

Site	Radionuclides	Det.	Obs.	Concentration	Benchmark value ^b	HQ ^c
SD11	Thorium-228	1	1	0.55	11069	0.00
SD11	Thorium-230	1	1	0.48	306208	0.00
SD11	Thorium-232	1	1	0.49	25440	0.00
SD11	Uranium-234	1	1	4.72	9093	0.00
SD11	Uranium-235	1	1	0.21	9207	0.00
SD11	Uranium-238	1	1	7.98	8351	0.00
SD11 Total						0.00
SD12	Cesium-137	1	1	0.12	23627	0.00
SD12	Thorium-228	1	1	0.68	17450	0.00
SD12	Thorium-230	1	1	0.75	306208	0.00
SD12	Thorium-232	1	1	0.55	25440	0.00
SD12	Uranium-234	1	1	1.21	9093	0.00
SD12	Uranium-238	1	1	1.55	8351	0.00
SD12 Total						0.00
SD13	Thorium-228	1	1	1.04	17450	0.00
SD13	Thorium-230	1	1	1.03	306208	0.00
SD13	Thorium-232	1	1	0.94	25440	0.00
SD13	Uranium-234	1	1	1.02	9093	0.00
SD13	Uranium-238	1	1	1.27	8351	0.00
SD13 Total						0.00
SD14	Americium-241	1	1	0.05	4076	0.00
SD14	Technetium-99	1	1	4.93	14532	0.00
SD14	Thorium-228	1	1	2.17	17450	0.00
SD14	Thorium-230	1	1	1.3	306208	0.00
SD14	Thorium-232	1	1	1.65	25440	0.00
SD14	Uranium-234	1	1	22.52	9093	0.00
SD14	Uranium-235	1	1	1.01	9207	0.00
SD14	Uranium-238	1	1	36.53	8351	0.00
SD14 Total						0.01
SD15	Cesium-137	1	1	0.09	23627	0.00
SD15	Thorium-228	1	1	0.83	17450	0.00
SD15	Thorium-230	1	1	0.59	306208	0.00
SD15	Thorium-232	1	1	0.61	25440	0.00
SD15	Uranium-234	1	1	1.35	9093	0.00
SD15	Uranium-235	1	1	0.11	9207	0.00
SD15	Uranium-238	1	1	2.36	8351	0.00
SD15 Total						0.00
SD16	Cesium-137	1	1	0.1	23627	0.00
SD16	Thorium-228	1	1	1.06	17450	0.00
SD16	Thorium-230	1	1	0.74	306208	0.00
SD16	Thorium-232	1	1	0.82	25440	0.00
SD16	Uranium-234	1	1	1.84	9093	0.00
SD16	Uranium-235	1	1	0.07	9207	0.00

Table G.15 (continued)

Site	Radionuclides	Det.	Obs.	Concentration	Benchmark value ^a	HQ ^c
SD16	Uranium-238	1	1	2.13	8351	0.00
SD16 Total						0.00
SD17	Thorium-228	1	1	1.18	17450	0.00
SD17	Thorium-230	1	1	0.96	306208	0.00
SD17	Thorium-232	1	1	0.97	25440	0.00
SD17	Uranium-234	1	1	3.34	9093	0.00
SD17	Uranium-235	1	1	0.24	9207	0.00
SD17	Uranium-238	1	1	4.75	8351	0.00
SD17 Total						0.00
SD18	Cesium-137	1	1	0.11	23627	0.00
SD18	Thorium-228	1	1	1.02	17450	0.00
SD18	Thorium-230	1	1	0.84	306208	0.00
SD18	Thorium-232	1	1	0.9	25440	0.00
SD18	Uranium-234	1	1	6.98	9093	0.00
SD18	Uranium-235	1	1	0.2	9207	0.00
SD18	Uranium-238	1	1	5.28	8351	0.00
SD18 Total						0.00

^aAll concentration and benchmark values are pCi/g.

^bSediment concentrations resulting in a total dose rate to small insects of 1 rad/d.

^cHazard quotient = concentration/benchmark value.

Table G.16. Summary of the risk characterization for benthic invertebrates in depositional areas in Bear Creek and tributaries NT-2, NT-3, NT-4, NT-6, NT-8, and ET-4

Exposure area (site)	Evidence	Result	Explanation
Reach 1 (SD 2)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	+	Cadmium, mercury, manganese, and nickel concentrations are likely to be toxic.
	Weight of evidence	-	SD 2 sediment does not appear to be toxic to benthic invertebrates.
Reach 1 (SD 1)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	+	Endrin concentrations are likely to be toxic.
	Weight of evidence	-	SD 1 sediment does not appear to be toxic to benthic invertebrates.
Reach 1 (SD 14)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	+	Cadmium, iron, manganese, and nickel concentrations are likely to be toxic.
	Weight of evidence	-	SD 14 sediment does not appear to be toxic to benthic invertebrates.
NT-2 (SD 3)	Toxicity tests	±	<i>D. magna</i> survival was reduced by 33%, which was not statistically different from references, and <i>H. azteca</i> survival was not reduced by 20% or more relative to references.
	Media analyses	+	Manganese concentrations are likely to be toxic, but concentrations are higher at several other sites where toxicity was not evident. The highest concentration of 2,4,5-T, for which a benchmark is not available, occurs at this site.
	Weight of evidence	+	SD 3 sediment appears to pose a significant risk to benthic invertebrates, potentially from high concentrations of 2,4,5-T.
NT-3 (SD 4)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	+	Cadmium, chromium, copper, iron, lead, mercury, manganese, silver, zinc, and Total PAH concentrations are likely to be toxic.
	Weight of evidence	-	Although this is the most contaminated site, SD 4 sediment does not appear to be toxic to benthic invertebrates.
NT-4 (SD 5)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	-	None of the COPECs occur at concentrations that are likely to be toxic.
	Weight of evidence	-	SD 5 sediment does not appear to be toxic to benthic invertebrates.

Table G.16 (continued)

Exposure area (site)	Evidence	Result	Explanation
Reach 2 (SD 7)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	+	Cadmium and manganese concentrations are likely to be toxic.
	Weight of evidence	-	SD 7 sediment does not appear to be toxic to benthic invertebrates.
Reach 2 (SD 6)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	+	None of the COPECs occur at concentrations that are likely to be toxic.
	Weight of evidence	-	SD 6 sediment does not appear to be toxic to benthic invertebrates.
NT-6 (SD 8)	Toxicity tests	±	<i>D. magna</i> survival was reduced by 30%, which was not statistically different from references, and <i>H. azteca</i> survival was not reduced by 20% or more relative to references.
	Media analyses	+	Iron and manganese concentrations are likely to be toxic. This is the highest manganese concentration, but iron concentrations are higher at other sites where toxicity was not observed. Also, some of the highest concentrations of two chemicals for which benchmarks are not available occur at this site: selenium and 2,4,5-T.
	Weight of evidence	+	SD 8 sediment appears to pose a significant risk to the benthic invertebrate community from high concentrations of manganese, and, potentially, selenium and 2,4,5-T.
NT-8 (SD 9)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	-	None of the COPECs occur at concentrations that are likely to be toxic.
	Weight of evidence	-	SD 9 sediment does not appear to be toxic to benthic invertebrates.
Reach 2 (SD 10)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	+	Endrin and manganese concentrations are likely to be toxic.
	Weight of evidence	-	SD 10 sediment does not appear to be toxic to benthic invertebrates.
Reach 3 (SD 11)	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.

Table G.16 (continued)

Exposure area (site)	Evidence	Result	Explanation
Reach 3 (SD 12)	Media analyses	+	Chromium, iron, and manganese concentrations are likely to be toxic.
	Weight of evidence	-	SD 11 sediment does not appear to be toxic to benthic invertebrates.
	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
	Media analyses	-	None of the COPECs occur at concentrations that are likely to be toxic.
	Weight of evidence	-	SD 12 sediment does not appear to be toxic to benthic invertebrates.
Reach 3 (SD 13)	Toxicity tests	±	<i>D. magna</i> survival was reduced by 22%, but this was not statistically different from references, this test may not be reliable, and <i>H. azteca</i> survival was not reduced by 20% or more relative to references.
	Media analyses	-	None of the COPECs occur at concentrations that are likely to be toxic. All chemicals detected at this site for which benchmarks were not available are present at higher concentrations at other sites where toxicity was not evident.
	Weight of evidence	-	SD 13 sediment was toxic to <i>D. magna</i> , but confidence in this test is low and none of the COPECs occur at concentrations that are likely to be toxic.
	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
Reach 3 (SD 15)	Media analyses	-	None of the COPECs occur at concentrations that are likely to be toxic.
	Weight of evidence	-	SD 15 sediment does not appear to be toxic to benthic invertebrates.
	Toxicity tests	-	<i>H. azteca</i> and <i>D. magna</i> survival were not significantly reduced.
Reach 3 (SD 16)	Media analyses	-	None of the COPECs occur at concentrations that are likely to be toxic.
	Weight of evidence	-	SD 16 sediment does not appear to be toxic to benthic invertebrates.
	Toxicity tests	+	<i>H. azteca</i> and <i>D. magna</i> survival were reduced by 38% and 44%, respectively, and the mortality of <i>H. azteca</i> was statistically significantly different from controls.

Table G.16 (continued)

Exposure area (site)	Evidence	Result	Explanation
ET-4 (SD 18)	Media analyses	-	None of the COPECs occur at concentrations that are likely to be toxic. All chemicals detected at this site for which toxicological data were not available are present at higher concentrations at other sites where toxicity was not evident.
	Weight of evidence	+	SD 17 sediment appears to pose a significant risk to benthic invertebrates at this site, but none of the COPECs occur at concentrations that are likely to be toxic.
	Toxicity tests	N/A	Toxicity tests were not conducted for this site.
	Media analyses	-	None of the COPECs occur at concentrations that are likely to be toxic.
	Weight of evidence	-	SD 18 sediment is not expected to be toxic to benthic invertebrates.

+ indicates that the evidence is consistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.

- indicates that the evidence is inconsistent with the occurrence of a 20% reduction in species richness of abundance of the fish community.

± indicates that the evidence is too ambiguous to interpret.

Table. G.17. Comparison of soil contaminant concentrations in floodplain transects with screening benchmarks for toxicity to earthworms^a

Location	Chemical	Weighted average conc. (mg/kg)	Maximum detected conc. (mg/kg)	Benchmark (mg/kg)	HQ
TS012	Cadmium	4.5	9.3	20	0.5
	Copper	16.9	42.7	50	0.9
	Lead	49.125	52.3	500	0.1
	Mercury	3.025	7.3	0.1	70
	Selenium	2.125	2.5	70	0.04
TS016	Mercury	0.43	0.43	0.1	4
	Selenium	2.375	2.4	70	0.03
TS023	Cadmium	0.2925	0.96	20	0.05
	Mercury	0.7075	1.6	0.1	20
	Selenium	2.45	3.2	70	0.05
TS033	Cadmium	10.5	11.1	20	0.06
	Mercury	2.2	2.4	0.1	20
	Nickel	55.85	62.8	200	0.3
	Selenium	1.95	2.1	70	0.03
TS034	Cadmium	10.325	10.9	20	0.5
	Mercury	2.3	2.5	0.1	30
	Nickel	54.5	57.3	200	0.3
	Selenium	1.975	2.1	70	0.03
TS041	Selenium	1.8	2.7	70	0.04
TS042	Mercury	0.43	0.43	0.1	4
	Selenium	2.475	2.5	70	0.04
TS051	Cadmium	0.43	0.51	20	0.03
	Selenium	1.6	1.7	70	0.02
TS063	Cadmium	0.5325	0.63	20	0.03
	Mercury	0.2425	0.46	0.1	5
TS064	Cadmium	0.56	1.4	20	0.07
	Mercury	0.67	0.67	0.1	7
	Selenium	1.35	1.4	70	0.02
TS071	Cadmium	1.34	3.5	20	0.2
	Mercury	0.425	0.98	0.1	10
	Selenium	1.45	1.6	70	0.02
TS073	Cadmium	0.3075	0.81	20	0.04
	Mercury	0.24	0.57	0.1	6
	Selenium	1.375	1.4	70	0.02

Table G.17 (continued)

Location	Chemical	Weighted average conc. (mg/kg)	Maximum detected conc. (mg/kg)	Benchmark (mg/kg)	HQ
TS086	Mercury	0.42	0.42	0.1	4
	Selenium	1.8	2	70	0.03
TS103	Cadmium	0.31	0.37	20	0.02
	Selenium	1.4	1.4	70	0.02
TS132	Mercury	0.165	0.36	0.1	4
	Selenium	1.35	1.5	70	0.02

*Boldface type indicates the exceedence of toxicity benchmark.

Table G.18. Summary of risk characterization for soil invertebrates by transect

Transect	Evidence	Result	Explanation
TS01	Literature toxicity data	+	Mercury at concentration 70 times benchmark.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.
	Weight of evidence	-	There is no evidence that the soils of TS01 are toxic to soil invertebrates.
TS02	Literature toxicity data	+	Mercury at concentration 20 times benchmark.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.
	Weight of evidence	-	There is no evidence that the soils of TS02 are toxic to soil invertebrates.
TS03	Literature toxicity data	+	Mercury at concentration 30 times benchmark.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.
	Weight of evidence	-	There is no evidence that the soils of TS03 are toxic to soil invertebrates.
TS04	Literature toxicity data	+	Mercury at concentration above benchmark.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.
	Weight of evidence	-	There is no evidence that the soils of TS04 are toxic to soil invertebrates.
TS05	Literature toxicity data	-	No contaminants above benchmark concentration.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.
	Weight of evidence	-	There is no evidence that the soils of TS05 are toxic to soil invertebrates.
TS06	Literature toxicity data	+	Mercury at concentration above benchmark.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.
	Weight of evidence	-	There is no evidence that the soils of TS06 are toxic to soil invertebrates.
TS07	Literature toxicity data	+	Mercury at concentration benchmark.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.
	Weight of evidence	-	There is no evidence that the soils of TS07 are toxic to soil invertebrates.
TS08	Literature toxicity data	+	Mercury at concentration above benchmark.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.

Table G.18 (continued)

Transect	Evidence	Result	Explanation
TS09	Weight of evidence	-	There is no evidence that the soils of TS08 are toxic to soil invertebrates.
	Literature toxicity data	-	Contaminant concentrations not measured above background.
	Medium toxicity tests	±	Low growth of earthworms at one site.
TS10	Weight of evidence	-	There is no evidence that the soils of TS09 are toxic to soil invertebrates.
	Literature toxicity data	-	No contaminants above benchmark concentration.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.
TS11	Weight of evidence	-	There is no evidence that the soils of TS10 are toxic to soil invertebrates.
	Literature toxicity data	-	Contaminant concentrations not measured above background.
	Medium toxicity tests	NA	Growth of earthworms not tested.
TS12	Weight of evidence	-	There is no evidence that the soils of TS11 are toxic to soil invertebrates.
	Literature toxicity data	-	Contaminant concentrations not measured above background.
	Medium toxicity tests	NA	Growth of earthworms was not tested.
TS13	Weight of evidence	-	There is no evidence that the soils of TS12 are toxic to soil invertebrates.
	Literature toxicity data	-	No contaminants above benchmark concentration.
	Medium toxicity tests	-	No evidence of toxicity to earthworms.
TS13	Weight of evidence	-	There is no evidence that the soils of TS13 are toxic to soil invertebrates.

Table G.19. Summary data for S-3 Ponds area surface soils

Analyte (units)	Results > detection limit	Mean	Maximum detect	Minimum detect	Standard error	UCL95
Aluminum (mg/kg)	20/20	14600	29000	1600	1470.00	17133.3 3
Antimony (mg/kg)	1/1	0.25	0.25	0.25		
Arsenic (mg/kg)	20/20	4.92	20.5	0.82	1.10	6.83
Barium (mg/kg)	20/20	112	277	13.2	16.00	139.97
Beryllium (mg/kg)	18/20	0.821	1.5	0.6	0.07	0.95
Cadmium (mg/kg)	1/20	0.254	2	2	0.09	0.41
Calcium (mg/kg)	19/19	36000	318000	189	16600.00	64803.5 6
Chromium (mg/kg)	20/20	28	43.3	5.4	2.40	32.17
Cobalt (mg/kg)	20/20	15.2	27.6	2.9	1.50	17.79
Copper (mg/kg)	19/20	23.6	50.8	5.3	3.07	28.89
Cyanide (mg/kg)	2/20	0.389	1.4	1.2	0.07	0.51
Iron (mg/kg)	20/20	26400	48300	4610	2360.00	30475.9 0
Lead (mg/kg)	20/20	19.9	82.3	5.5	3.88	26.59
Magnesium (mg/kg)	20/20	7060	33900	401	1790.00	10152.5 5
Manganese (mg/kg)	20/20	614	2000	116	88.60	766.88
Mercury (mg/kg)	17/20	14.8	82.9	0.076	5.42	24.19
Molybdenum (mg/kg)	1/20	0.639	3.7	3.7	0.17	0.94
Nickel (mg/kg)	20/20	25.5	128	5.7	5.65	35.27
Potassium (mg/kg)	20/20	1660	3100	413	163.00	1940.34
Silver (mg/kg)	12/20	1.91	4.3	0.85	0.29	2.42
Sodium (mg/kg)	14/20	88.6	214	40.1	12.70	110.52
Thallium (mg/kg)	1/20	0.227	0.75	0.75	0.03	0.27
Tin (mg/kg)	3/20	2.05	7.7	5.6	0.44	2.81
Vanadium (mg/kg)	20/20	27.9	91.9	3.9	4.52	35.71
Zinc (mg/kg)	20/20	52.1	163	18.3	8.52	66.83
Methoxychlor (µg/kg)	1/6	9.07	5.9	5.9	0.64	10.36
PCB-1248 (µg/kg)	3/20	27.8	140	20	6.34	38.78
PCB-1254 (µg/kg)	12/20	70.6	370	12	19.30	103.95

Table G.19 (continued)

Analyte (units)	Results > detection limit	Mean	Maximum detect	Minimum detect	Standard error	UCL95
PCB-1260 (µg/kg)	5/20	42.4	210	16	12.20	63.45
2-Butanone (µg/kg)	1/19	6.16	10	10	0.25	6.58
4-Methyl-2-pentanone (µg/kg)	1/20	7.05	28	28	1.11	8.97
Acetone (µg/kg)	11/18	451	4200	14	246.00	878.22
Methylene chloride (µg/kg)	1/18	13.8	180	180	9.79	30.81
Tetrachloroethene (µg/kg)	4/20	4.23	24	2	1.07	6.08
Toluene (µg/kg)	12/19	8.74	22	1	1.75	11.78
Gross α (pCi/g)	11/20	7.58	23	5	1.51	10.18
Gross β (pCi/g)	12/20	14	47	9.3	2.56	18.45
Neptunium-237 (pCi/g)	5/20	0.0252	0.13	0.026	0.01	0.04
Plutonium-239/240 (pCi/g)	1/19	0.00241	0.015	0.015	0.00	0.00
Technetium-99 (pCi/g)	2/20	2.05	6.8	4.6	0.55	3.00
Thorium-228 (pCi/g)	15/20	0.682	1.7	0.4	0.09	0.83
Thorium-230 (pCi/g)	15/20	0.555	2.7	0.21	0.12	0.77
Thorium-232 (pCi/g)	13/20	0.411	1.5	0.2	0.08	0.55
Uranium-234 (pCi/g)	20/20	1.87	7.7	0.1	0.49	2.72
Uranium-235 (pCi/g)	11/20	0.109	0.54	0.042	0.03	0.16
Uranium-238 (pCi/g)	20/20	3.74	18	0.15	1.05	5.56

Table G.20. Summary data for Boneyard/Burnyard surface soils

Analyte (units)	Results > detection		Mean	Maximum detect	Minimum detect	Standard error	95% UCL
	limit						
Aluminum (mg/kg)	32/32	29900	65900	6730	3240.00	35393.81	
Antimony (mg/kg)	12/12	139	1650	0.27	137.00	385.95	
Arsenic (mg/kg)	15/15	13.3	32.5	2.1	2.68	18.01	
Barium (mg/kg)	32/32	262	1100	47.7	33.20	317.89	
Beryllium (mg/kg)	30/32	1.16	3.3	0.6	0.11	1.35	
Cadmium (mg/kg)	11/32	5.97	32.3	0.87	1.57	8.62	
Calcium (mg/kg)	32/32	34500	225000	500	8400.00	48695.28	
Cerium (mg/kg)	16/17	42.4	80	30	3.49	48.44	
Chromium (mg/kg)	32/32	61.4	210	10	6.87	73.09	
Cobalt (mg/kg)	32/32	19.1	131	3	3.86	25.68	
Copper (mg/kg)	31/32	968	6220	8	314.00	1500.43	
Cyanide (mg/kg)	1/14	0.334	0.69	0.69	0.03	0.38	
Gallium (mg/kg)	2/5	14	20	20	2.45	19.22	
Iron (mg/kg)	32/32	32300	102000	4380	3240.00	37824.91	
Lead (mg/kg)	23/23	426	1870	16.2	119.00	629.86	
Lithium (mg/kg)	16/17	28.8	50	20	2.70	33.53	
Magnesium (mg/kg)	32/32	7190	20600	793	929.00	8764.04	
Manganese (mg/kg)	32/32	918	2980	100	124.00	1128.19	

Table G.20 (continued)

Analyte (units)	Results > detection limit	Mean	Maximum detect	Minimum detect	Standard error	95% UCL
Mercury (mg/kg)	15/15	31.7	77.7	2.4	6.57	43.24
Molybdenum (mg/kg)	3/28	6.81	50.3	36	2.50	11.07
Nickel (mg/kg)	31/32	415	10600	6.9	329.00	972.82
Niobium (mg/kg)	5/17	6.76	20	9	1.02	8.54
Potassium (mg/kg)	32/32	8940	30900	669	1440.00	11375.29
Selenium (mg/kg)	4/13	10.9	132	0.76	10.10	28.88
Silver (mg/kg)	14/32	11.8	61.5	0.62	3.03	16.97
Sodium (mg/kg)	31/32	648	2720	34.9	107.00	829.28
Strontium (mg/kg)	17/17	79.6	303	22.8	17.70	110.46
Thallium (mg/kg)	1/15	0.25	0.87	0.87	0.04	0.33
Thorium (mg/kg)	3/17	5.53	11	9	0.53	6.45
Tin (mg/kg)	10/14	34.3	102	3.3	8.50	49.32
Titanium (mg/kg)	17/17	2130	3110	370	159.00	2412.38
Vanadium (mg/kg)	32/32	40.5	97	8	3.23	45.99
Zinc (mg/kg)	32/32	615	4380	11	178.00	916.41
Zirconium (mg/kg)	17/17	90.7	153	5	8.77	106.01
2378-TCDD (pCi/g)	2/3	3.3	7.72	0.91	2.21	9.76
PCB-1254 (µg/kg)	11/11	1660	5800	190	506.00	2582.31

Table G.20 (continued)

Analyte (units)	Results > detection limit	Mean	Maximum defect	Minimum defect	Standard error	95% UCL
PCB-1260 (µg/kg)	3/10	267	1600	360	160.00	560.32
2,4-Dimethylphenol (µg/kg)	1/13	193	110	110	7.33	205.76
2-Methylnaphthalene (µg/kg)	10/14	364	2600	53	175.00	674.47
4-Methylphenol (µg/kg)	1/13	195	140	140	5.22	204.30
Acenaphthene (µg/kg)	13/14	1030	6700	110	457.00	1838.14
Acenaphthylene (µg/kg)	8/12	175	490	53	35.10	237.62
Anthracene (µg/kg)	13/14	5570	53000	220	3700.00	12113.57
Benzo(a)anthracene (µg/kg)	14/14	14400	120000	92	8320.00	29156.03
Benzo(a)pyrene (µg/kg)	14/14	9860	76000	100	5270.00	19199.20
Benzo(b)fluoranthene (µg/kg)	14/14	11800	86000	120	5990.00	22391.35
Benzo(ghi)perylene (µg/kg)	14/14	4480	30000	58	2090.00	8184.61
Benzo(k)fluoranthene (µg/kg)	14/14	10100	80000	120	5530.00	19911.09
Bis(2-ethylhexyl)phthalate (µg/kg)	11/12	238	600	71	48.30	324.77
Butylbenzylphthalate (µg/kg)	2/10	173	87	43	18.60	207.01
Carbazole (µg/kg)	13/14	2840	25000	120	1730.00	5907.98
Chrysene (µg/kg)	14/14	14500	120000	96	8330.00	29205.14
Di-n-butylphthalate (µg/kg)	1/12	411	2500	2500	191.00	754.01
Dibenzo(a,h)anthracene (µg/kg)	13/14	2060	12000	54	838.00	3540.44

Table G.20 (continued)

Analyte (units)	Results > detection limit	Mean	Maximum detect	Minimum detect	Standard error	95% UCL
Dibenzofuran ($\mu\text{g/kg}$)	13/14	1140	10000	68	691.00	2368.23
Diethylphthalate ($\mu\text{g/kg}$)	1/12	209	65	65	23.20	250.79
Fluoranthene ($\mu\text{g/kg}$)	14/14	31800	270000	230	18800.00	64979.31
Fluorene ($\mu\text{g/kg}$)	13/14	2040	17000	180	1180.00	4135.71
Indeno(1,2,3-cd)pyrene ($\mu\text{g/kg}$)	14/14	4620	31000	63	2170.00	8467.28
Naphthalene ($\mu\text{g/kg}$)	13/14	552	5000	57	345.00	1162.51
Phenanthrene ($\mu\text{g/kg}$)	14/14	20300	180000	120	12500.00	42485.96
Phenol ($\mu\text{g/kg}$)	9/12	127	280	41	23.20	168.12
Pyrene ($\mu\text{g/kg}$)	14/14	25500	210000	200	14600.00	51244.18
Acetone ($\mu\text{g/kg}$)	7/15	33.2	110	23	9.77	50.40
Tetrachloroethene ($\mu\text{g/kg}$)	1/16	3.13	5	5	0.13	3.36
Toluene ($\mu\text{g/kg}$)	12/16	124	590	2	51.40	213.78
Gross α (pCi/g)	17/17	198	710	8	57.40	298.58
Gross β (pCi/g)	16/17	279	1600	9.6	109.00	469.77
Strontium-90 (pCi/g)	3/14	0.322	1.9	0.58	0.14	0.57
Technetium-99 (pCi/g)	6/14	21.9	77	10	7.75	35.61
Thorium-228 (pCi/g)	12/16	0.544	2.4	0.23	0.13	0.77
Thorium-230 (pCi/g)	16/16	1.01	7.1	0.13	0.42	1.74

Table G-20 (continued)

Analyte (units)	Results > detection limit	Mean	Maximum detect	Minimum detect	Standard error	95% UCL
Thorium-232 (pCi/g)	10/16	0.413	1.9	0.26	0.11	0.61
Uranium (pCi/g)	21/21	0.00188	0.026	0.000018	0.00	0.00
Uranium-234 (pCi/g)	17/17	95.2	260	1.4	23.50	136.31
Uranium-235 (pCi/g)	36/38	2.25	17	7.0299E-6	0.73	3.47
Uranium-238 (pCi/g)	17/17	149	880	1.8	59.70	253.12

Table G.21. Summary data for Sanitary Landfill/Oil Landfarm surface soils

Analyte (units)	Results >					Standard error	UCL95
	detection limit	Mean	Maximum detect	Minimum detect			
Aluminum (mg/kg)	32/32	37800	77500	10700	4300.0	45051.91	
Antimony (mg/kg)	1/1	0.34	0.34	0.34			
Arsenic (mg/kg)	13/13	8.13	31.8	1.1	2.45	12.50	
Barium (mg/kg)	32/32	182	380	31.2	16.30	209.61	
Beryllium (mg/kg)	27/32	1.18	2.5	0.6	0.09	1.34	
Cadmium (mg/kg)	1/32	1.33	3.2	3.2	0.17	1.62	
Calcium (mg/kg)	30/32	5130	20900	672	1030.00	6881.24	
Cerium (mg/kg)	19/19	60	200	30	8.09	74.03	
Chromium (mg/kg)	32/32	43.9	76	22	2.91	48.86	
Cobalt (mg/kg)	32/32	28.8	406	5	12.20	49.50	
Copper (mg/kg)	31/31	44.6	252	7.1	10.00	61.68	
Iron (mg/kg)	32/32	30200	49400	10900	1610.00	32965.43	
Lead (mg/kg)	29/29	35.8	201	5.9	7.05	47.80	
Lithium (mg/kg)	19/19	40	120	20	5.46	49.47	
Magnesium (mg/kg)	32/32	3810	7400	820	376.00	4442.09	
Manganese (mg/kg)	32/32	781	4900	45.3	151.00	1036.56	
Mercury (mg/kg)	8/13	4	41.5	0.09	3.15	9.61	
Molybdenum (mg/kg)	2/32	2.18	4.4	1.3	0.20	2.51	

Table G.21 (continued)

Analyte (units)	Results >		Mean	Maximum detect	Minimum detect	Standard error	UCL95
	detection limit						
Nickel (mg/kg)	32/32	31.8	123	9	3.51	37.74	
Niobium (mg/kg)	3/19	5.34	10	7	0.36	5.97	
Potassium (mg/kg)	32/32	11600	43400	1050	2150.00	15227.18	
Silver (mg/kg)	10/32	2.82	7.6	0.57	0.23	3.20	
Sodium (mg/kg)	29/32	410	1210	14.9	61.70	514.34	
Strontium (mg/kg)	19/19	35.5	61.6	11.9	2.99	40.73	
Thallium (mg/kg)	1/13	0.225	0.48	0.48	0.02	0.26	
Thorium (mg/kg)	8/19	6.95	12	9	0.65	8.08	
Tin (mg/kg)	3/13	2.27	4.8	2.6	0.50	3.16	
Titanium (mg/kg)	19/19	2240	2800	1480	85.60	2392.04	
Vanadium (mg/kg)	32/32	45.2	90	14.4	3.26	50.73	
Zinc (mg/kg)	32/32	100	470	26.5	17.10	129.10	
Zirconium (mg/kg)	19/19	94.5	168	58	7.21	106.98	
PCB-1232 (µk/kg)	1/13	119	1300	1300	98.50	294.05	
PCB-1254 (µk/kg)	2/13	205	1700	750	137.00	448.56	
PCB-1260 (µk/kg)	4/12	50.6	220	36	17.50	82.12	
Acenaphthene (µk/kg)	1/5	237	320	320	23.20	286.38	
Acenaphthylene (µk/kg)	1/5	183	49	49	35.00	257.41	
Anthracene (µk/kg)	3/5	331	1100	49	195.00	745.66	

Table G.21 (continued)

Analyte (units)	Results >				
	detection limit	Mean	Maximum detect	Minimum detect	Standard error
Benzo(a)anthracene ($\mu\text{k/kg}$)	3/5	1300	5700	130	1100.00
Benzo(a)pyrene ($\mu\text{k/kg}$)	3/5	985	4200	110	804.0
Benzo(b)fluoranthene ($\mu\text{k/kg}$)	3/5	1310	5800	110	1120.00
Benzo(ghi)perylene ($\mu\text{k/kg}$)	3/5	449	1700	54	314.00
Benzo(k)fluoranthene ($\mu\text{k/kg}$)	3/5	929	3900	140	743.00
Bis(2-ethylhexyl)phthalate ($\mu\text{k/kg}$)	3/5	742	3200	51	615.00
Carbazole ($\mu\text{k/kg}$)	2/5	198	310	71	38.00
Chrysene ($\mu\text{k/kg}$)	4/5	1190	5300	44	1030.00
Di-n-butylphthalate ($\mu\text{k/kg}$)	2/5	182	110	100	32.30
Dibenzo(a,h)anthracene ($\mu\text{k/kg}$)	1/5	373	1000	1000	157.00
Dibenzofuran ($\mu\text{k/kg}$)	1/5	199	130	130	20.10
Fluoranthene ($\mu\text{k/kg}$)	4/5	2410	11000	100	2150.00
Fluorene ($\mu\text{k/kg}$)	2/5	221	410	83	52.80
Indeno(1,2,3-cd)pyrene ($\mu\text{k/kg}$)	3/5	412	1500	67	273.00
Phenanthrene ($\mu\text{k/kg}$)	4/5	1160	4900	52	938.00
Phenol ($\mu\text{k/kg}$)	1/5	183	50	50	34.80
Pyrene ($\mu\text{k/kg}$)	4/5	2000	9000	77	1750.00
Acetone ($\mu\text{k/kg}$)	11/13	109	590	7	44.70
Chloroform ($\mu\text{k/kg}$)	1/13	2.92	1	1	0.19
					3.26

Table G.21 (continued)

Analyte (units)	Results >		Mean	Maximum detect	Minimum detect	Standard error	UCL95
	detection limit						
Methylene chloride (μk/kg)	2/13	3.23	4	3	0.11	3.42	
Toluene (μk/kg)	10/13	15.7	110	1	8.15	30.22	
Cobalt-60 (pCi/g)	5/13	1.08	1.7	0.7	0.32	1.65	
Gross α (pCi/g)	11/13	9.28	35	1.8	2.97	14.57	
Gross β (pCi/g)	7/13	12.7	51	7.6	3.55	19.07	
Lead-212 (pCi/g)	1/13	1.01	6.2	6.2	0.47	1.83	
Potassium-40 (pCi/g)	2/13	15.6	20	18	5.40	25.18	
Thallium-208 (pCi/g)	1/13	3.48	4.6	4.6	0.71	4.75	
Thorium-228 (pCi/g)	12/13	0.588	1.1	0.23	0.07	0.71	
Thorium-230 (pCi/g)	10/13	0.355	0.82	0.19	0.06	0.46	
Thorium-232 (pCi/g)	9/13	0.364	0.72	0.14	0.06	0.47	
Uranium (pCi/g)	24/24	0.000685	0.004	0.00008	0.00	0.00	
Uranium-234 (pCi/g)	13/13	2.55	14	0.067	1.21	4.71	
Uranium-235 (pCi/g)	30/37	0.0415	0.7	0.00002996	0.02	0.08	
Uranium-238 (pCi/g)	13/13	3.35	22	0.066	1.70	6.39	

Table G.22. Summary data for Burial Ground surface soils

Analyte (units)	Results >				
	detection limit	Mean	Maximum detect	Minimum detect	Standard error
Aluminum (mg/kg)	70/70	33000	85800	3050	2640.00
Antimony (mg/kg)	9/9	0.313	0.56	0.23	0.04
Arsenic (mg/kg)	35/35	7.51	42.3	0.57	2.10
Barium (mg/kg)	70/70	155	454	16.4	10.80
Beryllium (mg/kg)	69/70	1.07	4.8	0.28	0.07
Calcium (mg/kg)	68/70	9050	183000	28.9	3350.00
Cerium (mg/kg)	35/36	46	80	20	2.46
Chromium (mg/kg)	70/70	37.2	84	9.7	2.07
Cobalt (mg/kg)	70/70	12.1	37	2	0.76
Copper (mg/kg)	65/69	16.1	45	3.8	0.94
Cyanide (mg/kg)	2/34	4.53	142	1.7	4.17
Iron (mg/kg)	70/70	26500	45500	6860	1040.00
Lead (mg/kg)	42/42	13.9	30.7	4.8	0.98
Lithium (mg/kg)	35/36	28	50	20	1.43
Magnesium (mg/kg)	70/70	4370	35700	295	606.00
Manganese (mg/kg)	70/70	541	2450	52	57.00
Mercury (mg/kg)	16/34	0.112	0.47	0.094	0.02
Molybdenum (mg/kg)	1/69	1.66	3.4	3.4	0.14
					0.14
					1.89
					37406.94
					0.38
					11.06
					172.82
					1.19
					14634.33
					50.13
					40.65
					13.32
					17.66
					11.58
					28261.44
					15.52
					30.41
					5382.40
					636.32
					0.14

Table G.22 (continued)

Analyte (units)	Results > detection limit	Mean	Maximum detect	Minimum detect	Standard error	95% UCL
Nickel (mg/kg)	69/70	22	206	5.2	2.90	26.79
Niobium (mg/kg)	5/36	5.03	11	7	0.31	5.55
Potassium (mg/kg)	70/70	8280	31500	546	901.00	9778.72
Selenium (mg/kg)	10/34	0.56	2.8	0.57	0.10	0.72
Silver (mg/kg)	23/70	2.25	4	0.79	0.11	2.43
Sodium (mg/kg)	44/71	500	9300	36.1	142.00	737.25
Strontium (mg/kg)	36/36	47.2	167	7.3	5.14	55.85
Thorium (mg/kg)	7/36	5.25	10	8	0.33	5.80
Tin (mg/kg)	6/34	2.15	9.4	3.6	0.33	2.71
Titanium (mg/kg)	36/36	2090	3150	700	105.00	2267.04
Vanadium (mg/kg)	70/70	38.4	82	12	2.10	41.92
Zinc (mg/kg)	69/70	55.5	199	14.1	4.32	62.73
Zirconium (mg/kg)	36/36	91	175	28	4.78	99.07
4,4'-DDE ($\mu\text{g/kg}$)	1/33	2.11	0.92	0.92	0.07	2.23
4,4'-DDT ($\mu\text{g/kg}$)	1/33	2.11	1	1	0.07	2.23
PCB-1248 ($\mu\text{g/kg}$)	1/33	33	400	400	11.50	52.46
PCB-1254 ($\mu\text{g/kg}$)	11/33	360	10000	20	302.00	871.18
PCB-1260 ($\mu\text{g/kg}$)	4/33	1180	36000	31	1090.00	3028.18
1,4-Dichlorobenzene ($\mu\text{g/kg}$)	1/15	216	92	92	15.20	242.55

Table G.22 (continued)

Analyte (units)	Results >				
	detection limit	Mean	Maximum detect	Minimum detect	Standard error
Benzo(a)anthracene ($\mu\text{g/kg}$)	1/15	211	87	87	14.50
Benzo(b)fluoranthene ($\mu\text{g/kg}$)	1/15	212	90	90	14.40
Benzo(k)fluoranthene ($\mu\text{g/kg}$)	1/15	212	94	94	14.20
Bis(2-ethylhexyl)phthalate ($\mu\text{g/kg}$)	5/15	323	1700	66	109.00
Chrysene ($\mu\text{g/kg}$)	1/15	212	93	93	14.30
Di-n-octylphthalate ($\mu\text{g/kg}$)	1/15	214	63	63	16.40
Fluoranthene ($\mu\text{g/kg}$)	1/15	221	230	230	11.50
Phenanthrene ($\mu\text{g/kg}$)	2/15	207	150	99	14.50
Pyrene ($\mu\text{g/kg}$)	3/15	211	240	69	15.30
1,1,1-Trichloroethane ($\mu\text{g/kg}$)	2/34	3.68	19	3	0.48
1,1-Dichloroethane ($\mu\text{g/kg}$)	2/34	5.21	72	2	2.03
1,1-Dichloroethene ($\mu\text{g/kg}$)	1/34	3.26	5	5	0.11
1,2-Dichloroethane ($\mu\text{g/kg}$)	1/34	3.21	3	3	0.10
1,2-Dichloroethene ($\mu\text{g/kg}$)	1/34	3.32	7	7	0.15
2-Butanone ($\mu\text{g/kg}$)	1/34	7.43	42	42	1.06
4-Methyl-2-pentanone ($\mu\text{g/kg}$)	3/33	6.18	5	2	0.26
Acetone ($\mu\text{g/kg}$)	6/29	21.4	110	18	4.98
Chloroethane ($\mu\text{g/kg}$)	2/34	11.7	170	26	4.83
Tetrachloroethene ($\mu\text{g/kg}$)	2/33	5.58	82	2	2.39

Table G.22 (continued)

Analyte (units)	Results >		Maximum detect	Minimum detect	Standard error	95% UCL
	detection limit	Mean				
Toluene (µg/kg)	17/34	36	360	1	13.80	59.34
Trichloroethene (µg/kg)	1/34	3.31	6	6	0.13	3.53
Vinyl chloride (µg/kg)	1/34	6.43	6	6	0.19	6.74
Cobalt-60 (pCi/g)	1/34	1.67	1.2	1.2	0.34	2.23
Gross α (pCi/g)	20/34	9.9	140	1.8	4.12	16.86
Gross β (pCi/g)	22/34	12.6	71	4.8	2.52	16.83
Potassium-40 (pCi/g)	2/34	33.7	20	16	5.39	42.85
Technetium-99 (pCi/g)	6/31	8.28	130	5.9	4.48	15.88
Thallium-208 (pCi/g)	1/34	3.18	3.7	3.7	0.50	4.03
Thorium-228 (pCi/g)	30/31	0.618	1.3	0.17	0.05	0.71
Thorium-230 (pCi/g)	28/31	0.486	1.2	0.15	0.04	0.56
Thorium-232 (pCi/g)	27/31	0.384	1.1	0.16	0.04	0.45
Uranium (pCi/g)	42/42	0.000384	0.00344	0.00006	0.00	0.00
Uranium-234 (pCi/g)	32/34	0.927	5.8	0.053	0.27	1.39
Uranium-235 (pCi/g)	48/76	0.0334	0.037	0.000025359	0.01	0.05
Uranium-238 (pCi/g)	33/34	3.03	36	0.061	1.27	5.19

Table G.23. Comparison of maximum contaminant concentrations in soil aggregates with benchmarks for toxicity to soil invertebrates

Analyte	Background (mg/kg)	Toxicity benchmark (mg/kg)	Concentration (mg/kg)		
			Mean	Maximum	Max HQ
S-3 Ponds					
Arsenic	20.2	60	4.9	20.5	0.3
Cadmium	0.31	20	0.25	2	0.1
Copper ^a	35.5	50	23.6	50.8	1.0
Lead	49.6	500	19.9	82.3	0.2
Mercury	0.34	0.1	14.8	82.9	829
Nickel	56.7	200	25.5	128	0.6
Zinc	108	200	52.1	163	0.8
Boneyard Burnyard area					
Arsenic	20.2	60	13.3	32.5	0.5
Cadmium	0.31	20	5.97	32.3	1.6
Chromium	80.1	0.4	61.4	210	525
Copper	35.5	50	968	6220	124.4
Lead	49.6	500	426	1870	3.7
Mercury	0.34	0.1	31.7	77.7	777
Nickel	56.7	200	415	10600	53
Zinc	108	200	615	4380	21.9
Sanitary Landfill/Oil Landfarm area					
Arsenic	20.2	60	8.13	31.8	0.5
Cadmium	0.31	20	1.33	3.2	0.2
Copper	35.5	50	44.6	252	5.0
Lead	49.6	500	35.8	201	0.4
Mercury	0.34	0.1	4	41.5	415
Nickel	56.7	200	31.8	123	0.6
Zinc	108	200	100	470	2.4
Burial Grounds area					
Arsenic	20.2	60	7.51	42.3	0.7
Chromium	80.1	0.4	37.2	84	210
Copper	35.5	50	16.1	45	0.9
Mercury	0.34	0.1	0.11	0.47	4.7

Table G.23 (continued)

Analyte	Background (mg/kg)	Toxicity benchmark (mg/kg)	Concentration (mg/kg)		
			Mean	Maximum	Max HQ
Nickel	56.7	200	22	206	1.0
Zinc	108	200	55.5	199	1.0
<i>Creelside Debris Burial area</i>					
Arsenic	20.2	60	<i>b</i>	7.9	0.13
Cadmium	0.31	20		1.7	0.085
Chromium	80.1	0.4		107	268
Copper	35.5	50		52	1.04
Mercury	0.34	0.1		33	330
Nickel	56.7	200		43	0.22
Selenium	1.2	70		2.5	0.035
Zinc	108	200		151	0.78
<i>Bear Creek Road Debris Burial area</i>					
Arsenic	20.2	60	<i>b</i>	10.7	0.18
Cadmium	0.31	20		15.6	0.78
Chromium	80.1	0.4		78.1	195
Copper	35.5	50		1650	33
Mercury	0.34	0.1		5.4	54
Nickel	56.7	200		86.5	0.43
Selenium	1.2	70		2.2	0.03
Zinc	108	200		875	4.38
<i>S-3 Ponds Slides, future exposure (from Table A.3)</i>					
Arsenic	20.2	60	<i>b</i>	1.12	0.02
Cadmium	0.31	20		4.9	0.24
Chromium (III)	80.1	0.4		133.2	333
Chromium (VI)	<i>c</i>	0.4		0.19	0.5
Cooper	35.5	50		92.45	1.85
Lead	49.6	500		35.8	0.07
Mercury	0.34	0.1		2.28	22.8
Nickel	56.7	200		550.3 2	2.75
Selenium	1.2	70		0.8	0.01

Table G.23 (continued)

Analyte	Background (mg/kg)	Toxicity benchmark (mg/kg)	Concentration (mg/kg)		
			Mean	Maximum	Max HQ
Zinc	108	200		58.3	0.29
<i>Waste Inventory - Walk-In Pit 1 (North), future exposure (from Table A.24)</i>					
Arsenic	20.2	60	b	0.004	0.000 07
Chromium	2.12	0.4		4.4	11
Lead	49.6	500		6.0	0.01
Mercury	0.34	0.1		17	170
Phenol	NA	30		47	1.6

*Boldface font indicates COPECs whose maximum concentrations exceed benchmarks.

^bOnly a single sample was taken.

*Background concentrations were not determined.

Table G.24. Summary of risk characterization for soil invertebrates in source areas

Source area	Evidence	Result	Explanation
S-3 Ponds area	Literature toxicity data	+	Mercury concentrations at mean of 148 and maximum of 829 times toxicity benchmarks.
	Medium toxicity tests	Insufficient data	No evidence that concentrations of mercury that are toxic to earthworms under laboratory conditions are not toxic in BCV soils.
	Weight of evidence	+	Mercury is an apparent COC for exposure of soil invertebrates in some parts of the S-3 Ponds area.
Boneyard Burnyard area	Literature toxicity data	+	Maximum concentrations of cadmium, chromium, copper, lead, mercury, nickel, and zinc are above toxicity benchmarks by a range of 1.6 to >750 fold.
	Medium toxicity tests	Insufficient data	No evidence that concentrations of contaminants that are toxic to earthworms under laboratory conditions are not toxic in BCV soils.
	Weight of evidence	+	Cadmium, chromium, copper, lead, mercury, nickel, and zinc are apparent COCs for exposure of soil invertebrates in some parts of the BYBY area.
Sanitary Landfill/Oil Landfarm area	Literature toxicity data	+	Maximum concentrations of copper, mercury, and zinc are above toxicity benchmarks. Mean copper and zinc concentrations are below toxicity benchmarks.
	Medium toxicity tests	Insufficient data	No evidence that concentrations of contaminants that are toxic to earthworms under laboratory conditions are not toxic in BCV soils.
	Weight of evidence	+	Copper, mercury, and zinc are apparent COCs for exposure of soil invertebrates in some parts of the SL/OLF area.
Burial Grounds area	Literature toxicity data	±	Maximum concentrations of chromium, mercury, and nickel exceed toxicity benchmarks. However, chromium exceeds background by only 5%, mercury is within the range of unpolluted soils, and nickel exceeds the benchmark by only 3%. The mean concentrations of all three COPECs are below background.

Table G.24 (continued)

Source area	Evidence	Result	Explanation
Creekside Debris Burial area	Medium toxicity tests	Insufficient data	No evidence that concentrations of contaminants that are toxic to earthworms under laboratory conditions are not toxic in BCV soils.
	Weight of evidence	-	No evidence that BG soils are toxic to soil invertebrates.
	Literature toxicity data	+	The observed concentration of mercury exceeds the toxicity benchmark by >100-fold. The observed concentration of chromium exceeds the toxicity benchmark by >20-fold.
	Medium toxicity tests	Insufficient data	No evidence that concentrations of contaminants that are toxic to earthworms under laboratory conditions are not toxic in BCV soils.
Bear Creek Road Debris Burial area	Weight of evidence	+	Chromium and mercury are apparent COCs for exposure of soil invertebrates in the Creekside Debris Burial area.
	Literature toxicity data	+	The observed concentration of chromium exceeds the toxicity benchmark by >100-fold. The observed concentrations of copper and mercury exceed the toxicity benchmark by >30-fold. The observed concentration of zinc exceeds the toxicity benchmark by >5-fold.
	Medium toxicity tests	Insufficient data	No evidence that concentrations of contaminants that are toxic to earthworms under laboratory conditions are not toxic in BCV soils.
	Weight of evidence	+	Chromium, copper, mercury, and zinc are apparent COCs for exposure of soil invertebrates in the Bear Creek Road Debris Burial area.

Table G.25. Comparison of maximum detected soil contaminant concentrations in floodplain transects with screening benchmarks for toxicity to plants^a

Location	Chemical	Weighted average conc. (mg/kg)	Maximum detected conc. (mg/kg)	Benchmark	HQ
TS012	Cadmium	4.5	9.3	3	3
	Copper	16.9	42.7	100	0.4
	Di-n-butylphthalate	0.215	0.26	200	0.0013
	Lead	49.125	52.3	50	1
	Lithium	14	41	2	20
	Mercury	3.025	7.3	0.3	20
	Selenium	2.125	2.5	1	3
TS016	Mercury	0.43	0.43	0.3	1
	Selenium	2.375	2.4	1	2
TS023	Cadmium	0.2925	0.96	3	0.3
	Mercury	0.7075	1.6	0.3	5
	Selenium	2.45	3.2	1	3
	Thallium	1.3	1.9	1	2
TS033	Cadmium	10.5	11.1	3	4
	Di-n-butylphthalate	0.1445	0.16	200	0.0008
	Lithium	32.725	33.4	2	20
	Mercury	2.2	2.4	0.3	8
	Nickel	55.85	62.8	30	2
	Selenium	1.95	2.1	1	2
TS034	Cadmium	10.325	10.9	3	4
	Di-n-butylphthalate	0.1075	0.13	200	0.0007
	Mercury	2.3	2.5	0.3	8
	Nickel	54.5	57.3	30	2
	Selenium	1.975	2.1	1	2
TS041	Beryllium	1.415	2.9	10	0.3
	Selenium	1.8	2.7	1	3
TS042	Beryllium	2.775	3	10	0.3
	Lithium	43.125	55.2	2	30
	Mercury	0.43	0.43	0.3	1
	Selenium	2.475	2.5	1	3

Table G.25 (continued)

Location	Chemical	Weighted average conc. (mg/kg)	Maximum detected conc. (mg/kg)	Benchmark	HQ
TS051	Cadmium	0.43	0.51	3	0.2
	Di-n-butylphthalate	0.1315	0.15	200	0.0008
	Selenium	1.6	1.7	1	2
TS063	Cadmium	0.5325	0.63	3	0.2
	Di-n-butylphthalate	0.0675	0.071	200	0.0004
	Mercury	0.2425	0.46	0.3	2
TS064	Cadmium	0.56	1.4	3	0.5
	Mercury	0.67	0.67	0.3	2
	Selenium	1.35	1.4	1	1
TS071	Cadmium	1.34	3.5	3	1
	Di-n-butylphthalate	0.0735	0.12	200	0.0006
	Mercury	0.425	0.98	0.3	3
	Selenium	1.45	1.6	1	2
TS073	Cadmium	0.3075	0.81	3	0.3
	Mercury	0.24	0.57	0.3	2
	Selenium	1.375	1.4	1	1
TS086	Mercury	0.42	0.42	0.3	1
	Selenium	1.8	2	1	2
TS103	Cadmium	0.31	0.37	3	0.1
	Di-n-butylphthalate	0.143	0.16	200	0.0008
	Selenium	1.4	1.4	1	1
TS132	Mercury	0.165	0.36	0.3	1
	Selenium	1.35	1.5	1	2

*Boldface type indicates the exceedence of toxicity benchmark.

Table G.26. Comparison of unfiltered contaminant concentrations^a in seeps with screening benchmarks for toxicity to plants in solution^b

Location	Chemical	Mean (mg/L)	Maximum detect (mg/L)	Benchmark (mg/L)	HQ
SS1	Aluminum	0.3369444	3.28	0.2	20
	Boron	0.0513571	0.09	1	0.09
	Cadmium	0.0029208	0.024	0.1	0.2
	Fluoride ^c	0.2114815	0.8	5	0.2
	Iron	0.4997481	5.34	10	0.5
	Lead	0.0040083	0.026	0.02	1
	Lithium	0.0041286	0.0061	3	0.002
	Manganese	0.1934426	4	4	1
	Mercury	0.0001146	0.00034	0.005	0.07
	Nickel	0.0065796	0.08	0.5	0.2
	Silver	0.0026185	0.0069	0.1	0.07
	Tetrachloroethene	0.0021667	0.003	10	0.0003
	Uranium	0.0365714	0.047	40	0.001
	Vanadium	0.0025296	0.0138	0.2	0.07
	Zinc	0.0108259	0.066	0.4	0.2
SS4	1,1,1-Trichloroethane	0.0024815	0.001	100	1E-05
	Aluminum	0.3362333	2.98	0.2	10
	Boron	0.1103571	0.26	1	0.3
	Fluoride ^c	0.3618519	0.6	5	0.1
	Lithium	0.0293143	0.0356	3	0.01
	Manganese	0.1371148	0.809	4	0.2
	Nickel	0.0047944	0.022	0.5	0.04
	Silver	0.0026037	0.0065	0.1	0.07
	Uranium	0.1355714	0.285	40	0.007
	Vanadium	0.0019426	0.0044	0.2	0.02
SS5	Boron	0.0754286	0.18	1	0.2
	Lead	0.0028333	0.012	0.02	0.6
	Lithium	0.0103	0.014	3	0.005
	Uranium	0.0580714	0.117	40	0.003

Table G.26 (continued)

Location	Chemical	Mean (mg/L)	Maximum detect (mg/L)	Benchmark (mg/L)	HQ
SS6	Aluminum	0.247194	3.77	0.2	20
	Copper	0.003822	0.049	0.05	1
	Lithium	0.0042714	0.0057	3	0.002
	Manganese	0.041794	0.352	4	0.09
	Silver	0.002558	0.0071	0.1	0.07
	Vanadium	0.00213	0.009	0.2	0.05
	Zinc	0.017538	0.078	0.4	0.2
SS8	Boron	0.017475	0.036	1	0.04
	Lithium	0.0011143	0.0019	3	0.0006
	Silver	0.002628	0.0079	0.1	0.08
	Vanadium	0.00196	0.0046	0.2	0.02

*Only chemicals with maximum detects above background are listed. Lithium and organic chemical concentrations were not compared to background values.

^bBoldface type indicates the exceedence of a toxicity benchmark.

^cBenchmark available for fluorine only.

Table G.27. Comparison of filtered contaminant concentrations in springs with screening benchmarks for toxicity to plants in solution^a

Location	Chemical	Mean (mg/L)	Maximum detect (mg/L)^b	Benchmark (mg/L)	HQ
SS1	Boron	0.0540714	0.1	1	0.1
	Cadmium	0.00275	0.022	0.1	0.22
	Copper	0.003087	0.018	0.05	0.36
	Fluoride ^c	0.2114815	0.8	5	0.16
	Lithium ^d	0.0033286	0.0042	3	0.0014
	Mercury	0.0001192	0.00059	0.005	0.118
	Nickel	0.0075074	0.09	0.5	0.18
	Uranium	0.0384286	0.056	40	0.0014
	Tetrachloroethene	0.0021667	0.003	10	0.0003
SS4	Boron	0.1222857	0.29	1	0.29
	Copper	0.0029222	0.0084	0.05	0.168
	Fluoride ^c	0.3618519	0.6	5	0.12
	Lead	0.0024833	0.0078	0.02	0.39
	Lithium	0.0290857	0.0364	3	0.0121
	Mercury	0.0001052	0.00024	0.005	0.048
	Nickel	0.0058241	0.031	0.5	0.062
	Uranium	0.1185714	0.285	40	0.0071
	1,1,1-trichloroethane	0.0024815	0.001	100	0.00001
SS5	Arsenic	0.0052321	0.059	0.001	59
	Beryllium	0.0001841	0.00043	0.5	0.0009
	Boron	0.0643571	0.17	1	0.17
	Copper	0.0028148	0.016	0.05	0.32
	Lithium	0.0092643	0.014	3	0.0047
	Mercury	0.0001024	0.00041	0.005	0.082
	Nickel	0.0045611	0.024	0.5	0.048
	Uranium	0.0585	0.115	40	0.0029
SS6	Beryllium	0.000174	0.00035	0.5	0.0007
	Boron	0.0393667	0.25	1	0.25
	Copper	0.0028846	0.0105	0.05	0.21
	Lithium	0.0029786	0.005	3	0.0017
	Nickel	0.0049808	0.017	0.5	0.034

Table G.27 (continued)

Location	Chemical	Mean (mg/L)	Maximum detect (mg/L) ^d	Benchmark (mg/L)	HQ
SS8	Uranium	0.01475	0.17	40	0.0043
	Arsenic	0.0047357	0.052	0.001	52
	Beryllium	0.0001748	0.00035	0.5	0.0007
	Copper	0.004946	0.07	0.05	1.4
	Lithium	0.0037857	0.0222	3	0.0074
	Nickel	0.005048	0.016	0.5	0.032
	Uranium	0.001875	0.014	40	0.0004
	Vanadium	0.002298	0.0128	0.2	0.064
	Zinc	0.009384	0.1	0.4	0.25

^aBoldface type indicates the exceedence of a toxicity benchmark.

^bOnly chemicals with maximum detects above background are listed.

^cSamples of fluoride were not filtered. Benchmark was available for fluorine only.

^dLithium and organic chemical concentrations were not compared with background values.

Table G.28. Comparison of maximum detected, unfiltered contaminant concentrations in groundwater below the floodplain with screening benchmarks for toxicity to plants*

Location	Chemical	Average conc. (mg/L)	Maximum detect (mg/L)	Benchmark (mg/L)	Hazard quotient
GW 345	Beryllium	0.0003	0.0008	0.5	0.002
	Boron	0.0318	0.053	1	0.05
	Copper	0.024	0.083	0.05	2
	Uranium	0.0009	0.002	40	0.00005
GW 526	Copper	0.1188	0.46	0.05	9
	Iron	2.59	7	10	.7
	Mercury	0.0001	0.0006	0.005	.1
	Nickel	0.01	0.025	0.5	0.05
	Uranium	0.0006	0.001	40	.00003
	Zinc	0.1192	0.45	0.4	1
GW 537	Boron	0.0407	0.14	1	0.1
	Copper	0.0153	0.032	0.05	0.6
	Nickel	0.204	0.12	0.5	0.2
	Uranium	0.001	0.002	40	0.00005
	Zinc	0.0163	0.042	.4	0.1

*Boldface type indicates the exceedence of a phytotoxicity benchmark.

Table G.29 Comparison of maximum detected, unfiltered contaminant concentrations in groundwater wells below NT-1 with screening benchmarks for toxicity to plants^a

Chemical	Maximum (mg/L)	Benchmark (mg/L)	Hazard Quotient
Aluminum	90.3	0.2	500
Cadmium	0.788	0.1	8
Chromium	0.08	0.05	2
Cobalt	0.62	0.06	10
Manganese	115	4	30
Nickel	3.45	0.5	7
Thallium	0.135	0.02	7
Titanium	0.41	0.06	7

^a Only exceedences of benchmarks in P1 or P2 are presented.

Table G.30. Locations where predicted maximum future groundwater concentrations exceed phytotoxicity benchmarks

Location	Chemical	Time Range to Peak (yr) *	Range of maxima above benchmarks	Relative to Current Conc.
BC (BYBY)	Manganese	steady state	some	<
	Mercury	steady state	all	<
	Nickel	steady state	all	<
BC (S3)	Cadmium	<45	some	<
	Manganese	<45	all	<
	Mercury	<45	some	<
	Nickel	<45	all	<
NT-1 (S3)	Cadmium	40 to 200	all	>>
	Manganese	steady state	all	<
	Mercury	40 to 100	all	>>
	Nickel	40 to 100	all	>>
NT-2 (S3)	Manganese	50 to 200	some	>>
NT-3 (BYBY)	Mercury	steady state	all	same
	Nickel	steady state	some	same
NT-7 (BG A)	Beryllium	>1000	some	>
	Boron	>1000	all	>
	Copper	>1000	all	>
	Lead	>1000	all	>
	Manganese	>1000	some	>
	Tetrachloroethene	>1000	some	>
	Nickel	>1000	some	>
NT-8 (CW)	Arsenic	steady state	all	same
	Boron	steady state	all	same
	Chromium	steady state	all	same
	Manganese	steady state	some	same
NT-8 (WIP)	Arsenic	>1000	all	>
	Beryllium	>1000	some	>
	Boron	>1000	all	>
	Chromium	>1000	all	>
	Copper	>1000	all	>
	Lead	>1000	all	>
	Manganese	>1000	all	>
PICKETT A	Arsenic	>1000	all	
	Boron	>1000	all	
	Chromium	>1000	all	
	Lead	>1000	some	
	Manganese	>1000	some	
	Nickel	>1000	all	

* 40 years corresponds to the present time; thus, 200 years is 160 years from now.

Table G.31. Summary of risk characterization for terrestrial plants by transect

Transect	Evidence	Result	Explanation
TS01	Literature toxicity data	+	Cadmium (TS012), lead (TS012), lithium (TS012), mercury (TS012, TS016), and selenium (TS012, TS016) at concentrations above benchmarks.
	Biological surveys	-	Several dead trees southeast of NT2 (near TS011, TS012, TS013), attributable to causes other than contaminants.
	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings.
	Weight of evidence	-	There is no evidence that the soils of TS02 are toxic to plants.
TS02	Literature toxicity data	+	Mercury, selenium, and thallium at concentrations above benchmarks at TS023.
	Biological surveys	NA	No surveys were performed.
	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings.
	Weight of evidence	-	There is no evidence that the soils of TS02 are toxic to plants.
TS03	Literature toxicity data	+	Cadmium (TS033), lithium (TS033), mercury (TS033, TS034), nickel (TS033, TS034), selenium (TS033, TS034) at concentrations above benchmarks.
	Biological surveys	-	No dead or visibly stressed vegetation near NT7 confluence with Bear Creek (near TS034, TS035, and TS036).
	Medium toxicity tests	±	Marginally low mean growth of lettuce seedlings at TS034.
	Weight of evidence	+	There is some evidence of adverse impacts to the plant community at TS033 and TS034.
TS04	Literature toxicity data	+	Lithium (TS042), selenium (TS041, TS042), mercury (TS042) at concentrations above benchmarks.
	Biological surveys	±	Several dead trees and stumps in wetland.
	Medium toxicity tests	+	Low mean growth of lettuce seedlings at TS041 and TS042.
	Weight of evidence	+	There is some evidence of adverse impacts to the plant community at TS041 and TS042.
TS05	Literature toxicity data	±	Selenium at concentration above benchmark at TS051.
	Biological surveys	NA	No surveys were performed.

Table G.31 (continued)

Transect	Evidence	Result	Explanation
TS06	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings.
	Weight of evidence	-	There is no evidence that the soils of TS05 are toxic to plants.
	Literature toxicity data	+	Mercury (TS063, TS064) and selenium (TS064) at concentrations above benchmark.
	Biological surveys	NA	No surveys were performed.
	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings.
TS07	Weight of evidence	-	There is no evidence that the soils of TS06 are toxic to plants.
	Literature toxicity data	+	Cadmium (TS071), mercury (TS071, TS073), selenium (TS071, TS073) at concentrations above benchmark.
	Biological surveys	NA	No surveys were performed.
	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings.
	Weight of evidence	-	There is no evidence that the soils of TS07 are toxic to plants.
TS08	Literature toxicity data	+	Mercury and selenium at concentrations above benchmark.
	Biological surveys	NA	No surveys were performed.
	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings.
	Weight of evidence	-	There is no evidence that the soils of TS08 are toxic to plants.
TS09	Literature toxicity data	-	Contaminant concentrations not measured above background.
	Biological surveys	NA	No surveys were performed.
	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings.
	Weight of evidence	-	There is no evidence that the soils of TS09 are toxic to plants.
TS10	Literature toxicity data	±	Selenium concentration slightly above benchmarks.
	Biological surveys	NA	No surveys were performed.
	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings.
	Weight of evidence	-	There is little evidence that the soils of TS10 are toxic to plants.
TS11	Literature toxicity data	-	Contaminant concentrations not measured above background.

Table G.31 (continued)

Transect	Evidence	Result	Explanation
TS12	Biological surveys	NA	No surveys were performed.
	Medium toxicity tests	NA	Growth of lettuce seedlings not tested.
	Weight of evidence	-	There is no evidence that the soils of TS11 are toxic to plants.
	Literature toxicity data	-	Contaminant concentrations not measured above background.
	Biological surveys	NA	No surveys were performed.
	Medium toxicity tests	NA	Growth of lettuce seedlings not tested.
	Weight of evidence		There is no evidence that the soils of TS12 are toxic to plants.
TS13	Literature toxicity data		Mercury, selenium at concentrations slightly above benchmarks.
	Biological surveys	NA	No surveys were performed.
	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings.
	Weight of evidence	-	There is little evidence that the soils of TS13 are toxic to plants.

Table G.32. Summary of risk characterization for plants exposed to groundwater

Location	Evidence	Result	Explanation
SS1 region	Literature toxicity data	±	Aluminum at concentrations above benchmarks in unfiltered samples, but below background in filtered.
	Biological surveys	NA	The plant community was not surveyed.
	Weight of evidence	-	There is no evidence that groundwater feeding the spring is adversely impacting vegetation.
SS2 region	Literature toxicity data	NA	No contaminant data available.
	Biological surveys	-	Two dead trees observed, probably caused by canopy closure.
	Weight of evidence	-	There is no evidence that groundwater feeding the spring is adversely impacting vegetation.
SS3 region	Literature toxicity data	NA	No contaminant data available.
	Biological surveys	-	No dead, damaged or stressed vegetation was observed.
	Weight of evidence	-	There is no evidence that groundwater feeding the spring is adversely impacting vegetation.
SS4 region	Literature toxicity data	±	Aluminum at concentrations above benchmarks in unfiltered samples, but below background in filtered.
	Biological surveys	-	No dead, damaged or stressed vegetation was observed.
	Weight of evidence	-	There is no evidence that groundwater feeding the spring is adversely impacting vegetation.
SS5 region	Literature toxicity data	±	Arsenic at concentrations above benchmarks in two (of 14) filtered samples, but below background in unfiltered.
	Biological surveys	-	No dead, damaged or stressed vegetation was observed.
	Weight of evidence	-	There is no evidence that groundwater feeding the spring is adversely impacting vegetation.
SS6 region	Literature toxicity data	±	Aluminum at concentrations above benchmarks in unfiltered samples, but below background in filtered.
	Biological surveys	NA	The plant community was not surveyed.

Table G.32 (continued)

Location	Evidence	Result	Explanation
SS8 region	Weight of evidence	-	There is no evidence that groundwater feeding the spring is adversely impacting vegetation.
	Literature toxicity data	+	Cadmium (TS071), mercury (TS071, TS073), selenium (TS071, TS073) at concentrations above benchmark.
	Biological surveys	NA	The plant community was not surveyed.
BCV floodplain at NT-1	Weight of evidence	-	There is no evidence that the soils of TS07 are toxic to plants.
	Literature toxicity data	±	Copper at concentrations above benchmarks in unfiltered samples from GW 345 and GW 526.
	Biological surveys	-	Several dead green ash and red maples, surrounded by healthy saplings
BCV floodplain at NT-2	Weight of evidence	-	There is no evidence that groundwater is adversely impacting vegetation.
	Literature toxicity data	-	Contaminant concentrations not measured above background in GW 537
	Biological surveys	±	Dead honeysuckle and several dead trees southeast of NT2, including tulip poplar and misshapen ash
	Medium toxicity tests	-	No evidence of toxicity to lettuce seedlings
	Weight of evidence	-	There is no evidence that groundwater is adversely impacting vegetation.

Table G.33. Groundwater wells used to evaluate soil solution exposure

Area	Well number	Screened depth (ft)	Cluster
S3 Ponds, NT1	GW-345	26.3	2
S3 Ponds, NT2	GW-537	24.5	3
BYBY, NT3	GW-087	19	3
BYBY, NT4	GW-097	19	1
BG, NT6	GW-014	22.5	1
	GW-039	13.2	10
BG, NT7	GW-021	15	1
	GW-046	20.5	2
BG, NT8	GW-287	12.5	3
	GW-291	17	3
	GW-654	15.5	3
BG source area	GW-018	20.8	2

Table G.34. Comparison of maximum contaminant concentrations in soil aggregates with benchmarks for toxicity to plants in soil

Analyte	Background (mg/kg)	Toxicity benchmark (mg/kg)	Concentration (mg/kg)		
			Mean	Maximum	Max HQ
S-3 Ponds area					
Arsenic ^a	20.2	10	4.92	20.5	2.0
Barium	212	500	112	277	0.55
Cadmium	0.31	3	0.25	2	0.7
Copper	35.5	100	23.6	50.8	0.5
Lead	49.6	500	19.9	82.3	0.2
Mercury	0.34	0.3	14.8	82.9	278
Nickel	56.7	30	25.5	128	4.3
Silver	2.8	2	1.91	4.3	2.15
Tin	NA ^b	50	2.05	7.7	0.15
Vanadium	60.1	2	27.9	91.9	46
Zinc	108	50	52.1	163	3.3
Aroclor 1254	NA ^b	40	0.07	0.37	0.01
Aroclor 1260	NA	40	0.04	0.21	0.005
Toluene	NA	200	0.009	0.022	0.0001
Boneyard Burnyard area					
Aluminum	46700	50	29900	65900	1318
Antimony	1	5	139	1650	330
Arsenic	20.2	10	13.3	32.5	3.25
Barium	212	500	262	1100	2.2
Beryllium	2.12	10	1.16	3.30	0.3
Cadmium	0.31	3	5.97	32.3	10.8
Chromium	80.1	1	61.4	210	210
Cobalt	40.1	20	19.1	131	65.5
Copper	35.5	100	968	6220	62.2
Lead	49.6	500	426	1870	3.74
Lithium	33	2	28.8	50	25.0
Manganese	2220	500	918	2980	5.9
Mercury	0.34	0.3	31.7	77.7	259
Molybdenum	12.8	2	6.81	50.3	25.2

Table G.34 (continued)

Analyte	Background (mg/kg)	Toxicity benchmark (mg/kg)	Concentration (mg/kg)		
			Mean	Maximum	Max HQ
Nickel	56.7	30	415	10600	353
Selenium	1.2	1	10.9	132	132
Silver	2.8	2	11.8	61.5	30.8
Thallium	0.79	1	0.25	0.87	0.9
Tin	NA	50	34.3	102	2.0
Vanadium	60.1	2	40.5	97	48.5
Zinc	108	50	615	4380	87.6
Aroclor 1254	NA	40	1.66	5.8	0.14
Aroclor 1260	NA	40	0.27	1.6	0.04
Toluene	NA	200	0.124	0.59	0.003
<i>Sanitary Landfill/Oil Landfarm area</i>					
Aluminum	46700	50	37800	77500	1550
Arsenic	20.2	10	8.13	31.8	3.18
Barium	212	500	182	380	0.76
Beryllium	2.12	10	1.18	2.5	0.25
Cadmium	0.31	3	1.33	3.2	1.07
Cobalt	40.1	20	28.8	406	20.3
Copper	35.5	100	44.6	252	2.52
Lead	49.6	500	35.8	201	0.4
Lithium	33	2	40	120	60.0
Manganese	2220	500	781	4900	9.8
Mercury	0.34	0.3	4	41.5	138.3
Nickel	56.7	30	31.8	123	4.1
Silver	2.8	2	2.82	7.6	3.8
Tin	NA	50	2.27	4.8	0.09
Vanadium	60.1	2	45.2	90	45.0
Zinc	108	50	100	470	9.4
Aroclor 1232	NA	40	0.12	1.3	0.03
Aroclor 1254	NA	40	0.02	1.7	0.04
Aroclor 1260	NA	40	0.005	0.22	0.005
Toluene	NA	200	0.016	0.11	0.0006

Table G.34 (continued)

Analyte	Background (mg/kg)	Toxicity benchmark (mg/kg)	Concentration (mg/kg)		
			Mean	Maximum	Max HQ
Burial Grounds area					
Aluminum	46700	50	33000	85800	1716
Arsenic	20.2	10	7.51	42.3	4.23
Barium	212	500	155	454	0.9
Beryllium	2.12	10	1.07	4.8	0.5
Chromium	80.1	1	37.2	84	84.0
Copper	35.5	100	16.1	45	0.45
Lithium	33	2	28	50	25.0
Manganese	2220	500	541	2450	4.9
Mercury	0.34	0.3	0.11	0.47	1.57
Nickel	56.7	30	22	206	6.87
Selenium	1.2	1	0.56	2.8	2.8
Silver	2.8	2	2.25	4	2.0
Tin	NA	50	2.15	9.4	0.2
Vanadium	60.1	2	38.4	82	41.0
Zinc	108	50	55.5	199	4.0
Aroclor 1248	NA	40	0.033	0.4	0.01
Aroclor 1254	NA	40	0.36	10	0.25
Aroclor 1260	NA	40	1.18	36	0.9
Toluene	NA	200	0.036	0.36	0.002

*Boldface font indicates COPECs whose maximum concentrations exceed benchmarks.

^aNA = Background not established for tin; background not applicable for organic analytes.

Table G.35. Comparison of maximum contaminant concentrations in debris burial areas with benchmarks for toxicity to plants in soil

Analyte	Background (mg/kg)	Toxicity benchmark (mg/kg)	Conc. (mg/kg) HQ	
<i>Creekside Debris Burial Area</i>				
Barium ^a	212	500	99.7	0.2
Cadmium	0.31	3	1.7	0.57
Chromium	80.1	1	107	107
Copper	35.5	100	52	0.52
Mercury	0.34	0.3	33	110
Selenium	1.2	1	2.5	2.5
Silver	2.8	2	8.7	4.35
Zinc	108	50	151	3.02
Acenaphthene	NA ^b	20	4.2	0.05
Aroclor 1254	NA ^b	40	1.2	0.03
Di-n-butyl phthalate	NA ^b	200	0.069	0.00034
Phenol	NA ^b	70	0.09	0.001
<i>Bear Creek Road Debris Burial Area</i>				
Barium ^a	212	500	633	1.27
Cadmium	0.31	3	15.6	5.2
Copper	35.5	100	1650	16.5
Lead	49.6	500	516	1.03
Mercury	0.34	0.3	5.4	18
Nickel	56.7	30	86.5	2.88
Selenium	1.2	1	2.2	2.2
Silver	2.8	2	32.7	16.4
Zinc	108	50	875	17.5
Aroclor 1254	NA ^b	40	3.6	0.09
<i>S-3 Ponds Sludges (from Table A.3)</i>				
Beryllium	2.12	10	2.74	0.27
Boron	34	0.5	37.64	75.3
Cadmium	0.31	3	4.9	1.63
Chromium (III)	80.1	1	133.2	133
Chromium (VI)	a	1	0.19	0.19

Table G.35 (continued)

Analyte	Background (mg/kg)	Toxicity benchmark (mg/kg)	Conc. (mg/kg) HQ	
Copper	35.5	100	92.45	0.92
Lithium	33	2	75.68	151
Mercury	0.34	0.3	2.28	7.6
Molybdenum	12.8	2	15.2	7.6
Nickel	56.7	30	550.32	18.3
Tin	<i>a</i>	50	1.57	0.03
Uranium	<i>a</i>	5	997.71	199.5
Aroclor 1248	NA ^b	40	5.67	0.14
Diethylphthalate	NA ^b	100	0.523	0.005
Toluene	NA ^b	200	0.00027	0.00
<i>Waste Inventory—Burial Ground A-South (from Table A.13)</i>				
Uranium	<i>a</i>	5	15000	3000
PCBs	NA ^b	40	21	0.52
<i>Waste Inventory—Burial Ground A-North (from Table A.14)</i>				
Uranium	<i>a</i>	5	15000	3000
PCBs	NA ^b	40	21	0.52
<i>Waste Inventory—Burial Ground A-16 (from Table A.15)</i>				
Uranium	<i>a</i>	5	610	122
<i>Waste Inventory—Burial Ground A-17 (from Table A.16)</i>				
Uranium	<i>a</i>	5	610	122
<i>Waste Inventory—Burial Ground A-18 (from Table A.17)</i>				
Uranium	<i>a</i>	5	610	122
<i>Waste Inventory—Burial Ground B (from Table A.18)</i>				
Uranium	<i>a</i>	5	300000	60000
<i>Waste Inventory—Burial Ground C-East (from Table A.19)</i>				
Beryllium	2.12	10	1100	110
Lithium	33	2	280	140
Uranium	<i>a</i>	5	610	122

Table G.35 (continued)

Analyte	Background (mg/kg)	Toxicity benchmark (mg/kg)	Conc. (mg/kg) HQ	
Waste Inventory—Burial Ground C-West (from Table A.20)				
Beryllium	2.12	10	1100	110
Lithium	33	2	280	140
Uranium	a	5	22000	4400
Waste Inventory—Burial Ground D-East (from Table A.21)				
Uranium	a	5	240000	48000
Waste Inventory—Burial Ground D-South (from Table A.22)				
Uranium	a	5	240000	48000
Waste Inventory—Burial Ground D-West, E, and J (from Table A.23)				
Uranium	a	5	260000	52000
Waste Inventory—Walk-In Pit 1 (North) (from Table A.24)				
Beryllium	2.12	10	26	2.6
Lead	49.6	50	516	10.3
Mercury	0.34	0.3	17	56.7
PCBs	NA ^b	40	1.7	0.42
Waste Inventory—Walk-In Pits 2 and 3 (South) (from Table A.25)				
Mercury	0.34	0.3	2	0.67
Uranium	a	5	260000	52000

^aBoldface font indicates COPECs whose maximum concentrations exceed benchmarks.

^bNA = background not applicable for organic analytes.

Table G.36. Comparison of maximum contaminant concentrations above background criteria in shallow groundwater wells with benchmarks for toxicity to plants in soil

Analyte	Background (mg/L)	Toxicity benchmark (mg/L)	Maximum concentration (mg/L)	Max HQ
<i>S3 Ponds area, Wells GW-345 (cluster 2) and GW-537 (cluster 3)</i>				
Beryllium	0.00045	0.5	0.0008	0.0016
Boron	0.028 (0.041) ^a	1	0.49	0.49
Copper	0.012	0.05	0.083	1.66
Nickel	0.06	0.5	0.12	0.24
Zinc	0.041 (0.043)	0.4	0.051	0.013
<i>BYBY NT3 area, Well GW-087 (cluster 2)</i>				
Aluminum	6.1	0.2	3.1	15.5
Arsenic	0.078	0.001	0.0025	2.5
Beryllium	0.00045	0.5	0.0002	0.0004
Copper	0.012	0.05	0.035	0.7
Lead	0.0096	0.02	0.026	1.3
Lithium		3	0.015	0.005
Manganese	1.7	4	0.57	0.14
Mercury	0.0003	0.005	0.0006	0.12
Vanadium	0.0044	0.2	0.0054	0.027
Zinc	0.043	0.4	0.052	0.013
Toluene	NA ^c	10	0.001	0.0001
<i>SL/OLF NT4 area, Well GW-010 (cluster 1)</i>				
No analytes above background concentrations.				
<i>BG NT6 area, Wells GW-014 and GW-039 (Cluster 1)</i>				
Aluminum	2.4	0.2	3.2	16
Beryllium	0.00045	0.5	0.0022	0.0044
Cadmium	0.002	0.1	0.052	0.52
Chromium	0.029	0.05	0.06	1.2
Cobalt	0.019	0.06	0.014	0.23
Copper	0.012	0.05	0.017	0.35
Lead	0.0096	0.02	0.11	5.5
Lithium		3	0.016	0.005
Manganese	1.7	4	2.4	0.6
Nickel	0.06	0.5	0.092	0.18

Table G.36 (continued)

Analyte	Background (mg/L)	Toxicity benchmark (mg/L)	Maximum concentration (mg/L)	Max HQ
Vanadium	0.0044	0.2	0.006	0.03
Toluene	NA	10	0.003	0.0003
<i>BG NT7 area, Wells GW-021 (cluster 1) and GW-046 (cluster 2)</i>				
Cadmium	0.002 (0.0028)	0.1	0.008	0.08
Chromium	0.029 (0.041)	0.05	0.04	0.8
Lead	0.0096	0.02	0.53	26.5
Lithium		3	0.1	0.33
Mercury	0.0003	0.005	0.0007	0.14
Zinc	0.041 (0.043)	0.4	0.068	0.17
Toluene	NA	10	0.002	0.0002
<i>BG NT8 area, Wells GW-287, GW-291, and GW-654 (cluster 3)</i>				
Aluminum	2.4	0.2	4.5	22.5
Beryllium	0.00045	0.5	0.0023	0.0046
Cadmium	0.0025	0.1	0.0049	0.049
Copper	0.012	0.05	6.6	132
Iron	8.7	10	33	3.3
Lead	0.0096	0.02	0.7	35
Lithium		3	0.016	0.005
Manganese	1.7	4	2.4	0.6
Mercury	0.0003	0.005	0.0004	0.08
Thallium		0.02	0.005	0.25
Zinc	0.041	0.4	0.092	0.023
Toluene	NA	10	0.0008	0.00008
<i>BG area, Well GW-018 (cluster 2)</i>				
Copper	0.012	0.05	0.015	0.3

^aBackground for second cluster given in parentheses.

^bBoldface font indicates COPECs whose maximum concentrations exceed benchmarks.

^cNA = Background not applicable for organic analytes.

Table G.37. Summary of risk characterization for terrestrial plants exposed to contaminants in soil in source areas

Evidence	Result	Explanation
<i>S-3 Ponds area, current exposure</i>		
Literature toxicity data	+	Mercury concentrations at maximum of 278 times toxicity benchmarks; arsenic, nickel, silver, vanadium, and zinc also exceed toxicity benchmarks.
Biological surveys	-	No dead or visibly stressed vegetation was observed in vegetated areas near the S-3 Ponds area during the June-July 1996 survey.
Medium toxicity tests	Insufficient data	Growth of lettuce seedlings was not tested. There is no evidence that observed concentrations of COPECs above soil toxicity benchmarks are not toxic to lettuce seeds.
Weight of evidence	-	Despite high apparent exposure of plants to arsenic, mercury, nickel, silver, vanadium, and zinc in soil, biological surveys do not indicate that soils in the S3 Ponds area are toxic to plants.
<i>BYBY area, current exposure</i>		
Literature toxicity data	+	Maximum concentrations of aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, tin, vanadium, and zinc are above toxicity benchmarks by a range of 2 to >350 fold.
Biological surveys	-	No dead or visibly stressed vegetation was observed in portions of the BYBY area east, south, and northwest of the HCDA, except for willows that have died and resprouted in a seep north of the HCDA.
Medium toxicity tests	Insufficient data	Growth of lettuce seedlings was not tested. There is no evidence that observed concentrations of COPECs above soil toxicity benchmarks are not toxic to lettuce seeds.
Weight of evidence	-	Despite high apparent exposures of plants to aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, tin, vanadium, and zinc in soil, biological surveys do not indicate that soils in the BYBY area are toxic to plants.
<i>SL 1/OLF area, current exposure</i>		
Literature toxicity data	+	Maximum concentrations of aluminum, arsenic, cobalt, copper, lithium, manganese, mercury, nickel, silver, vanadium, and zinc are above toxicity benchmarks by a range of 2.5 to 138 fold.
Biological surveys	-	No dead or visibly stressed vegetation was observed in the eastern end of the SL 1/OLF during the June-July 1996 survey.
Medium toxicity tests	Insufficient data	Growth of lettuce seedlings was not tested. There is no evidence that observed concentrations of COPECs above soil toxicity benchmarks are not toxic to lettuce seeds.
Weight of evidence	-	Despite high apparent exposure of plants to aluminum, arsenic, cobalt, copper, lithium, manganese, mercury, nickel, silver, vanadium, and zinc in soil, biological surveys do not indicate that soils in the SL 1/OLF area are toxic to plants.

Table G.37 (continued)

Evidence	Result	Explanation
<i>BCBG area, current exposure</i>		
Literature toxicity data	+	Maximum concentrations of aluminum, arsenic, chromium, lithium, manganese, nickel, selenium, silver, vanadium, and zinc are above toxicity benchmarks by a range of 2 to >80 fold.
Biological surveys	-	No dead or visibly stressed vegetation was observed in portions of the BCBG area during the June-July 1996 survey. Ground cover was lacking or sparse at disturbed sites or those with little or no surface soil.
Medium toxicity tests	Insufficient data	Growth of lettuce seedlings was not tested. There is no evidence that observed concentrations of COPECs above soil toxicity benchmarks are not toxic to lettuce seeds.
Weight of evidence	-	Despite high apparent exposure of plants to aluminum, arsenic, chromium, lithium, manganese, nickel, selenium, silver, vanadium, and zinc in soil, biological surveys do not indicate that soils in the BCBG area are toxic to plants.
<i>Creekside Debris Burial area, current exposure</i>		
Literature toxicity data	+	Maximum concentrations of chromium, mercury, selenium, silver, and zinc exceed toxicity benchmarks by a range of 2.5 to ~150 fold.
Biological surveys	-	No dead or visibly stressed vegetation was observed in the Creekside Debris Burial area during the June-July 1996 survey.
Medium toxicity tests	Insufficient data	Growth of lettuce seedlings was not tested. There is no evidence that observed concentrations of COPECs above soil toxicity benchmarks are not toxic to lettuce seeds.
Weight of evidence	-	Despite high apparent exposure of plants to chromium, mercury, selenium, silver, and zinc in soil, biological surveys do not indicate that soils in the Creekside Debris Burial area are toxic to plants.
<i>Bear Creek Road Debris Burial area, current exposure</i>		
Literature toxicity data	+	Maximum concentrations of barium, cadmium, copper, mercury, nickel, selenium, silver, and zinc exceed toxicity benchmarks by a range of 1.2 to 18 fold.
Biological surveys	Insufficient data	Biological survey was not conducted.
Medium toxicity tests	Insufficient data	Growth of lettuce seedlings was not tested.
Weight of evidence	-	Concentrations of barium, cadmium, copper, mercury, nickel, selenium, silver, and zinc in debris are not higher than at sites where biological surveys do not indicate that soils are toxic to plants.
<i>S-3 Ponds sludges, future exposure</i>		

Table G.37 (continued)

Evidence	Result	Explanation
Literature toxicity data	+	Estimated concentrations of chromium, lithium, and uranium exceed toxicity benchmarks by >100-fold. Concentrations of boron and nickel exceed toxicity benchmarks by >10-fold. concentrations of cadmium, mercury, and molybdenum exceed toxicity benchmarks by <10-fold.
Biological surveys	Insufficient data	Biological survey was not conducted.
Medium toxicity tests	Insufficient data	Growth of lettuce seedlings was not tested. There is no evidence that observed concentrations of COPECs above soil toxicity benchmarks are not toxic to lettuce seeds.
Weight of evidence	+	Boron, cadmium, chromium, lithium, mercury, molybdenum, nickel, and uranium are COCs for potential future exposure of plants to S-3 Pond sludges.
<i>BCBG Waste Inventory, future exposure</i>		
Literature toxicity data	+	Estimated concentrations of uranium exceed toxicity benchmarks by a range of >100 to >50,000-fold. Concentrations of beryllium and lithium exceed toxicity benchmarks by up to 110-fold and 140-fold, respectively. Lead and mercury exceed toxicity benchmarks by a range of 10- to >50-fold.
Biological surveys	Insufficient data	Biological survey was not conducted.
Medium toxicity tests	Insufficient data	Growth of lettuce seedlings was not tested. There is no evidence that observed concentrations of COPECs above soil toxicity benchmarks are not toxic to lettuce seeds.
Weight of evidence	+	Beryllium, lead, lithium, mercury, and uranium are COCs for potential future exposure of plants to inventoried wastes at the Burial Grounds area.

Table G.38. Summary of risk characterization for terrestrial plants exposed to contaminants in soil solution in source areas

Evidence	Result	Explanation
<i>5-3 Ponds area, NT1 and NT2</i>		
Literature toxicity data	+	Copper exceeded background and the toxicity benchmark, with HQ=1.6.
Medium toxicity tests	Insufficient data	No ambient toxicity testing of soil solutions was done.
Vegetation survey	-	No evidence was found for damage to plants by contaminants in groundwater or soil near NT1 and NT2.
Weight of evidence	-	Single chemical toxicity screen not supported by results of the vegetation survey.
<i>Boneyard Burnyard area, NT3</i>		
Literature toxicity data	+	Maximum concentrations of aluminum, arsenic, and lead are above toxicity benchmarks by a range of 2.5 to >15 fold.
Medium toxicity tests	Insufficient data	No ambient toxicity testing of soil solutions was done.
Vegetation survey	-	No evidence was found for damage to plants by contaminants in groundwater or soil near NT3.
Weight of evidence	±	HQs are low, and results of single chemical toxicity screen were not supported by results of the vegetation survey.
<i>Sanitary Landfill/Oil Landfarm area, NT4</i>		
Literature toxicity data	-	There were no analytes above background in the shallow groundwater sample.
Medium toxicity tests	Insufficient data	No ambient toxicity testing of soil solutions was done.
Vegetation survey	Insufficient data	Vegetation near NT4 was not surveyed.
Weight of evidence	-	No evidence was found for risk to plant populations.
<i>Burial Grounds area, NT6</i>		
Literature toxicity data	+	Maximum concentrations of aluminum, chromium, and lead are above toxicity benchmarks by a range of 1.2 to 16-fold.
Vegetation survey	Insufficient data	Vegetation near NT6 was not surveyed.
Medium toxicity tests	Insufficient data	No ambient toxicity testing of soil solutions was done.

Table G.38 (continued)

Evidence	Result	Explanation
Weight of evidence	-	Chromium HQ is low. Aluminum and lead concentrations are lower than at locations where the vegetation survey found no evidence of lead or stressed vegetation.
<i>Burial Grounds area, NT7</i>		
Literature toxicity data	+	Maximum concentrations of lead are above toxicity benchmarks by 26-fold.
Medium toxicity tests	Insufficient data	No ambient toxicity testing of soil solutions was done.
Vegetation survey	Insufficient data	Vegetation at NT7 was not surveyed.
Weight of evidence	+	Lead concentration was lower than at NT8 where the vegetation survey found no evidence of lead or stressed vegetation.
<i>Burial Grounds area, NT8</i>		
Literature toxicity data	+	Maximum concentrations of aluminum, copper, iron, and lead are above toxicity benchmarks by a range of 3.3 to 132-fold.
Medium toxicity tests	Insufficient data	No ambient toxicity testing of soil solutions was done.
Vegetation survey	-	No evidence of stressed vegetation.
Weight of evidence	-	Single chemical toxicity screen not supported by results of the vegetation survey.
<i>Burial Grounds area</i>		
Literature toxicity data	-	No contaminants were above background and a toxicity benchmark.
Medium toxicity tests	Insufficient data	No ambient toxicity testing of soil solutions was done.
Vegetation survey	-	No evidence of lead or stressed vegetation.
Weight of evidence	-	No COCs for exposure of plants to soil solution in parts of the BG area away from tributaries.

Table G.39. Summary statistics for Bear Creek biota uptake factors

Analyte	Media	N	Mean	Standard error	UCL95	Maximum	Minimum
Aluminum	Browse	36	0.004	0.001	0.006	0.022	0.001
Americium-241	Browse	5	1.694	0.323	2.328	2.489	0.894
Antimony	Browse	18	0.039	0.017	0.072	0.324	0.011
Arsenic	Browse	36	0.006	0.001	0.008	0.015	0.000
Barium	Browse	36	0.112	0.017	0.146	0.446	0.008
Beryllium	Browse	30	0.007	0.001	0.008	0.013	0.002
Cadmium	Browse	35	2.525	0.989	4.464	28.387	0.002
Calcium	Browse	36	1.912	0.256	2.413	6.367	0.104
Chromium	Browse	36	0.021	0.002	0.026	0.065	0.001
Cobalt	Browse	36	0.003	0.000	0.004	0.010	0.001
Copper	Browse	36	0.317	0.040	0.396	0.864	0.001
Curium-244	Browse	3	2.276	0.767	3.780	3.378	0.800
Iron	Browse	36	0.001	0.000	0.002	0.003	0.000
Lead	Browse	36	0.008	0.002	0.011	0.043	0.000
Lithium	Browse	36	0.006	0.002	0.009	0.055	0.000
Magnesium	Browse	30	1.031	0.102	1.231	2.350	0.402
Manganese	Browse	30	0.156	0.031	0.218	0.504	0.015
Mercury	Browse	27	0.051	0.008	0.067	0.135	0.007
Nickel	Browse	36	0.050	0.011	0.072	0.277	0.001
Plutonium-238	Browse	3	5.200	1.499	8.137	7.200	2.267
Plutonium-239/240	Browse	5	4.070	1.255	6.529	7.600	0.750
Potassium	Browse	30	6.313	0.575	7.440	12.455	2.513
Selenium	Browse	30	0.056	0.040	0.133	1.200	0.008
Silver	Browse	28	0.067	0.025	0.115	0.513	0.000
Sodium	Browse	36	0.353	0.031	0.414	0.748	0.011
Thallium	Browse	9	0.010	0.003	0.017	0.035	0.004
Uranium	Browse	1	0.000			0.000	0.000
Vanadium	Browse	36	0.025	0.002	0.028	0.044	0.010
Zinc	Browse	36	0.397	0.060	0.515	1.319	0.004
Aluminum	Canopy	35	0.006	0.001	0.008	0.021	0.000
Americium-241	Canopy	6	2.774	1.493	5.700	10.194	0.748
Antimony	Canopy	17	0.021	0.002	0.024	0.037	0.011
Arsenic	Canopy	35	0.016	0.007	0.028	0.230	0.001
Barium	Canopy	35	0.139	0.024	0.186	0.628	0.007
Beryllium	Canopy	29	0.015	0.004	0.023	0.114	0.002

Table G.39 (continued)

Analyte	Media	N	Mean	Standard error	UCL95	Maximum	Minimum
Cadmium	Canopy	33	0.240	0.056	0.350	1.178	0.003
Calcium	Canopy	35	2.513	0.296	3.094	6.297	0.081
Chromium	Canopy	35	0.027	0.004	0.035	0.147	0.001
Cobalt	Canopy	35	0.002	0.000	0.003	0.009	0.001
Copper	Canopy	35	0.148	0.016	0.180	0.349	0.001
Curium-244	Canopy	3	1.306	0.380	2.051	2.050	0.800
Iron	Canopy	35	0.002	0.001	0.003	0.019	0.000
Lead	Canopy	35	0.035	0.009	0.053	0.228	0.000
Lithium	Canopy	35	0.016	0.006	0.028	0.161	0.000
Magnesium	Canopy	29	1.059	0.107	1.269	2.615	0.324
Manganese	Canopy	29	0.147	0.030	0.206	0.733	0.011
Mercury	Canopy	26	0.043	0.006	0.055	0.128	0.006
Nickel	Canopy	35	0.089	0.017	0.122	0.327	0.002
Plutonium-238	Canopy	3	5.941	1.464	8.810	7.600	3.022
Plutonium-239/240	Canopy	5	10.010	5.056	19.920	30.000	2.850
Potassium	Canopy	29	3.684	0.436	4.539	11.415	0.288
Selenium	Canopy	29	0.064	0.037	0.136	1.036	0.007
Silver	Canopy	26	0.114	0.034	0.181	0.545	0.000
Sodium	Canopy	35	0.349	0.032	0.412	0.707	0.012
Thallium	Canopy	5	0.549	0.449	1.430	2.318	0.004
Uranium	Canopy	1	0.001			0.001	0.001
Vanadium	Canopy	35	0.029	0.004	0.036	0.151	0.010
Zinc	Canopy	35	0.227	0.027	0.280	0.737	0.013
Aluminum	Earthworm	12	0.068	0.015	0.098	0.197	0.012
Americium-241	Earthworm	10	3.115	1.002	5.079	9.200	0.800
Antimony	Earthworm	8	0.081	0.008	0.097	0.124	0.048
Arsenic	Earthworm	12	0.078	0.022	0.122	0.281	0.006
Barium	Earthworm	12	0.105	0.024	0.152	0.310	0.005
Beryllium	Earthworm	10	0.045	0.009	0.063	0.109	0.009
Cadmium	Earthworm	12	10.791	4.531	19.671	44.553	0.253
Calcium	Earthworm	12	0.542	0.175	0.885	2.274	0.023
Chromium	Earthworm	12	3.033	1.039	5.069	11.416	0.064
Cobalt	Earthworm	12	0.120	0.024	0.167	0.321	0.031
Copper	Earthworm	12	0.622	0.445	1.495	5.498	0.002
Curium-244	Earthworm	7	1.180	0.503	2.166	4.089	0.152

Table G.39 (continued)

Analyte	Media	N	Mean	Standard error	UCL95	Maximum	Minimum
Iron	Earthworm	12	0.042	0.009	0.059	0.100	0.006
Lead	Earthworm	12	0.215	0.171	0.550	2.087	0.000
Lithium	Earthworm	12	0.228	0.139	0.500	1.733	0.008
Magnesium	Earthworm	10	0.240	0.044	0.326	0.539	0.108
Manganese	Earthworm	10	0.052	0.011	0.074	0.127	0.012
Mercury	Earthworm	9	0.611	0.182	0.968	1.663	0.038
Nickel	Earthworm	12	2.617	0.744	4.076	7.802	0.038
PCB-1254	Earthworm	8	0.541	0.130	0.796	1.065	0.040
PCB-1260	Earthworm	11	1.855	1.093	3.996	12.381	0.014
Plutonium-238	Earthworm	8	9.246	2.378	13.908	20.000	0.914
Plutonium-239/240	Earthworm	9	3.922	1.400	6.667	14.400	0.667
Potassium	Earthworm	10	1.925	0.362	2.633	4.195	0.681
Selenium	Earthworm	10	0.822	0.114	1.045	1.395	0.301
Silver	Earthworm	11	0.926	0.305	1.523	2.807	0.001
Sodium	Earthworm	12	4.528	1.040	6.567	14.605	0.146
Thallium	Earthworm	1	0.017			0.017	0.017
Uranium	Earthworm	2	0.033	0.030	0.092	0.063	0.003
Vanadium	Earthworm	12	0.066	0.021	0.108	0.293	0.016
Zinc	Earthworm	12	1.121	0.188	1.489	2.183	0.032
Aluminum	Herbaceous	36	0.025	0.004	0.034	0.115	0.001
Americium-241	Herbaceous	5	3.800	2.484	8.669	13.686	0.813
Antimony	Herbaceous	17	0.020	0.002	0.024	0.038	0.011
Arsenic	Herbaceous	36	0.015	0.002	0.019	0.063	0.001
Barium	Herbaceous	36	0.103	0.009	0.121	0.203	0.016
Beryllium	Herbaceous	30	0.015	0.002	0.020	0.068	0.002
Cadmium	Herbaceous	35	0.239	0.049	0.335	1.115	0.004
Calcium	Herbaceous	36	0.763	0.098	0.956	2.165	0.024
Chromium	Herbaceous	36	0.066	0.015	0.096	0.528	0.001
Cobalt	Herbaceous	36	0.010	0.002	0.013	0.040	0.001
Copper	Herbaceous	36	0.141	0.015	0.171	0.340	0.001
Curium-244	Herbaceous	3	4.296	2.381	8.963	8.950	1.093
Iron	Herbaceous	36	0.011	0.002	0.014	0.047	0.000
Lead	Herbaceous	36	0.019	0.003	0.025	0.088	0.000
Lithium	Herbaceous	36	0.022	0.003	0.028	0.082	0.000
Magnesium	Herbaceous	30	0.703	0.070	0.841	1.701	0.219

Table G.39 (continued)

Analyte	Media	N	Mean	Standard error	UCL95	Maximum	Minimum
Manganese	Herbaceous	30	0.038	0.008	0.054	0.218	0.008
Mercury	Herbaceous	27	0.032	0.005	0.041	0.094	0.004
Nickel	Herbaceous	36	0.028	0.005	0.037	0.108	0.001
Plutonium-238	Herbaceous	3	5.822	1.778	9.307	7.600	2.267
Plutonium-239/240	Herbaceous	5	5.660	1.269	8.148	10.600	3.400
Potassium	Herbaceous	30	3.762	0.505	4.752	13.008	1.244
Selenium	Herbaceous	30	0.014	0.002	0.018	0.057	0.008
Silver	Herbaceous	29	0.434	0.272	0.966	7.763	0.000
Sodium	Herbaceous	36	0.353	0.031	0.414	0.707	0.013
Thallium	Herbaceous	7	0.008	0.003	0.013	0.023	0.004
Uranium	Herbaceous	1	0.002			0.002	0.002
Vanadium	Herbaceous	36	0.030	0.003	0.036	0.084	0.010
Zinc	Herbaceous	36	0.382	0.042	0.463	0.856	0.009
Aluminum	Small mammal	24	0.005	0.001	0.006	0.018	0.000
Americium-241	Small mammal	20	1.432	0.152	1.730	2.889	0.565
Antimony	Small mammal	16	0.030	0.005	0.040	0.075	0.011
Arsenic	Small mammal	24	0.005	0.001	0.006	0.013	0.001
Barium	Small mammal	24	0.035	0.005	0.045	0.097	0.002
Beryllium	Small mammal	20	0.006	0.001	0.007	0.010	0.003
Cadmium	Small mammal	24	0.069	0.018	0.104	0.320	0.001
Calcium	Small mammal	24	4.463	0.698	5.830	12.844	0.222
Chromium	Small mammal	24	0.057	0.015	0.087	0.272	0.001
Cobalt	Small mammal	24	0.006	0.001	0.008	0.020	0.002
Copper	Small mammal	24	2.529	2.178	6.797	52.601	0.001
Curium-244	Small mammal	11	1.939	0.377	2.678	4.711	0.587
Iron	Small mammal	24	0.004	0.000	0.005	0.008	0.001
Lead	Small mammal	24	0.062	0.053	0.165	1.273	0.000
Lithium	Small mammal	24	0.018	0.008	0.033	0.182	0.001
Magnesium	Small mammal	20	0.569	0.050	0.667	0.921	0.253
Manganese	Small mammal	20	0.003	0.000	0.004	0.006	0.001
Mercury	Small mammal	20	0.188	0.076	0.337	1.175	0.009
Nickel	Small mammal	24	0.210	0.127	0.459	3.102	0.001
PCB-1254	Small mammal	4	0.052	0.004	0.059	0.060	0.042
PCB-1260	Small mammal	24	1.967	0.756	3.450	18.108	0.050
Plutonium-238	Small mammal	14	4.695	0.437	5.552	6.267	2.044

Table G.39 (continued)

Analyte	Media	N	Mean	Standard error	UCL95	Maximum	Minimum
Plutonium-239/240	Small mammal	20	4.693	0.616	5.899	11.000	1.800
Potassium	Small mammal	20	3.659	0.294	4.236	5.807	1.735
Selenium	Small mammal	20	0.148	0.012	0.171	0.266	0.076
Silver	Small mammal	11	0.077	0.026	0.128	0.269	0.000
Sodium	Small mammal	24	6.735	0.700	8.107	13.722	0.253
Thallium	Small mammal	5	0.008	0.005	0.017	0.027	0.003
Uranium	Small mammal	4	0.000	0.000	0.000	0.000	0.000
Vanadium	Small mammal	24	0.021	0.001	0.024	0.036	0.009
Zinc	Small mammal	24	1.391	0.346	2.069	8.492	0.016

Table G.40. Summary statistics for Bear Creek soil contaminant data (depth 0-4 in.)^a

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Aluminum	TS1	2	2	17795.00	10005.00	80964.08	27800.00
Arsenic	TS1	2	2	10.05	2.55	26.15	12.60
Barium	TS1	2	2	100.90	19.10	221.49	120.00
Beryllium	TS1	2	2	1.32	0.68	5.61	2.00
Cadmium	TS1	2	1	4.94	4.37	32.49	9.30
Calcium	TS1	2	2	3695.00	1715.00	14523.08	5410.00
Chromium	TS1	2	2	19.55	3.65	42.60	23.20
Cobalt	TS1	2	2	16.80	1.60	26.90	18.40
Copper	TS1	2	2	33.40	9.30	92.12	42.70
Iron	TS1	2	2	15600.00	2100.00	28858.88	17700.00
Lead	TS1	2	2	42.85	3.25	63.37	46.10
Lithium	TS1	2	2	23.85	17.15	132.13	41.00
Magnesium	TS1	2	2	1238.50	711.50	5730.73	1950.00
Manganese	TS1	2	2	1195.00	5.00	1226.57	1200.00
Mercury	TS1	2	2	3.87	3.44	25.55	7.30
Nickel	TS1	2	2	27.40	14.70	120.21	42.10
Potassium	TS1	2	2	1217.50	782.50	6158.01	2000.00
Selenium	TS1	2	2	2.40	0.10	3.03	2.50
Silver	TS1	2	1	0.19	0.02	0.32	0.17
Sodium	TS1	2	2	239.50	46.50	533.09	286.00
Vanadium	TS1	2	2	25.65	1.35	34.17	27.00
Zinc	TS1	2	2	79.30	23.70	228.94	103.00
2,4,5-T	TS1	2	1	0.02	0.01	0.10	0.01
2,4-D	TS1	2	1	0.07	0.06	0.44	0.01
4,4'-DDD	TS1	2	1	0.00	0.00	0.02	0.00
DDT — total	TS1	2	1	0.02	0.01	0.05	0.01
4,4'-DDE	TS1	2	1	0.01	0.00	0.01	0.00
Benzo(a)anthracene	TS1	2	2	0.11	0.04	0.39	0.15
Benzo(a)pyrene	TS1	2	2	0.08	0.02	0.23	0.10
Benzo(b)fluoranthene	TS1	2	2	0.13	0.06	0.53	0.19
Benzo(k)fluoranthene	TS1	2	2	0.10	0.06	0.49	0.16
Bis(2-ethylhexyl)phthalate	TS1	2	2	0.17	0.02	0.26	0.18
Chlordane — total	TS1	2	2	0.00	0.00	0.02	0.01
Chrysene	TS1	2	2	0.10	0.04	0.34	0.14
Di-n-butylphthalate	TS1	2	1	0.35	0.09	0.88	0.26
Dieldrin	TS1	2	2	0.00	0.00	0.01	0.00
Endosulfan I	TS1	2	1	0.00	0.00	0.01	0.00
Endosulfan — total	TS1	2	1	0.01	0.01	0.05	0.01
Endosulfan II	TS1	2	1	0.01	0.00	0.02	0.00
Endosulfan sulfate	TS1	2	1	0.00	0.00	0.02	0.00
Endrin — total	TS1	2	2	0.02	0.00	0.04	0.02
Endrin aldehyde	TS1	2	2	0.01	0.00	0.01	0.01

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Fluoranthene	TS1	2	2	0.13	0.05	0.44	0.18
Methoxychlor	TS1	2	1	0.01	0.01	0.07	0.00
PCB-1254	TS1	2	1	0.43	0.36	2.67	0.78
PCB-1260	TS1	2	1	0.12	0.08	0.62	0.20
Phenanthrene	TS1	2	1	0.26	0.17	1.35	0.09
Pyrene	TS1	2	2	0.13	0.06	0.48	0.19
Silvex	TS1	2	1	0.02	0.02	0.12	0.00
BHC — total	TS1	2	1	0.01	0.00	0.03	0.00
alpha-Chlordane	TS1	2	2	0.00	0.00	0.02	0.01
delta-BHC	TS1	2	1	0.00	0.00	0.01	0.00
gamma-Chlordane	TS1	2	2	0.00	0.00	0.00	0.00
Americium-241	TS1	2	1	0.04	0.04	0.29	0.08
CURIUM-243	TS1	2	1	0.04	0.04	0.26	0.07
Cesium-137	TS1	2	2	0.74	0.44	3.48	1.17
Plutonium-238	TS1	2	1	0.02	0.01	0.08	0.03
Plutonium-239/240	TS1	2	1	0.02	0.02	0.11	0.03
Technetium-99	TS1	2	1	6.64	4.17	32.97	10.81
Thorium-228	TS1	2	2	1.21	0.23	2.63	1.43
Thorium-230	TS1	2	2	1.02	0.03	1.21	1.05
Thorium-232	TS1	2	2	1.00	0.18	2.10	1.17
Uranium-234	TS1	2	2	29.44	14.70	122.22	44.13
Uranium-235	TS1	2	2	1.47	1.20	9.01	2.66
Uranium-238	TS1	2	2	35.66	31.35	233.56	67.00
Aluminum	TS2	1	1	6630.00	0.00	0.00	6630.00
Arsenic	TS2	1	1	6.40	0.00	0.00	6.40
Barium	TS2	1	1	86.90	0.00	0.00	86.90
Beryllium	TS2	1	1	0.62	0.00	0.00	0.62
Cadmium	TS2	1	1	0.96	0.00	0.00	0.96
Calcium	TS2	1	1	2160.00	0.00	0.00	2160.00
Chromium	TS2	1	1	27.10	0.00	0.00	27.10
Cobalt	TS2	1	1	14.00	0.00	0.00	14.00
Copper	TS2	1	1	13.60	0.00	0.00	13.60
Iron	TS2	1	1	17000.00	0.00	0.00	17000.00
Lead	TS2	1	1	24.20	0.00	0.00	24.20
Magnesium	TS2	1	1	705.00	0.00	0.00	705.00
Manganese	TS2	1	1	1020.00	0.00	0.00	1020.00
Mercury	TS2	1	1	1.60	0.00	0.00	1.60
Nickel	TS2	1	1	15.50	0.00	0.00	15.50
Potassium	TS2	1	1	768.00	0.00	0.00	768.00
Selenium	TS2	1	1	3.20	0.00	0.00	3.20
Thallium	TS2	1	1	1.90	0.00	0.00	1.90
Vanadium	TS2	1	1	18.20	0.00	0.00	18.20

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Zinc	TS2	1	1	41.00	0.00	0.00	41.00
2,4,5-T	TS2	1	1	0.01	0.00	0.00	0.01
2,4-D	TS2	1	1	0.12	0.00	0.00	0.12
Bis(2-ethylhexyl)phthalate	TS2	1	1	0.04	0.00	0.00	0.04
Endrin — total	TS2	1	1	0.01	0.00	0.00	0.01
Endrin aldehyde	TS2	1	1	0.00	0.00	0.00	0.00
Fluoranthene	TS2	1	1	0.09	0.00	0.00	0.09
PCB-1260	TS2	1	1	0.03	0.00	0.00	0.03
Phenanthrene	TS2	1	1	0.06	0.00	0.00	0.06
Pyrene	TS2	1	1	0.05	0.00	0.00	0.05
Silvex	TS2	1	1	0.01	0.00	0.00	0.01
Americium-241	TS2	1	1	0.06	0.00	0.00	0.06
Cesium-137	TS2	1	1	0.44	0.00	0.00	0.44
Technetium-99	TS2	1	1	8.38	0.00	0.00	8.38
Thorium-228	TS2	1	1	0.96	0.00	0.00	0.96
Thorium-230	TS2	1	1	1.03	0.00	0.00	1.03
Thorium-232	TS2	1	1	0.83	0.00	0.00	0.83
Uranium-234	TS2	1	1	4.07	0.00	0.00	4.07
Uranium-235	TS2	1	1	0.25	0.00	0.00	0.25
Uranium-238	TS2	1	1	5.45	0.00	0.00	5.45
Aluminum	TS3	2	2	10390.00	1810.00	21817.89	12200.00
Arsenic	TS3	2	2	6.10	2.30	20.62	8.40
Barium	TS3	2	2	111.00	2.00	123.63	113.00
Beryllium	TS3	2	2	0.90	0.00	0.90	0.90
Cadmium	TS3	2	2	8.65	0.05	8.97	8.70
Calcium	TS3	2	2	2115.00	25.00	2272.84	2140.00
Chromium	TS3	2	2	18.20	5.70	54.19	23.90
Cobalt	TS3	2	2	17.95	0.15	18.90	18.10
Copper	TS3	2	2	22.60	2.30	37.12	24.90
Iron	TS3	2	2	15900.00	2700.00	32947.13	18600.00
Lead	TS3	2	2	25.50	3.40	46.97	28.90
Lithium	TS3	2	2	31.45	0.75	36.19	32.20
Magnesium	TS3	2	2	986.00	104.00	1642.63	1090.00
Manganese	TS3	2	2	1470.00	140.00	2353.93	1610.00
Mercury	TS3	2	2	1.65	0.05	1.97	1.70
Nickel	TS3	2	2	40.55	5.55	75.59	46.10
Potassium	TS3	2	2	999.00	311.00	2962.58	1310.00
Selenium	TS3	2	2	1.85	0.25	3.43	2.10
Silver	TS3	2	2	0.38	0.03	0.53	0.40
Sodium	TS3	2	2	160.50	12.50	239.42	173.00
Vanadium	TS3	2	2	21.50	6.40	61.91	27.90
Zinc	TS3	2	2	63.40	5.90	100.65	69.30

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
2,4,5-T	TS3	2	2	0.01	0.00	0.02	0.01
2,4-D	TS3	2	1	0.08	0.06	0.44	0.03
DDT — total	TS3	2	2	0.01	0.00	0.02	0.01
4,4'-DDE	TS3	2	1	0.00	0.00	0.02	0.00
4,4'-DDT	TS3	2	2	0.00	0.00	0.00	0.00
Benzo(a)anthracene	TS3	2	2	0.11	0.02	0.23	0.13
Benzo(a)pyrene	TS3	2	1	0.27	0.18	1.39	0.10
Benzo(b)fluoranthene	TS3	2	2	0.18	0.00	0.21	0.18
Benzo(k)fluoranthene	TS3	2	2	0.14	0.01	0.17	0.14
Bis(2-ethylhexyl)phthalate	TS3	2	2	0.07	0.01	0.15	0.08
Chlordane — total	TS3	2	2	0.00	0.00	0.01	0.00
Chrysene	TS3	2	2	0.13	0.01	0.16	0.13
Di-n-butylphthalate	TS3	2	2	0.11	0.02	0.22	0.13
Dieldrin	TS3	2	2	0.00	0.00	0.00	0.00
Endosulfan — total	TS3	2	1	0.01	0.00	0.02	0.01
Endosulfan sulfate	TS3	2	1	0.00	0.00	0.02	0.00
Endrin — total	TS3	2	2	0.01	0.00	0.02	0.01
Endrin aldehyde	TS3	2	2	0.00	0.00	0.01	0.01
Fluoranthene	TS3	2	2	0.16	0.01	0.19	0.16
Methoxychlor	TS3	2	2	0.00	0.00	0.02	0.01
PCB-1260	TS3	2	2	0.15	0.03	0.30	0.17
Phenanthrene	TS3	2	2	0.08	0.00	0.11	0.08
Pyrene	TS3	2	2	0.14	0.03	0.33	0.17
alpha-Chlordane	TS3	2	2	0.00	0.00	0.01	0.00
gamma-Chlordane	TS3	2	1	0.00	0.00	0.00	0.00
Americium-241	TS3	2	2	0.11	0.03	0.26	0.13
Cesium-137	TS3	2	2	0.31	0.04	0.59	0.35
Technetium-99	TS3	2	2	9.49	2.49	25.21	11.98
Thorium-228	TS3	2	2	1.23	0.14	2.11	1.37
Thorium-230	TS3	2	2	0.84	0.02	0.97	0.86
Thorium-232	TS3	2	2	0.95	0.08	1.42	1.02
Uranium-234	TS3	2	2	20.28	0.66	24.45	20.94
Uranium-235	TS3	2	2	1.48	0.14	2.36	1.62
Uranium-238	TS3	2	2	38.27	1.29	46.38	39.55
Aluminum	TS4	2	2	12550.00	1450.00	21704.94	14000.00
Arsenic	TS4	2	2	9.45	6.35	49.54	15.80
Barium	TS4	2	2	126.00	20.00	252.28	146.00
Beryllium	TS4	2	2	2.95	0.05	3.27	3.00
Calcium	TS4	2	2	7465.00	2125.00	20881.72	9590.00
Chromium	TS4	2	2	21.20	1.80	32.56	23.00
Cobalt	TS4	2	2	12.50	0.70	16.92	13.20
Copper	TS4	2	2	17.90	3.60	40.63	21.50

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Iron	TS4	2	2	23550.00	950.00	29548.06	24500.00
Lead	TS4	2	2	17.00	3.00	35.94	20.00
Lithium	TS4	2	2	40.55	14.65	133.05	55.20
Magnesium	TS4	2	2	2120.00	30.00	2309.41	2150.00
Manganese	TS4	2	2	1300.00	120.00	2057.65	1420.00
Nickel	TS4	2	2	17.30	3.10	36.87	20.40
Potassium	TS4	2	2	1810.00	110.00	2504.51	1920.00
Selenium	TS4	2	2	2.55	0.15	3.50	2.70
Silver	TS4	2	1	0.19	0.03	0.34	0.21
Sodium	TS4	2	2	256.50	21.50	392.25	278.00
Vanadium	TS4	2	2	28.55	0.45	31.39	29.00
Zinc	TS4	2	2	75.75	27.25	247.80	103.00
2,4,5-T	TS4	2	1	0.02	0.02	0.14	0.01
DDT — total	TS4	2	1	0.02	0.00	0.02	0.02
4,4'-DDE	TS4	2	1	0.00	0.00	0.01	0.00
Aldrin	TS4	2	1	0.00	0.00	0.01	0.00
Bis(2-ethylhexyl)phthalate	TS4	2	1	0.32	0.23	1.80	0.08
Chlordane — total	TS4	2	1	0.01	0.00	0.01	0.01
Dieldrin	TS4	2	1	0.00	0.00	0.02	0.00
Diethylphthalate	TS4	2	1	0.30	0.25	1.86	0.06
Endrin — total	TS4	2	1	0.02	0.00	0.05	0.02
Endrin aldehyde	TS4	2	1	0.01	0.00	0.03	0.01
Lindane	TS4	2	1	0.00	0.00	0.01	0.00
PCB-1260	TS4	2	2	0.84	0.04	1.06	0.87
Silvex	TS4	2	1	0.02	0.02	0.14	0.01
BHC — total	TS4	2	2	0.01	0.00	0.01	0.01
alpha-Chlordane	TS4	2	1	0.00	0.00	0.01	0.00
beta-BHC	TS4	2	1	0.00	0.00	0.01	0.00
delta-BHC	TS4	2	1	0.00	0.00	0.01	0.00
gamma-Chlordane	TS4	2	1	0.00	0.00	0.01	0.00
Cesium-137	TS4	2	1	0.17	0.06	0.55	0.23
Curium-244	TS4	1	1	0.14	0.00	0.00	0.14
Technetium-99	TS4	2	2	4.49	0.06	4.87	4.55
Thorium-228	TS4	2	2	0.85	0.14	1.70	0.98
Thorium-230	TS4	2	2	0.65	0.17	1.69	0.81
Thorium-232	TS4	2	2	0.62	0.02	0.71	0.63
Uranium-234	TS4	2	2	11.86	2.85	29.85	14.71
Uranium-235	TS4	2	2	1.07	0.15	1.98	1.21
Uranium-238	TS4	2	2	46.85	16.57	151.43	63.41
Aluminum	TS5	1	1	4090.00	0.00	0.00	4090.00
Arsenic	TS5	1	1	1.10	0.00	0.00	1.10
Barium	TS5	1	1	66.30	0.00	0.00	66.30

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Beryllium	TS5	1	1	0.37	0.00	0.00	0.37
Cadmium	TS5	1	1	0.19	0.00	0.00	0.19
Calcium	TS5	1	1	2770.00	0.00	0.00	2770.00
Chromium	TS5	1	1	9.40	0.00	0.00	9.40
Cobalt	TS5	1	1	5.10	0.00	0.00	5.10
Copper	TS5	1	1	4.60	0.00	0.00	4.60
Iron	TS5	1	1	7790.00	0.00	0.00	7790.00
Lead	TS5	1	1	10.50	0.00	0.00	10.50
Lithium	TS5	1	1	4.30	0.00	0.00	4.30
Magnesium	TS5	1	1	763.00	0.00	0.00	763.00
Manganese	TS5	1	1	376.00	0.00	0.00	376.00
Mercury	TS5	1	1	0.30	0.00	0.00	0.30
Nickel	TS5	1	1	10.90	0.00	0.00	10.90
Potassium	TS5	1	1	545.00	0.00	0.00	545.00
Selenium	TS5	1	1	1.30	0.00	0.00	1.30
Sodium	TS5	1	1	136.00	0.00	0.00	136.00
Vanadium	TS5	1	1	9.70	0.00	0.00	9.70
Zinc	TS5	1	1	22.40	0.00	0.00	22.40
2,4,5-T	TS5	1	1	0.00	0.00	0.00	0.00
2,4-D	TS5	1	1	0.01	0.00	0.00	0.01
4,4'-DDD	TS5	1	1	0.00	0.00	0.00	0.00
DDT — total	TS5	1	1	0.00	0.00	0.00	0.00
4,4'-DDE	TS5	1	1	0.00	0.00	0.00	0.00
4,4'-DDT	TS5	1	1	0.00	0.00	0.00	0.00
Chlordane — total	TS5	1	1	0.00	0.00	0.00	0.00
Di-n-butylphthalate	TS5	1	1	0.08	0.00	0.00	0.08
Silvex	TS5	1	1	0.00	0.00	0.00	0.00
alpha-Chlordane	TS5	1	1	0.00	0.00	0.00	0.00
gamma-Chlordane	TS5	1	1	0.00	0.00	0.00	0.00
Cesium-137	TS5	1	1	0.55	0.00	0.00	0.55
Plutonium-239/240	TS5	1	1	0.02	0.00	0.00	0.02
Thorium-228	TS5	1	1	1.24	0.00	0.00	1.24
Thorium-230	TS5	1	1	0.94	0.00	0.00	0.94
Thorium-232	TS5	1	1	1.11	0.00	0.00	1.11
Uranium-234	TS5	1	1	1.33	0.00	0.00	1.33
Uranium-235	TS5	1	1	0.03	0.00	0.00	0.03
Uranium-238	TS5	1	1	1.38	0.00	0.00	1.38
Aluminum	TS6	2	2	4950.00	330.00	7033.54	5280.00
Arsenic	TS6	2	2	2.15	0.05	2.47	2.20
Barium	TS6	2	2	64.75	3.15	84.64	67.90
Beryllium	TS6	2	2	0.49	0.00	0.49	0.49
Cadmium	TS6	2	2	1.02	0.39	3.45	1.40

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Calcium	TS6	2	2	1100.00	90.00	1668.24	1190.00
Chromium	TS6	2	2	9.25	0.75	13.99	10.00
Cobalt	TS6	2	2	8.70	1.00	15.01	9.70
Copper	TS6	2	2	6.85	0.25	8.43	7.10
Iron	TS6	2	2	8915.00	55.00	9262.26	8970.00
Lead	TS6	2	2	15.25	0.25	16.83	15.50
Lithium	TS6	2	2	7.85	0.15	8.80	8.00
Magnesium	TS6	2	2	570.00	26.00	734.16	596.00
Manganese	TS6	2	2	691.50	121.50	1458.62	813.00
Mercury	TS6	2	2	0.57	0.11	1.23	0.67
Nickel	TS6	2	2	10.60	1.90	22.60	12.50
Potassium	TS6	2	2	453.50	8.50	507.17	462.00
Selenium	TS6	2	1	1.20	0.00	1.20	1.20
Sodium	TS6	2	2	142.50	2.50	158.28	145.00
Vanadium	TS6	2	2	11.35	0.55	14.82	11.90
Zinc	TS6	2	2	27.55	0.15	28.50	27.70
2,4-D	TS6	2	1	0.10	0.03	0.29	0.07
4,4'-DDD	TS6	2	2	0.00	0.00	0.00	0.00
DDT — total	TS6	2	2	0.01	0.00	0.01	0.01
4,4'-DDE	TS6	2	2	0.00	0.00	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS6	2	1	0.24	0.20	1.48	0.05
Chlordane — total	TS6	2	1	0.00	0.00	0.01	0.00
Di-n-butylphthalate	TS6	2	1	0.25	0.19	1.46	0.06
Dieldrin	TS6	2	2	0.01	0.00	0.01	0.01
Endrin — total	TS6	2	1	0.02	0.01	0.06	0.03
Endrin aldehyde	TS6	2	1	0.01	0.01	0.05	0.02
Heptachlor — total	TS6	2	1	0.00	0.00	0.01	0.00
Heptachlor epoxide	TS6	2	1	0.00	0.00	0.00	0.00
Methoxychlor	TS6	2	1	0.01	0.01	0.08	0.00
PCB-1260	TS6	2	2	0.42	0.09	0.99	0.51
BHC — total	TS6	2	1	0.01	0.00	0.01	0.00
alpha-BHC	TS6	2	1	0.00	0.00	0.01	0.00
alpha-Chlordane	TS6	2	1	0.00	0.00	0.01	0.00
Americium-241	TS6	2	1	0.10	0.06	0.48	0.16
CURIUM-243	TS6	2	1	0.13	0.02	0.22	0.14
Cesium-137	TS6	2	2	0.92	0.41	3.51	1.33
Technetium-99	TS6	2	2	3.06	0.37	5.40	3.43
Thorium-228	TS6	2	2	1.52	0.41	4.07	1.92
Thorium-230	TS6	2	2	1.31	0.42	3.93	1.72
Thorium-232	TS6	2	2	1.40	0.52	4.65	1.91
Uranium-234	TS6	2	2	19.55	10.82	87.83	30.36
Uranium-235	TS6	2	2	1.21	0.71	5.69	1.92

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Uranium-238	TS6	2	2	39.03	21.69	175.98	60.72
Aluminum	TS7	2	2	6890.00	2380.00	21916.73	9270.00
Arsenic	TS7	2	2	2.55	0.55	6.02	3.10
Barium	TS7	2	2	82.55	16.95	189.57	99.50
Beryllium	TS7	2	2	0.61	0.13	1.39	0.73
Cadmium	TS7	2	2	2.16	1.35	10.65	3.50
Calcium	TS7	2	2	1770.00	260.00	3411.58	2030.00
Chromium	TS7	2	2	11.55	3.35	32.70	14.90
Cobalt	TS7	2	2	10.05	2.85	28.04	12.90
Copper	TS7	2	2	10.90	2.70	27.95	13.60
Iron	TS7	2	2	10550.00	2750.00	27912.82	13300.00
Lead	TS7	2	2	18.05	2.65	34.78	20.70
Lithium	TS7	2	2	15.40	8.10	66.54	23.50
Magnesium	TS7	2	2	830.50	259.50	2468.92	1090.00
Manganese	TS7	2	2	865.50	284.50	2661.76	1150.00
Mercury	TS7	2	2	0.78	0.21	2.07	0.98
Nickel	TS7	2	2	14.70	6.00	52.58	20.70
Potassium	TS7	2	2	832.50	407.50	3405.35	1240.00
Selenium	TS7	2	2	1.45	0.15	2.40	1.60
Sodium	TS7	2	2	169.50	14.50	261.05	184.00
Vanadium	TS7	2	2	12.95	3.05	32.21	16.00
Zinc	TS7	2	2	39.45	12.55	118.69	52.00
Chlordane — total	TS7	2	1	0.00	0.00	0.01	0.00
Di-n-butylphthalate	TS7	2	1	0.28	0.16	1.29	0.12
Dieldrin	TS7	2	1	0.01	0.00	0.04	0.01
Endrin — total	TS7	2	1	0.03	0.02	0.14	0.05
Endrin aldehyde	TS7	2	1	0.02	0.02	0.13	0.04
Fluoranthene	TS7	2	1	0.25	0.19	1.43	0.07
Methoxychlor	TS7	2	1	0.01	0.01	0.07	0.00
PCB-1254	TS7	2	1	0.16	0.12	0.90	0.28
PCB-1260	TS7	2	2	0.76	0.55	4.20	1.30
BHC — total	TS7	2	2	0.00	0.00	0.01	0.00
alpha-BHC	TS7	2	2	0.00	0.00	0.00	0.00
alpha-Chlordane	TS7	2	1	0.00	0.00	0.01	0.00
beta-BHC	TS7	2	1	0.00	0.00	0.01	0.00
Americium-241	TS7	2	1	0.05	0.04	0.27	0.08
Cesium-137	TS7	2	2	0.70	0.07	1.11	0.76
Plutonium-239/240	TS7	2	1	0.02	0.01	0.05	0.02
Technetium-99	TS7	2	1	2.51	0.04	2.76	2.47
Thorium-228	TS7	2	2	1.30	0.10	1.89	1.39
Thorium-230	TS7	2	2	1.01	0.14	1.89	1.15
Thorium-232	TS7	2	2	0.95	0.00	0.95	0.95

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Uranium-234	TS7	2	2	17.94	11.55	90.86	29.49
Uranium-235	TS7	2	2	1.21	0.88	6.73	2.08
Uranium-238	TS7	2	2	31.36	21.30	165.84	52.66
Aluminum	TS8	1	1	8140.00	0.00	0.00	8140.00
Arsenic	TS8	1	1	3.50	0.00	0.00	3.50
Barium	TS8	1	1	74.40	0.00	0.00	74.40
Beryllium	TS8	1	1	0.52	0.00	0.00	0.52
Cadmium	TS8	1	1	0.12	0.00	0.00	0.12
Calcium	TS8	1	1	2080.00	0.00	0.00	2080.00
Chromium	TS8	1	1	12.40	0.00	0.00	12.40
Cobalt	TS8	1	1	10.80	0.00	0.00	10.80
Copper	TS8	1	1	7.70	0.00	0.00	7.70
Iron	TS8	1	1	11300.00	0.00	0.00	11300.00
Lead	TS8	1	1	16.90	0.00	0.00	16.90
Lithium	TS8	1	1	11.70	0.00	0.00	11.70
Magnesium	TS8	1	1	957.00	0.00	0.00	957.00
Manganese	TS8	1	1	855.00	0.00	0.00	855.00
Mercury	TS8	1	1	0.42	0.00	0.00	0.42
Nickel	TS8	1	1	10.30	0.00	0.00	10.30
Potassium	TS8	1	1	842.00	0.00	0.00	842.00
Selenium	TS8	1	1	1.20	0.00	0.00	1.20
Vanadium	TS8	1	1	14.60	0.00	0.00	14.60
Zinc	TS8	1	1	33.70	0.00	0.00	33.70
2,4,5-T	TS8	1	1	0.01	0.00	0.00	0.01
2,4-D	TS8	1	1	0.06	0.00	0.00	0.06
DDT — total	TS8	1	1	0.01	0.00	0.00	0.01
4,4'-DDE	TS8	1	1	0.00	0.00	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS8	1	1	0.04	0.00	0.00	0.04
Chlordane — total	TS8	1	1	0.00	0.00	0.00	0.00
Dieldrin	TS8	1	1	0.00	0.00	0.00	0.00
Endrin — total	TS8	1	1	0.01	0.00	0.00	0.01
Endrin aldehyde	TS8	1	1	0.00	0.00	0.00	0.00
PCB-1260	TS8	1	1	0.15	0.00	0.00	0.15
alpha-Chlordane	TS8	1	1	0.00	0.00	0.00	0.00
Cesium-137	TS8	1	1	0.68	0.00	0.00	0.68
Plutonium-239/240	TS8	1	1	0.02	0.00	0.00	0.02
Thorium-228	TS8	1	1	1.18	0.00	0.00	1.18
Thorium-230	TS8	1	1	1.35	0.00	0.00	1.35
Thorium-232	TS8	1	1	1.04	0.00	0.00	1.04
Uranium-234	TS8	1	1	4.29	0.00	0.00	4.29
Uranium-235	TS8	1	1	0.33	0.00	0.00	0.33
Uranium-238	TS8	1	1	6.17	0.00	0.00	6.17

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Aluminum	TS9	1	1	5420.00	0.00	0.00	5420.00
Arsenic	TS9	1	1	3.80	0.00	0.00	3.80
Barium	TS9	1	1	58.20	0.00	0.00	58.20
Beryllium	TS9	1	1	0.53	0.00	0.00	0.53
Calcium	TS9	1	1	561.00	0.00	0.00	561.00
Chromium	TS9	1	1	11.80	0.00	0.00	11.80
Cobalt	TS9	1	1	8.50	0.00	0.00	8.50
Copper	TS9	1	1	6.50	0.00	0.00	6.50
Iron	TS9	1	1	10800.00	0.00	0.00	10800.00
Lead	TS9	1	1	14.00	0.00	0.00	14.00
Magnesium	TS9	1	1	622.00	0.00	0.00	622.00
Manganese	TS9	1	1	695.00	0.00	0.00	695.00
Nickel	TS9	1	1	6.90	0.00	0.00	6.90
Potassium	TS9	1	1	551.00	0.00	0.00	551.00
Sodium	TS9	1	1	178.00	0.00	0.00	178.00
Vanadium	TS9	1	1	15.90	0.00	0.00	15.90
Zinc	TS9	1	1	25.00	0.00	0.00	25.00
2,4,5-T	TS9	1	1	0.01	0.00	0.00	0.01
DDT — total	TS9	1	1	0.01	0.00	0.00	0.01
4,4'-DDE	TS9	1	1	0.00	0.00	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS9	1	1	0.16	0.00	0.00	0.16
Chlordane — total	TS9	1	1	0.00	0.00	0.00	0.00
Dieldrin	TS9	1	1	0.00	0.00	0.00	0.00
Endosulfan — total	TS9	1	1	0.01	0.00	0.00	0.01
Endosulfan II	TS9	1	1	0.00	0.00	0.00	0.00
PCB-1260	TS9	1	1	0.03	0.00	0.00	0.03
alpha-Chlordane	TS9	1	1	0.00	0.00	0.00	0.00
Cesium-137	TS9	1	1	0.62	0.00	0.00	0.62
Curium-244	TS9	1	1	0.17	0.00	0.00	0.17
Plutonium-239/240	TS9	1	1	0.02	0.00	0.00	0.02
Thorium-228	TS9	1	1	0.89	0.00	0.00	0.89
Thorium-230	TS9	1	1	1.23	0.00	0.00	1.23
Thorium-232	TS9	1	1	0.87	0.00	0.00	0.87
Uranium-234	TS9	1	1	1.83	0.00	0.00	1.83
Uranium-235	TS9	1	1	0.10	0.00	0.00	0.10
Uranium-238	TS9	1	1	2.69	0.00	0.00	2.69
Aluminum	TS10	1	1	4610.00	0.00	0.00	4610.00
Arsenic	TS10	1	1	2.30	0.00	0.00	2.30
Barium	TS10	1	1	55.90	0.00	0.00	55.90
Beryllium	TS10	1	1	0.48	0.00	0.00	0.48
Cadmium	TS10	1	1	0.37	0.00	0.00	0.37
Calcium	TS10	1	1	912.00	0.00	0.00	912.00

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Chromium	TS10	1	1	9.10	0.00	0.00	9.10
Cobalt	TS10	1	1	8.80	0.00	0.00	8.80
Copper	TS10	1	1	5.80	0.00	0.00	5.80
Cyanide	TS10	1	1	1.10	0.00	0.00	1.10
Iron	TS10	1	1	9040.00	0.00	0.00	9040.00
Lead	TS10	1	1	13.40	0.00	0.00	13.40
Lithium	TS10	1	1	4.90	0.00	0.00	4.90
Magnesium	TS10	1	1	657.00	0.00	0.00	657.00
Manganese	TS10	1	1	636.00	0.00	0.00	636.00
Mercury	TS10	1	1	0.28	0.00	0.00	0.28
Nickel	TS10	1	1	8.50	0.00	0.00	8.50
Potassium	TS10	1	1	510.00	0.00	0.00	510.00
Selenium	TS10	1	1	1.40	0.00	0.00	1.40
Sodium	TS10	1	1	169.00	0.00	0.00	169.00
Vanadium	TS10	1	1	11.40	0.00	0.00	11.40
Zinc	TS10	1	1	22.10	0.00	0.00	22.10
2,4-D	TS10	1	1	0.01	0.00	0.00	0.01
Chlordane — total	TS10	1	1	0.00	0.00	0.00	0.00
Di-n-butylphthalate	TS10	1	1	0.09	0.00	0.00	0.09
Dieldrin	TS10	1	1	0.00	0.00	0.00	0.00
Endrin — total	TS10	1	1	0.03	0.00	0.00	0.03
Endrin aldehyde	TS10	1	1	0.02	0.00	0.00	0.02
Fluoranthene	TS10	1	1	0.05	0.00	0.00	0.05
Heptachlor — total	TS10	1	1	0.00	0.00	0.00	0.00
Heptachlor epoxide	TS10	1	1	0.00	0.00	0.00	0.00
Methoxychlor	TS10	1	1	0.00	0.00	0.00	0.00
PCB-1254	TS10	1	1	0.39	0.00	0.00	0.39
PCB-1260	TS10	1	1	0.61	0.00	0.00	0.61
alpha-Chlordane	TS10	1	1	0.00	0.00	0.00	0.00
gamma-Chlordane	TS10	1	1	0.00	0.00	0.00	0.00
Cesium-137	TS10	1	1	0.44	0.00	0.00	0.44
Plutonium-239/240	TS10	1	1	0.03	0.00	0.00	0.03
Thorium-228	TS10	1	1	0.86	0.00	0.00	0.86
Thorium-230	TS10	1	1	0.76	0.00	0.00	0.76
Thorium-232	TS10	1	1	0.79	0.00	0.00	0.79
Uranium-234	TS10	1	1	7.24	0.00	0.00	7.24
Uranium-235	TS10	1	1	0.39	0.00	0.00	0.39
Uranium-238	TS10	1	1	13.14	0.00	0.00	13.14
Aluminum	TS13	1	1	7020.00	0.00	0.00	7020.00
Arsenic	TS13	1	1	2.50	0.00	0.00	2.50
Barium	TS13	1	1	87.20	0.00	0.00	87.20
Beryllium	TS13	1	1	0.57	0.00	0.00	0.57

Table G.40 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Calcium	TS13	1	1	1990.00	0.00	0.00	1990.00
Chromium	TS13	1	1	9.60	0.00	0.00	9.60
Cobalt	TS13	1	1	8.30	0.00	0.00	8.30
Copper	TS13	1	1	8.80	0.00	0.00	8.80
Iron	TS13	1	1	9850.00	0.00	0.00	9850.00
Lead	TS13	1	1	22.80	0.00	0.00	22.80
Lithium	TS13	1	1	7.50	0.00	0.00	7.50
Magnesium	TS13	1	1	799.00	0.00	0.00	799.00
Manganese	TS13	1	1	755.00	0.00	0.00	755.00
Mercury	TS13	1	1	0.36	0.00	0.00	0.36
Nickel	TS13	1	1	17.10	0.00	0.00	17.10
Potassium	TS13	1	1	767.00	0.00	0.00	767.00
Selenium	TS13	1	1	1.50	0.00	0.00	1.50
Sodium	TS13	1	1	186.00	0.00	0.00	186.00
Vanadium	TS13	1	1	15.60	0.00	0.00	15.60
Zinc	TS13	1	1	28.50	0.00	0.00	28.50
DDT — total	TS13	1	1	0.01	0.00	0.00	0.01
4,4'-DDT	TS13	1	1	0.00	0.00	0.00	0.00
Chlordane — total	TS13	1	1	0.00	0.00	0.00	0.00
Endrin — total	TS13	1	1	0.01	0.00	0.00	0.01
Endrin aldehyde	TS13	1	1	0.00	0.00	0.00	0.00
Endrin ketone	TS13	1	1	0.00	0.00	0.00	0.00
Methoxychlor	TS13	1	1	0.00	0.00	0.00	0.00
PCB-1260	TS13	1	1	0.08	0.00	0.00	0.08
alpha-Chlordane	TS13	1	1	0.00	0.00	0.00	0.00
Cesium-137	TS13	1	1	0.87	0.00	0.00	0.87
Thorium-228	TS13	1	1	1.25	0.00	0.00	1.25
Thorium-230	TS13	1	1	0.98	0.00	0.00	0.98
Thorium-232	TS13	1	1	0.99	0.00	0.00	0.99
Uranium-234	TS13	1	1	2.14	0.00	0.00	2.14
Uranium-235	TS13	1	1	0.07	0.00	0.00	0.07
Uranium-238	TS13	1	1	2.58	0.00	0.00	2.58

*All rads in pCi/g; all others in mg/kg.

Table G.41. Summary statistics for Bear Creek soil contaminant data (depth 0–16 in.)*

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Aluminum	TS1	4	4	9248.75	5737.82	22751.92	27800.00
Arsenic	TS1	4	4	10.09	3.08	17.34	14.20
Barium	TS1	4	4	90.14	14.89	125.19	120.00
Beryllium	TS1	4	4	0.83	0.36	1.68	2.00
Cadmium	TS1	4	2	2.40	2.35	7.92	9.30
Calcium	TS1	4	4	1976.00	1110.77	4590.04	5410.00
Chromium	TS1	4	4	14.00	3.02	21.10	23.20
Cobalt	TS1	4	4	17.48	0.81	19.38	18.40
Copper	TS1	4	4	15.96	9.15	37.49	42.70
Iron	TS1	4	4	15450.00	992.47	17785.65	17700.00
Lead	TS1	4	4	47.39	3.48	55.58	52.30
Lithium	TS1	4	4	9.41	9.77	32.40	41.00
Magnesium	TS1	4	4	628.75	410.53	1594.87	1950.00
Manganese	TS1	4	4	1450.00	210.87	1946.26	1780.00
Mercury	TS1	3	3	2.51	2.23	9.01	7.30
Nickel	TS1	4	4	15.74	8.15	34.91	42.10
Potassium	TS1	4	4	576.25	445.18	1623.91	2000.00
Selenium	TS1	4	4	2.25	0.16	2.63	2.50
Silver	TS1	4	1	0.15	0.02	0.20	0.17
Sodium	TS1	4	4	194.50	29.81	264.65	286.00
Vanadium	TS1	4	4	25.01	5.69	38.41	32.80
Zinc	TS1	4	4	46.34	18.77	90.50	103.00
2,4,5-T	TS1	4	1	0.03	0.01	0.05	0.01
2,4-D	TS1	4	2	0.08	0.04	0.17	0.04
4,4'-DDD	TS1	4	1	0.00	0.00	0.01	0.00
DDT — total	TS1	4	3	0.01	0.00	0.02	0.01
4,4'-DDE	TS1	4	2	0.00	0.00	0.01	0.00
4,4'-DDT	TS1	4	1	0.00	0.00	0.01	0.00
Benzo(a)anthracene	TS1	4	2	0.36	0.13	0.66	0.15
Benzo(a)pyrene	TS1	4	2	0.36	0.14	0.68	0.10
Benzo(b)fluoranthene	TS1	4	2	0.37	0.12	0.65	0.19
Benzo(k)fluoranthene	TS1	4	2	0.36	0.13	0.67	0.16
Bis(2-ethylhexyl)phthalate	TS1	4	3	0.38	0.11	0.63	0.42
Chlordane — total	TS1	4	4	0.00	0.00	0.01	0.01
Chrysene	TS1	4	2	0.36	0.13	0.66	0.14
Di-n-butylphthalate	TS1	4	2	0.32	0.08	0.51	0.26
Dieldrin	TS1	4	2	0.00	0.00	0.01	0.00
Endosulfan I	TS1	4	2	0.00	0.00	0.00	0.00
Endosulfan — total	TS1	4	2	0.01	0.00	0.02	0.01
Endosulfan II	TS1	4	1	0.00	0.00	0.01	0.00
Endosulfan sulfate	TS1	4	2	0.00	0.00	0.01	0.00
Endrin — total	TS1	4	4	0.01	0.00	0.02	0.02
Endrin aldehyde	TS1	4	4	0.00	0.00	0.01	0.01
Fluoranthene	TS1	4	3	0.20	0.14	0.52	0.18
Methoxychlor	TS1	4	2	0.01	0.01	0.03	0.00
PCB-1254	TS1	4	2	0.20	0.19	0.64	0.78
PCB-1260	TS1	4	2	0.06	0.04	0.16	0.20
Phenanthrene	TS1	4	1	0.40	0.10	0.64	0.09
Pyrene	TS1	4	3	0.20	0.14	0.52	0.19

Table G.41 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Silvex	TS1	4	2	0.02	0.01	0.05	0.00
BHC — total	TS1	4	2	0.01	0.00	0.01	0.00
alpha-Chlordane	TS1	4	4	0.00	0.00	0.01	0.01
delta-BHC	TS1	4	2	0.00	0.00	0.00	0.00
gamma-Chlordane	TS1	4	4	0.00	0.00	0.00	0.00
Americium-241	TS1	4	1	0.03	0.02	0.07	0.08
CURIUM-243	TS1	4	2	0.15	0.06	0.28	0.19
Cesium-137	TS1	4	3	0.28	0.28	0.94	1.17
Plutonium-238	TS1	4	1	0.01	0.01	0.03	0.03
Plutonium-239/240	TS1	4	1	0.01	0.01	0.03	0.03
Technetium-99	TS1	4	2	2.74	2.57	8.79	10.81
Thorium-228	TS1	4	4	1.28	0.10	1.51	1.43
Thorium-230	TS1	4	4	1.12	0.16	1.48	1.36
Thorium-232	TS1	4	4	0.96	0.08	1.16	1.17
Uranium-234	TS1	4	4	11.44	10.40	35.93	44.13
Uranium-235	TS1	4	4	0.53	0.66	2.09	2.66
Uranium-238	TS1	4	4	13.60	16.71	52.93	67.00
Aluminum	TS2	2	2	5460.00	955.30	11491.53	6630.00
Arsenic	TS2	2	2	6.25	0.12	7.02	6.40
Barium	TS2	2	2	85.85	0.86	91.26	86.90
Beryllium	TS2	2	2	0.61	0.01	0.68	0.62
Cadmium	TS2	2	1	0.29	0.55	3.73	0.96
Calcium	TS2	2	2	1173.00	805.88	6261.14	2160.00
Chromium	TS2	2	2	23.05	3.31	43.93	27.10
Cobalt	TS2	2	2	14.15	0.12	14.92	14.20
Copper	TS2	2	2	9.03	3.74	32.61	13.60
Iron	TS2	2	2	17600.00	489.90	20693.09	17800.00
Lead	TS2	2	2	20.60	2.94	39.16	24.20
Magnesium	TS2	2	2	555.75	121.86	1325.16	705.00
Manganese	TS2	2	2	1065.00	36.74	1296.98	1080.00
Mercury	TS2	2	2	0.71	0.73	5.31	1.60
Nickel	TS2	2	2	10.70	3.92	35.44	15.50
Potassium	TS2	2	2	604.50	133.50	1447.37	768.00
Selenium	TS2	2	2	2.45	0.61	6.32	3.20
Thallium	TS2	2	1	1.30	0.49	4.39	1.90
Vanadium	TS2	2	2	20.23	1.65	30.66	20.90
Zinc	TS2	2	2	27.80	10.78	95.85	41.00
2,4,5-T	TS2	2	2	0.01	0.00	0.02	0.01
2,4-D	TS2	2	2	0.07	0.04	0.31	0.12
Bis(2-ethylhexyl)phthalate	TS2	2	2	0.05	0.01	0.10	0.05
Endrin — total	TS2	2	1	0.01	0.00	0.02	0.01
Endrin aldehyde	TS2	2	1	0.00	0.00	0.02	0.00
Fluoranthene	TS2	2	1	0.31	0.19	1.49	0.09
PCB-1260	TS2	2	1	0.04	0.01	0.08	0.03
Phenanthrene	TS2	2	1	0.31	0.20	1.58	0.06
Pyrene	TS2	2	1	0.31	0.21	1.61	0.05
Silvex	TS2	2	2	0.01	0.00	0.02	0.01
Americium-241	TS2	2	1	0.02	0.03	0.22	0.06
Cesium-137	TS2	2	2	0.16	0.23	1.62	0.44
Curium-244	TS2	2	1	0.04	0.03	0.23	0.05

Table G.41 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Technetium-99	TS2	2	1	2.28	4.98	33.72	8.38
Thorium-228	TS2	2	2	0.82	0.12	1.55	0.96
Thorium-230	TS2	2	2	0.93	0.09	1.47	1.03
Thorium-232	TS2	2	2	0.84	0.01	0.88	0.84
Uranium-234	TS2	2	2	1.98	1.71	12.76	4.07
Uranium-235	TS2	2	2	0.12	0.10	0.78	0.25
Uranium-238	TS2	2	2	2.44	2.46	17.95	5.45
Aluminum	TS3	4	4	10585.00	765.32	12386.08	12200.00
Arsenic	TS3	4	4	4.83	1.12	7.45	8.40
Barium	TS3	4	4	132.00	11.10	158.12	146.00
Beryllium	TS3	4	4	0.94	0.02	0.98	0.95
Cadmium	TS3	4	4	10.41	0.83	12.38	11.10
Calcium	TS3	4	4	3348.75	585.16	4725.83	3850.00
Chromium	TS3	4	4	15.54	2.64	21.76	23.90
Cobalt	TS3	4	4	19.45	0.73	21.17	20.20
Copper	TS3	4	4	20.88	1.29	23.91	24.90
Iron	TS3	4	4	14625.00	1286.95	17653.67	18600.00
Lead	TS3	4	4	22.35	2.08	27.24	28.90
Lithium	TS3	4	4	28.49	4.41	38.87	33.40
Magnesium	TS3	4	4	1266.50	138.88	1593.33	1360.00
Manganese	TS3	4	4	1860.00	195.75	2320.66	2040.00
Mercury	TS3	4	4	2.25	0.29	2.92	2.50
Nickel	TS3	4	4	55.18	7.51	72.86	62.80
Potassium	TS3	4	4	1093.50	144.63	1433.86	1310.00
Selenium	TS3	4	4	1.96	0.14	2.28	2.10
Silver	TS3	4	4	0.26	0.07	0.42	0.40
Sodium	TS3	4	4	158.63	6.69	174.38	173.00
Vanadium	TS3	4	4	17.75	3.17	25.22	27.90
Zinc	TS3	4	4	65.39	2.59	71.47	69.30
2,4,5-T	TS3	4	3	0.01	0.01	0.04	0.01
2,4-D	TS3	4	1	0.12	0.03	0.19	0.03
DDT — total	TS3	4	4	0.01	0.00	0.01	0.01
4,4'-DDE	TS3	4	3	0.00	0.00	0.00	0.00
4,4'-DDT	TS3	4	3	0.00	0.00	0.01	0.00
Benzo(a)anthracene	TS3	4	3	0.23	0.12	0.53	0.13
Benzo(a)pyrene	TS3	4	2	0.26	0.14	0.59	0.10
Benzo(b)fluoranthene	TS3	4	4	0.13	0.05	0.25	0.18
Benzo(k)fluoranthene	TS3	4	4	0.11	0.04	0.20	0.15
Bis(2-ethylhexyl)phthalate	TS3	4	3	0.19	0.15	0.55	0.08
Chlordane — total	TS3	4	4	0.00	0.00	0.00	0.00
Chrysene	TS3	4	3	0.25	0.11	0.52	0.15
Di-n-butylphthalate	TS3	4	4	0.13	0.02	0.18	0.16
Dieldrin	TS3	4	3	0.00	0.00	0.01	0.00
Endosulfan — total	TS3	4	1	0.01	0.00	0.01	0.01
Endosulfan sulfate	TS3	4	1	0.00	0.00	0.01	0.00
Endrin — total	TS3	4	4	0.01	0.00	0.01	0.01
Endrin aldehyde	TS3	4	4	0.00	0.00	0.01	0.01
Fluoranthene	TS3	4	4	0.12	0.05	0.23	0.17
Indeno(1,2,3-cd)pyrene	TS3	4	1	0.29	0.15	0.65	0.06
Methoxychlor	TS3	4	4	0.00	0.00	0.01	0.01

Table G.41 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
PCB-1254	TS3	4	1	0.08	0.03	0.16	0.13
PCB-1260	TS3	4	4	0.13	0.03	0.20	0.17
Phenanthrene	TS3	4	3	0.21	0.14	0.54	0.09
Pyrene	TS3	4	4	0.11	0.04	0.22	0.17
alpha-Chlordane	TS3	4	4	0.00	0.00	0.00	0.00
gamma-Chlordane	TS3	4	1	0.00	0.00	0.00	0.00
Americium-241	TS3	4	4	0.07	0.02	0.12	0.13
Cesium-137	TS3	4	4	0.44	0.11	0.71	0.62
Techneium-99	TS3	4	3	3.93	2.84	10.60	11.98
Thorium-228	TS3	4	4	1.07	0.11	1.32	1.37
Thorium-230	TS3	4	4	0.86	0.04	0.96	0.92
Thorium-232	TS3	4	4	0.97	0.04	1.07	1.02
Uranium-234	TS3	4	4	27.95	3.97	37.31	32.81
Uranium-235	TS3	4	4	1.69	0.15	2.04	1.89
Uranium-238	TS3	4	4	47.70	4.54	58.39	51.94
Aluminum	TS4	4	4	10618.75	1097.52	13201.62	14000.00
Arsenic	TS4	4	4	3.57	3.82	12.57	15.80
Barium	TS4	4	4	118.73	17.11	158.99	146.00
Beryllium	TS4	4	4	2.10	0.75	3.85	3.00
Calcium	TS4	4	4	3265.00	2179.59	8394.37	9590.00
Chromium	TS4	4	4	18.88	1.41	22.19	23.00
Cobalt	TS4	4	4	11.53	0.78	13.37	13.20
Copper	TS4	4	4	10.96	3.82	19.94	21.50
Iron	TS4	4	4	18337.50	3179.34	25819.65	24500.00
Lead	TS4	4	4	13.51	2.55	19.52	20.00
Lithium	TS4	4	4	30.46	11.42	57.33	55.20
Magnesium	TS4	4	4	1512.50	292.17	2200.08	2150.00
Manganese	TS4	4	4	817.38	259.86	1428.92	1420.00
Mercury	TS4	2	2	0.32	0.20	1.57	0.43
Nickel	TS4	4	4	15.24	1.79	19.45	20.40
Potassium	TS4	4	4	1682.50	77.97	1865.99	1920.00
Selenium	TS4	4	4	2.14	0.41	3.10	2.70
Silver	TS4	4	2	0.21	0.06	0.35	0.30
Sodium	TS4	4	4	243.38	21.29	293.48	278.00
Vanadium	TS4	4	4	20.56	3.81	29.53	29.00
Zinc	TS4	4	4	42.23	19.84	88.92	103.00
2,4,5-T	TS4	4	2	0.02	0.01	0.05	0.01
DDT — total	TS4	4	2	0.02	0.00	0.02	0.02
4,4'-DDE	TS4	4	2	0.01	0.00	0.01	0.01
Aldrin	TS4	4	1	0.00	0.00	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS4	4	3	0.15	0.12	0.44	0.12
Chlordane — total	TS4	4	2	0.01	0.00	0.01	0.01
Dieldrin	TS4	4	2	0.00	0.00	0.01	0.00
Diethylphthalate	TS4	4	1	0.45	0.12	0.74	0.06
Endrin — total	TS4	4	2	0.02	0.01	0.04	0.03
Endrin aldehyde	TS4	4	2	0.01	0.01	0.03	0.02
Lindane	TS4	4	2	0.00	0.00	0.00	0.00
PCB-1260	TS4	4	4	1.26	0.29	1.95	1.70
Silvex	TS4	4	2	0.02	0.01	0.05	0.01
BHC — total	TS4	4	3	0.01	0.00	0.01	0.01

Table G.41 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
alpha-BHC	TS4	4	1	0.00	0.00	0.00	0.00
alpha-Chlordane	TS4	4	2	0.00	0.00	0.01	0.01
beta-BHC	TS4	4	1	0.00	0.00	0.00	0.00
delta-BHC	TS4	4	2	0.00	0.00	0.00	0.00
gamma-Chlordane	TS4	4	2	0.00	0.00	0.00	0.00
Americium-241	TS4	3	1	0.05	0.01	0.08	0.04
Cesium-137	TS4	4	3	0.43	0.22	0.95	0.77
Curium-244	TS4	3	1	0.02	0.05	0.17	0.14
Plutonium-239/240	TS4	4	1	0.02	0.01	0.05	0.04
Technetium-99	TS4	4	3	3.94	1.92	8.47	6.45
Thorium-228	TS4	4	4	1.13	0.18	1.56	1.38
Thorium-230	TS4	4	4	0.81	0.11	1.06	0.91
Thorium-232	TS4	4	4	0.87	0.12	1.16	1.00
Uranium-234	TS4	4	4	18.97	4.35	29.21	24.90
Uranium-235	TS4	4	4	1.58	0.32	2.34	2.04
Uranium-238	TS4	4	4	62.88	21.07	112.47	94.35
Aluminum	TS5	2	2	5657.50	1279.86	13738.21	6180.00
Arsenic	TS5	2	2	2.90	1.47	12.18	3.50
Barium	TS5	2	2	70.88	3.74	94.46	72.40
Beryllium	TS5	2	2	0.61	0.20	1.85	0.69
Cadmium	TS5	2	2	0.43	0.20	1.67	0.51
Calcium	TS5	2	2	1870.00	734.85	6509.64	2770.00
Chromium	TS5	2	2	17.58	6.67	59.72	20.30
Cobalt	TS5	2	2	6.60	1.22	14.33	7.10
Copper	TS5	2	2	4.53	0.06	4.91	4.60
Iron	TS5	2	2	14622.50	5578.71	49845.11	16900.00
Lead	TS5	2	2	12.75	1.84	24.35	13.50
Lithium	TS5	2	2	4.15	0.12	4.92	4.30
Magnesium	TS5	2	2	716.50	37.97	956.21	763.00
Manganese	TS5	2	2	412.75	30.01	602.20	425.00
Mercury	TS5	2	2	0.20	0.08	0.71	0.30
Nickel	TS5	2	2	8.50	1.96	20.87	10.90
Potassium	TS5	2	2	590.75	37.35	826.60	606.00
Selenium	TS5	2	2	1.60	0.24	3.15	1.70
Sodium	TS5	2	2	142.75	5.51	177.55	145.00
Vanadium	TS5	2	2	19.98	8.39	72.94	23.40
Zinc	TS5	2	2	20.60	1.47	29.88	22.40
2,4,5-T	TS5	2	2	0.00	0.00	0.00	0.00
2,4-D	TS5	2	2	0.02	0.01	0.06	0.02
4,4'-DDD	TS5	1	1	0.00	0.00	0.00	0.00
DDT — total	TS5	1	1	0.00	0.00	0.00	0.00
4,4'-DDE	TS5	1	1	0.00	0.00	0.00	0.00
4,4'-DDT	TS5	1	1	0.00	0.00	0.00	0.00
Chlordane — total	TS5	1	1	0.00	0.00	0.00	0.00
Di-n-butylphthalate	TS5	2	2	0.13	0.05	0.42	0.15
Silvex	TS5	2	1	0.03	0.02	0.15	0.00
alpha-Chlordane	TS5	1	1	0.00	0.00	0.00	0.00
gamma-Chlordane	TS5	1	1	0.00	0.00	0.00	0.00
Cesium-137	TS5	2	1	0.19	0.29	2.05	0.55
Plutonium-239/240	TS5	2	1	0.01	0.01	0.05	0.02

Table G.41 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Thorium-228	TS5	2	2	1.26	0.01	1.33	1.26
Thorium-230	TS5	2	2	0.92	0.02	1.03	0.94
Thorium-232	TS5	2	2	1.04	0.06	1.42	1.11
Uranium-234	TS5	2	2	1.05	0.23	2.51	1.33
Uranium-235	TS5	2	2	0.05	0.01	0.12	0.05
Uranium-238	TS5	2	2	1.09	0.24	2.60	1.38
Aluminum	TS6	4	4	5512.50	702.47	7165.66	6600.00
Arsenic	TS6	4	4	2.08	0.11	2.34	2.20
Barium	TS6	4	4	61.83	2.56	67.85	67.90
Beryllium	TS6	4	4	0.45	0.02	0.49	0.49
Cadmium	TS6	4	4	0.55	0.28	1.21	1.40
Calcium	TS6	4	4	710.75	187.90	1152.96	1190.00
Chromium	TS6	4	4	9.89	0.51	11.10	10.50
Cobalt	TS6	4	4	9.75	0.68	11.34	10.40
Copper	TS6	4	4	5.46	0.67	7.03	7.10
Iron	TS6	4	4	9545.00	298.86	10248.32	9790.00
Lead	TS6	4	4	13.94	0.95	16.16	15.50
Lithium	TS6	4	4	6.43	0.78	8.26	8.00
Magnesium	TS6	4	4	608.63	48.33	722.35	683.00
Manganese	TS6	4	4	742.50	55.12	872.22	813.00
Mercury	TS6	3	3	0.33	0.19	0.87	0.67
Nickel	TS6	4	4	8.99	1.24	11.91	12.50
Potassium	TS6	4	4	576.13	97.54	805.67	728.00
Selenium	TS6	4	2	1.24	0.11	1.49	1.40
Sodium	TS6	4	4	133.88	7.04	150.44	145.00
Vanadium	TS6	4	4	11.69	0.63	13.17	12.60
Zinc	TS6	4	4	26.05	1.25	28.98	27.70
2,4-D	TS6	4	1	0.12	0.02	0.16	0.07
4,4'-DDD	TS6	4	2	0.00	0.00	0.01	0.00
DDT — total	TS6	4	3	0.01	0.00	0.01	0.01
4,4'-DDE	TS6	4	3	0.00	0.00	0.01	0.00
Bis(2-ethylhexyl)phthalate	TS6	4	2	0.25	0.14	0.59	0.09
Chlordane — total	TS6	4	2	0.00	0.00	0.01	0.00
Di-n-butylphthalate	TS6	4	2	0.25	0.15	0.59	0.07
Dieldrin	TS6	4	4	0.00	0.00	0.01	0.01
Endrin — total	TS6	4	2	0.01	0.00	0.02	0.03
Endrin aldehyde	TS6	4	2	0.00	0.00	0.01	0.02
Heptachlor — total	TS6	4	1	0.00	0.00	0.00	0.00
Heptachlor epoxide	TS6	4	1	0.00	0.00	0.00	0.00
Methoxychlor	TS6	4	1	0.02	0.01	0.03	0.00
PCB-1260	TS6	4	4	0.13	0.14	0.47	0.51
BHC — total	TS6	4	1	0.01	0.00	0.01	0.00
alpha-BHC	TS6	4	1	0.00	0.00	0.00	0.00
alpha-Chlordane	TS6	4	2	0.00	0.00	0.00	0.00
gamma-Chlordane	TS6	4	1	0.00	0.00	0.00	0.00
Americium-241	TS6	4	1	0.03	0.04	0.13	0.16
CURIUM-243	TS6	4	2	0.14	0.05	0.25	0.14
Cesium-137	TS6	4	4	0.30	0.34	1.09	1.33
Technetium-99	TS6	4	2	0.86	1.05	3.34	3.43
Thorium-228	TS6	4	4	1.23	0.22	1.75	1.92

Table G.41 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Thorium-230	TS6	4	4	0.99	0.23	1.53	1.72
Thorium-232	TS6	4	4	1.00	0.28	1.66	1.91
Uranium-234	TS6	4	4	6.29	7.66	24.32	30.36
Uranium-235	TS6	4	4	0.36	0.50	1.52	1.92
Uranium-238	TS6	4	4	12.01	15.53	48.56	60.72
Aluminum	TS7	4	4	5318.75	1327.71	8443.33	9270.00
Arsenic	TS7	4	4	2.14	0.46	3.22	3.10
Barium	TS7	4	4	60.09	13.69	92.30	99.50
Beryllium	TS7	4	3	0.43	0.10	0.66	0.73
Cadmium	TS7	4	3	0.82	0.85	2.83	3.50
Calcium	TS7	4	4	1097.63	383.72	2000.66	2030.00
Chromium	TS7	4	4	10.91	1.46	14.36	14.90
Cobalt	TS7	4	4	7.80	2.14	12.84	12.90
Copper	TS7	4	4	6.55	2.40	12.19	13.60
Iron	TS7	4	4	9522.50	1627.95	13353.66	13300.00
Lead	TS7	4	4	12.69	2.97	19.68	20.70
Lithium	TS7	4	4	7.86	4.90	19.39	23.50
Magnesium	TS7	4	4	598.00	183.51	1029.87	1090.00
Manganese	TS7	4	4	571.88	231.21	1115.99	1150.00
Mercury	TS7	4	4	0.33	0.23	0.87	0.98
Nickel	TS7	4	4	9.11	3.63	17.65	20.70
Potassium	TS7	4	4	560.63	237.87	1120.43	1240.00
Selenium	TS7	4	4	1.41	0.06	1.56	1.60
Sodium	TS7	4	3	156.75	16.16	194.79	184.00
Vanadium	TS7	4	4	12.39	1.34	15.55	16.00
Zinc	TS7	4	4	24.41	9.21	46.10	52.00
DDT — total	TS7	4	1	0.01	0.00	0.02	0.01
4,4'-DDE	TS7	4	1	0.00	0.00	0.01	0.00
Bis(2-ethylhexyl)phthalate	TS7	4	1	0.25	0.14	0.58	0.04
Chlordane — total	TS7	4	1	0.00	0.00	0.01	0.00
Di-n-butylphthalate	TS7	4	2	0.16	0.10	0.39	0.12
Dieldrin	TS7	4	2	0.00	0.00	0.01	0.01
Endrin — total	TS7	4	2	0.02	0.01	0.04	0.05
Endrin aldehyde	TS7	4	2	0.01	0.01	0.03	0.04
Fluoranthene	TS7	4	1	0.34	0.09	0.55	0.07
Methoxychlor	TS7	4	1	0.02	0.00	0.03	0.00
PCB-1254	TS7	4	1	0.07	0.06	0.22	0.28
PCB-1260	TS7	4	4	0.20	0.34	1.01	1.30
BHC — total	TS7	4	3	0.01	0.00	0.01	0.00
alpha-BHC	TS7	4	2	0.00	0.00	0.00	0.00
alpha-Chlordane	TS7	4	1	0.00	0.00	0.00	0.00
beta-BHC	TS7	4	1	0.00	0.00	0.00	0.00
delta-BHC	TS7	4	1	0.00	0.00	0.00	0.00
Americium-241	TS7	4	2	0.04	0.02	0.08	0.08
Cesium-137	TS7	4	4	0.28	0.20	0.75	0.76
Curium-244	TS7	4	1	0.10	0.07	0.27	0.21
Plutonium-239/240	TS7	4	1	0.01	0.01	0.03	0.02
Technetium-99	TS7	4	1	1.15	0.71	2.83	2.47
Thorium-228	TS7	4	4	1.05	0.17	1.44	1.39
Thorium-230	TS7	4	4	0.88	0.14	1.22	1.15

Table G.41 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Thorium-232	TS7	4	4	0.85	0.12	1.14	0.98
Uranium-234	TS7	4	4	6.82	7.20	23.77	29.49
Uranium-235	TS7	4	3	0.39	0.53	1.64	2.08
Uranium-238	TS7	4	4	10.96	13.11	41.82	52.66
Aluminum	TS8	2	2	7037.50	900.19	12721.06	8140.00
Arsenic	TS8	2	2	2.38	0.92	8.17	3.50
Barium	TS8	2	2	74.48	0.06	74.86	74.50
Beryllium	TS8	2	2	0.54	0.01	0.61	0.54
Cadmium	TS8	2	1	0.09	0.02	0.24	0.12
Calcium	TS8	2	2	1292.50	642.99	5352.19	2080.00
Chromium	TS8	2	2	12.93	0.43	15.63	13.10
Cobalt	TS8	2	2	9.75	0.86	15.16	10.80
Copper	TS8	2	2	5.83	1.53	15.49	7.70
Iron	TS8	2	2	11000.00	244.95	12546.55	11300.00
Lead	TS8	2	2	12.70	3.43	34.35	16.90
Lithium	TS8	2	1	7.95	3.06	27.28	11.70
Magnesium	TS8	2	2	849.00	88.18	1405.76	957.00
Manganese	TS8	2	2	713.25	115.74	1443.99	855.00
Mercury	TS8	1	1	0.42	0.00	0.00	0.42
Nickel	TS8	2	2	8.50	1.47	17.78	10.30
Potassium	TS8	2	2	676.25	135.33	1530.72	842.00
Selenium	TS8	2	2	1.80	0.49	4.89	2.00
Vanadium	TS8	2	2	14.30	0.25	15.85	14.60
Zinc	TS8	2	2	25.30	6.86	68.60	33.70
2,4,5-T	TS8	2	2	0.01	0.00	0.04	0.01
2,4-D	TS8	2	1	0.11	0.05	0.39	0.06
DDT — total	TS8	2	1	0.01	0.00	0.03	0.01
4,4'-DDE	TS8	2	1	0.00	0.00	0.02	0.00
Bis(2-ethylhexyl)phthalate	TS8	2	2	0.04	0.00	0.05	0.04
Chlordane — total	TS8	2	1	0.00	0.00	0.01	0.00
Dieldrin	TS8	2	2	0.00	0.00	0.00	0.00
Endrin — total	TS8	2	1	0.01	0.00	0.02	0.01
Endrin aldehyde	TS8	2	1	0.00	0.00	0.01	0.00
PCB-1260	TS8	2	2	0.04	0.09	0.60	0.15
Silvex	TS8	2	1	0.02	0.01	0.09	0.02
alpha-Chlordane	TS8	2	1	0.00	0.00	0.01	0.00
Americium-241	TS8	2	1	0.05	0.02	0.20	0.06
Cesium-137	TS8	2	1	0.21	0.39	2.64	0.68
Plutonium-239/240	TS8	2	1	0.01	0.01	0.08	0.02
Thorium-228	TS8	2	2	0.98	0.17	2.02	1.18
Thorium-230	TS8	2	2	1.02	0.27	2.72	1.35
Thorium-232	TS8	2	2	0.97	0.06	1.32	1.04
Uranium-234	TS8	2	2	1.81	2.03	14.61	4.29
Uranium-235	TS8	2	2	0.10	0.19	1.30	0.33
Uranium-238	TS8	2	2	2.41	3.07	21.78	6.17
Aluminum	TS9	2	2	6267.50	691.98	10636.50	6550.00
Arsenic	TS9	2	2	2.98	0.67	7.23	3.80
Barium	TS9	2	2	86.18	22.84	230.39	95.50
Beryllium	TS9	2	2	0.73	0.17	1.78	0.80
Calcium	TS9	2	2	549.75	9.19	607.75	561.00

Table G.41 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Chromium	TS9	2	2	11.20	0.49	14.29	11.80
Cobalt	TS9	2	2	9.03	0.43	11.73	9.20
Copper	TS9	2	2	4.85	1.35	13.36	6.50
Iron	TS9	2	2	10725.00	61.24	11111.64	10800.00
Lead	TS9	2	2	12.05	1.59	22.10	14.00
Magnesium	TS9	2	2	715.00	75.93	1194.43	746.00
Manganese	TS9	2	2	878.00	149.42	1821.39	939.00
Nickel	TS9	2	2	7.95	0.86	13.36	8.30
Potassium	TS9	2	2	560.75	7.96	611.01	564.00
Selenium	TS9	2	1	1.18	0.06	1.56	1.20
Sodium	TS9	2	2	180.25	1.84	191.85	181.00
Vanadium	TS9	2	2	13.13	2.27	27.43	15.90
Zinc	TS9	2	2	25.15	0.12	25.92	25.20
2,4,5-T	TS9	2	2	0.01	0.00	0.03	0.01
2,4-D	TS9	2	1	0.10	0.02	0.20	0.10
DDT — total	TS9	2	2	0.01	0.00	0.01	0.01
4,4'-DDE	TS9	2	1	0.00	0.00	0.02	0.00
4,4'-DDT	TS9	2	1	0.00	0.00	0.02	0.00
Bis(2-ethylhexyl)phthalate	TS9	2	1	0.36	0.16	1.36	0.16
Chlordane — total	TS9	2	1	0.00	0.00	0.01	0.00
Dieldrin	TS9	2	1	0.00	0.00	0.02	0.00
Endosulfan — total	TS9	2	2	0.00	0.00	0.02	0.01
Endosulfan II	TS9	2	2	0.00	0.00	0.00	0.00
Endosulfan sulfate	TS9	2	1	0.00	0.00	0.01	0.00
Endrin	TS9	2	1	0.00	0.00	0.02	0.00
Endrin — total	TS9	2	1	0.01	0.00	0.02	0.01
PCB-1260	TS9	2	1	0.04	0.01	0.09	0.03
Silvex	TS9	2	1	0.01	0.01	0.10	0.01
alpha-Chlordane	TS9	2	1	0.00	0.00	0.01	0.00
CURIUM-243	TS9	2	1	0.02	0.02	0.14	0.03
Cesium-137	TS9	2	1	0.22	0.33	2.30	0.62
Curium-244	TS9	2	2	0.09	0.07	0.51	0.17
Plutonium-239/240	TS9	2	1	0.01	0.01	0.08	0.02
Thorium-228	TS9	2	2	0.91	0.01	0.98	0.91
Thorium-230	TS9	2	2	1.15	0.07	1.57	1.23
Thorium-232	TS9	2	2	0.93	0.05	1.24	0.95
Uranium-234	TS9	2	2	1.27	0.46	4.17	1.83
Uranium-235	TS9	2	2	0.07	0.02	0.22	0.10
Uranium-238	TS9	2	2	1.44	1.02	7.89	2.69
Aluminum	TS10	2	2	8202.50	2933.26	26722.40	9400.00
Arsenic	TS10	2	2	1.85	0.37	4.17	2.30
Barium	TS10	2	2	68.65	10.41	134.38	72.90
Beryllium	TS10	2	2	0.50	0.01	0.57	0.50
Cadmium	TS10	2	2	0.31	0.05	0.62	0.37
Calcium	TS10	2	2	777.00	110.23	1472.95	912.00
Chromium	TS10	2	2	13.00	3.18	33.11	14.30
Cobalt	TS10	2	2	8.65	0.12	9.42	8.80
Copper	TS10	2	2	5.80	0.00	5.80	5.80
Cyanide	TS10	2	1	0.75	0.29	2.56	1.10
Iron	TS10	2	2	9662.50	508.27	12871.58	9870.00

Table G.41 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Lead	TS10	2	2	11.68	1.41	20.57	13.40
Lithium	TS10	2	2	8.28	2.76	25.67	9.40
Magnesium	TS10	2	2	900.75	199.02	2157.32	982.00
Manganese	TS10	2	2	620.25	12.86	701.44	636.00
Mercury	TS10	1	1	0.28	0.00	0.00	0.28
Nickel	TS10	2	2	9.40	0.73	14.04	9.70
Potassium	TS10	2	2	1140.00	514.39	4387.75	1350.00
Selenium	TS10	2	2	1.40	0.00	1.40	1.40
Sodium	TS10	2	2	147.25	17.76	259.37	169.00
Vanadium	TS10	2	2	13.58	1.78	24.79	14.30
Zinc	TS10	2	2	26.90	3.92	51.64	28.50
2,4-D	TS10	2	2	0.02	0.01	0.10	0.03
Chlordane — total	TS10	2	2	0.00	0.00	0.01	0.00
Di-n-butylphthalate	TS10	2	2	0.14	0.04	0.41	0.16
Dieldrin	TS10	2	2	0.00	0.00	0.01	0.00
Endrin — total	TS10	2	2	0.02	0.01	0.09	0.03
Endrin aldehyde	TS10	2	2	0.01	0.01	0.08	0.02
Fluoranthene	TS10	2	1	0.32	0.22	1.73	0.05
Heptachlor — total	TS10	2	1	0.00	0.00	0.01	0.00
Heptachlor epoxide	TS10	2	1	0.00	0.00	0.01	0.00
Methoxychlor	TS10	2	2	0.00	0.00	0.01	0.00
PCB-1254	TS10	2	1	0.13	0.21	1.47	0.39
PCB-1260	TS10	2	2	0.20	0.34	2.33	0.61
alpha-Chlordane	TS10	2	2	0.00	0.00	0.01	0.00
gamma-Chlordane	TS10	2	1	0.00	0.00	0.01	0.00
Cesium-137	TS10	2	1	0.16	0.23	1.62	0.44
Plutonium-239/240	TS10	2	1	0.01	0.02	0.12	0.03
Thorium-228	TS10	2	2	0.85	0.01	0.89	0.86
Thorium-230	TS10	2	2	0.77	0.01	0.81	0.77
Thorium-232	TS10	2	2	0.90	0.09	1.44	0.93
Uranium-234	TS10	2	2	2.92	3.53	25.19	7.24
Uranium-235	TS10	2	2	0.14	0.20	1.42	0.39
Uranium-238	TS10	2	2	4.79	6.82	47.83	13.14
Aluminum	TS13	2	2	8362.50	1096.15	15283.30	8810.00
Arsenic	TS13	2	2	1.38	0.92	7.17	2.50
Barium	TS13	2	2	72.05	12.37	150.15	87.20
Beryllium	TS13	2	1	0.50	0.06	0.88	0.57
Calcium	TS13	2	2	1117.00	712.80	5617.45	1990.00
Chromium	TS13	2	2	10.58	0.80	15.60	10.90
Cobalt	TS13	2	2	9.20	0.74	13.84	9.50
Copper	TS13	2	2	5.88	2.39	20.95	8.80
Iron	TS13	2	2	9497.50	287.82	11314.69	9850.00
Lead	TS13	2	2	13.73	7.41	60.51	22.80
Lithium	TS13	2	2	10.20	2.21	24.12	11.10
Magnesium	TS13	2	2	901.00	83.28	1426.83	935.00
Manganese	TS13	2	2	559.25	159.83	1568.37	755.00
Mercury	TS13	2	1	0.17	0.16	1.17	0.36
Nickel	TS13	2	2	10.50	5.39	44.52	17.10
Potassium	TS13	2	2	809.75	34.91	1030.13	824.00
Selenium	TS13	2	2	1.35	0.12	2.12	1.50

Table G.41 (continued)

Analyte	Transect	OBS	Defects	Standard		UCL95	Maximum
				Mean	error		
Sodium	TS13	2	2	193.50	6.12	232.16	196.00
Vanadium	TS13	2	2	15.53	0.06	15.91	15.60
Zinc	TS13	2	2	28.58	0.06	28.96	28.60
DDT — total	TS13	2	1	0.01	0.00	0.02	0.01
4,4'-DDT	TS13	2	1	0.00	0.00	0.02	0.00
Chlordane — total	TS13	2	1	0.00	0.00	0.01	0.00
Chloroform	TS13	2	1	0.05	0.03	0.25	0.06
Endrin	TS13	2	1	0.00	0.00	0.02	0.00
Endrin — total	TS13	2	2	0.01	0.00	0.02	0.01
Endrin aldehyde	TS13	2	1	0.00	0.00	0.01	0.00
Endrin ketone	TS13	2	1	0.00	0.00	0.02	0.00
Methoxychlor	TS13	2	1	0.02	0.01	0.09	0.00
PCB-1260	TS13	2	1	0.05	0.02	0.20	0.08
alpha-Chlordane	TS13	2	1	0.00	0.00	0.01	0.00
Cesium-137	TS13	2	2	0.32	0.45	3.18	0.87
Thorium-228	TS13	2	2	1.15	0.08	1.66	1.25
Thorium-230	TS13	2	2	0.96	0.02	1.07	0.98
Thorium-232	TS13	2	2	0.98	0.01	1.05	0.99
Uranium-234	TS13	2	2	1.45	0.56	5.01	2.14
Uranium-235	TS13	2	2	0.04	0.02	0.19	0.07
Uranium-238	TS13	2	2	1.55	0.85	6.88	2.58

*All rads in pCi/g; all others in mg/kg.

Table G.42. Summary statistics for Bear Creek surface soil contaminant data

Analyte	Location	Units	OBS	Detects	Mean	Maximum	Standard error	UCL95
1,1-Dichloroethane	Burial Ground	(mg/kg)	2	34	0.01	0.07	0.00	0.01
1,1-Dichloroethene	Burial Ground	(mg/kg)	1	34	0.00	0.01	0.00	0.00
1,2-Dichloroethane	Burial Ground	(mg/kg)	1	34	0.00	0.00	0.00	0.00
1,2-Dichloroethene	Burial Ground	(mg/kg)	1	34	0.00	0.01	0.00	0.00
1,4-Dichlorobenzene	Burial Ground	(mg/kg)	1	15	0.22	0.09	0.02	0.24
111Trichloroethane	Burial Ground	(mg/kg)	2	34	0.00	0.02	0.00	0.00
2,4-Dimethylphenol	Boneyard/Burnyard	(mg/kg)	1	13	0.19	0.11	0.01	0.21
2-Butanone	Burial Ground	(mg/kg)	1	34	0.01	0.04	0.00	0.01
2-Butanone	S3 ponds	(mg/kg)	1	19	0.01	0.01	0.00	0.01
2-Methylnaphthalene	Boneyard/Burnyard	(mg/kg)	10	14	0.36	2.60	0.18	0.67
2378-TCDD	Boneyard/Burnyard	(mg/kg)	2	3	0.00	0.00	0.00	0.00
4,4'-DDE	Burial Ground	(mg/kg)	1	33	0.00	0.00	0.00	0.00
4,4'-DDT	Burial Ground	(mg/kg)	1	33	0.00	0.00	0.00	0.00
4-Methyl2pentanone	Burial Ground	(mg/kg)	3	33	0.01	0.01	0.00	0.01
4-Methyl2pentanone	S3 ponds	(mg/kg)	1	20	0.01	0.03	0.00	0.01
4-Methylphenol	Boneyard/Burnyard	(mg/kg)	1	13	0.20	0.14	0.01	0.20
Acenaphthene	Boneyard/Burnyard	(mg/kg)	13	14	1.03	6.70	0.46	1.84
Acenaphthene	Oil Land Farm	(mg/kg)	1	5	0.24	0.32	0.02	0.29
Acenaphthylene	Boneyard/Burnyard	(mg/kg)	8	12	0.18	0.49	0.04	0.24
Acenaphthylene	Oil Land Farm	(mg/kg)	1	5	0.18	0.05	0.04	0.26
Acetone	Burial Ground	(mg/kg)	6	29	0.02	0.11	0.00	0.03
Acetone	Boneyard/Burnyard	(mg/kg)	7	15	0.03	0.11	0.01	0.05
Acetone	Oil Land Farm	(mg/kg)	11	13	0.11	0.59	0.04	0.19
Acetone	S3 ponds	(mg/kg)	11	18	0.45	4.20	0.25	0.88
Aluminum	Burial Ground	(mg/kg)	70	70	33000.00	85800.00	2640.00	37406.94
Aluminum	Boneyard/Burnyard	(mg/kg)	32	32	29900.00	65900.00	3240.00	35393.81
Aluminum	Oil Land Farm	(mg/kg)	32	32	37800.00	77500.00	4300.00	45051.91
Aluminum	S3 ponds	(mg/kg)	20	20	14600.00	29000.00	1470.00	17133.33
Anthracene	Boneyard/Burnyard	(mg/kg)	13	14	5.57	53.00	3.70	12.11
Anthracene	Oil Land Farm	(mg/kg)	3	5	0.33	1.10	0.20	0.75
Antimony	Burial Ground	(mg/kg)	9	9	0.31	0.56	0.04	0.38
Antimony	Boneyard/Burnyard	(mg/kg)	12	12	139.00	1650.00	137.00	385.95
Antimony	Oil Land Farm	(mg/kg)	1	1	0.34	0.34		
Antimony	S3 ponds	(mg/kg)	1	1	0.25	0.25		
Arsenic	Burial Ground	(mg/kg)	35	35	7.51	42.30	2.10	11.06
Arsenic	Boneyard/Burnyard	(mg/kg)	15	15	13.30	32.50	2.68	18.01
Arsenic	Oil Land Farm	(mg/kg)	13	13	8.13	31.80	2.45	12.50
Arsenic	S3 ponds	(mg/kg)	20	20	4.92	20.50	1.10	6.83
Barium	Burial Ground	(mg/kg)	70	70	155.00	454.00	10.80	172.82

Table G.42 (continued)

Analyte	Location	Units	OBS	Detects	Mean	Maximum	Standard error	UCL95
Barium	Boneyard/Burnyard	(mg/kg)	32	32	262.00	1100.00	33.20	317.89
Barium	Oil Land Farm	(mg/kg)	32	32	182.00	380.00	16.30	209.61
Barium	S3 ponds	(mg/kg)	20	20	112.00	277.00	16.00	139.97
Benzo(a)anthracene	Burial Ground	(mg/kg)	1	15	0.21	0.09	0.01	0.24
Benzo(a)anthracene	Boneyard/Burnyard	(mg/kg)	14	14	14.40	120.00	8.32	29.16
Benzo(a)anthracene	Oil Land Farm	(mg/kg)	3	5	1.30	5.70	1.10	3.65
Benzo(a)pyrene	Boneyard/Burnyard	(mg/kg)	14	14	9.86	76.00	5.27	19.20
Benzo(a)pyrene	Oil Land Farm	(mg/kg)	3	5	0.99	4.20	0.80	2.70
Benzo(b)fluoranthene	Boneyard/Burnyard	(mg/kg)	14	14	11.80	86.00	5.99	22.39
Benzo(b)fluoranthene	Oil Land Farm	(mg/kg)	3	5	1.31	5.80	1.12	3.70
Benzo(b)fluoranthene	Burial Ground	(mg/kg)	1	15	0.21	0.09	0.01	0.24
Benzo(ghi)perylene	Boneyard/Burnyard	(mg/kg)	14	14	4.48	30.00	2.09	8.18
Benzo(ghi)perylene	Oil Land Farm	(mg/kg)	3	5	0.45	1.70	0.31	1.12
Benzo(k)fluoranthene	Boneyard/Burnyard	(mg/kg)	14	14	10.10	80.00	5.53	19.91
Benzo(k)fluoranthene	Oil Land Farm	(mg/kg)	3	5	0.93	3.90	0.74	2.51
Benzo(k)fluoranthene	Burial Ground	(mg/kg)	1	15	0.21	0.09	0.01	0.24
Beryllium	Burial Ground	(mg/kg)	69	70	1.07	4.80	0.07	1.19
Beryllium	Boneyard/Burnyard	(mg/kg)	30	32	1.16	3.30	0.11	1.35
Beryllium	Oil Land Farm	(mg/kg)	27	32	1.18	2.50	0.09	1.34
Beryllium	S3 ponds	(mg/kg)	18	20	0.82	1.50	0.07	0.95
Bis(2-ethylhexyl)	Burial Ground	(mg/kg)	5	15	0.32	1.70	0.11	0.52
Bis(2-ethylhexyl)	Boneyard/Burnyard	(mg/kg)	11	12	0.24	0.60	0.05	0.32
Bis(2-ethylhexyl)	Oil Land Farm	(mg/kg)	3	5	0.74	3.20	0.62	2.05
Butylbenzylphthalat	Boneyard/Burnyard	(mg/kg)	2	10	0.17	0.09	0.02	0.21
Cadmium	Boneyard/Burnyard	(mg/kg)	11	32	5.97	32.30	1.57	8.62
Cadmium	Oil Land Farm	(mg/kg)	1	32	1.33	3.20	0.17	1.62
Cadmium	S3 ponds	(mg/kg)	1	20	0.25	2.00	0.09	0.41
Calcium	Boneyard/Burnyard	(mg/kg)	32	32	34500.00	225000.00	8400.00	48695.28
Calcium	Oil Land Farm	(mg/kg)	30	32	5130.00	20900.00	1030.00	6881.24
Calcium	S3 ponds	(mg/kg)	19	19	36000.00	318000.00	16600.00	64803.56
Calcium	Burial Ground	(mg/kg)	68	70	9050.00	183000.00	3350.00	14634.33
Carbazole	Boneyard/Burnyard	(mg/kg)	13	14	2.84	25.00	1.73	5.91
Carbazole	Oil Land Farm	(mg/kg)	2	5	0.20	0.31	0.04	0.28
Cerium	Boneyard/Burnyard	(mg/kg)	16	17	42.40	80.00	3.49	48.44
Cerium	Oil Land Farm	(mg/kg)	19	19	60.00	200.00	8.09	74.03
Cerium	Burial Ground	(mg/kg)	35	36	46.00	80.00	2.46	50.13
Chloroethane	Burial Ground	(mg/kg)	2	34	0.01	0.17	0.00	0.02
Chloroform	Oil Land Farm	(mg/kg)	1	13	0.00	0.00	0.00	0.00
Chromium	Burial Ground	(mg/kg)	70	70	37.20	84.00	2.07	40.65

Table G.42 (continued)

Analyte	Location	Units	OBS	Detects	Mean	Maximum	Standard error	UCL95
Chromium	Boneyard/Burnyard	(mg/kg)	32	32	61.40	210.00	6.87	73.09
Chromium	Oil Land Farm	(mg/kg)	32	32	43.90	76.00	2.91	48.86
Chromium	S3 ponds	(mg/kg)	20	20	28.00	43.30	2.40	32.17
Chrysene	Burial Ground	(mg/kg)	1	15	0.21	0.09	0.01	0.24
Chrysene	Boneyard/Burnyard	(mg/kg)	14	14	14.50	120.00	8.33	29.21
Chrysene	Oil Land Farm	(mg/kg)	4	5	1.19	5.30	1.03	3.38
Cobalt	Burial Ground	(mg/kg)	70	70	12.10	37.00	0.76	13.32
Cobalt	Boneyard/Burnyard	(mg/kg)	32	32	19.10	131.00	3.86	25.68
Cobalt	Oil Land Farm	(mg/kg)	32	32	28.80	406.00	12.20	49.50
Cobalt	S3 ponds	(mg/kg)	20	20	15.20	27.60	1.50	17.79
Cobalt-60	Burial Ground	(pCi/g)	1	34	1.67	1.20	0.34	2.23
Cobalt-60	Oil Land Farm	(pCi/g)	5	13	1.08	1.70	0.32	1.65
Copper	Burial Ground	(mg/kg)	65	69	16.10	45.00	0.94	17.66
Copper	Boneyard/Burnyard	(mg/kg)	31	32	968.00	6220.00	314.00	1500.43
Copper	Oil Land Farm	(mg/kg)	31	31	44.60	252.00	10.00	61.68
Copper	S3 ponds	(mg/kg)	19	20	23.60	50.80	3.07	28.89
Cyanide	Burial Ground	(mg/kg)	2	34	4.53	142.00	4.17	11.58
Cyanide	Boneyard/Burnyard	(mg/kg)	1	14	0.33	0.69	0.03	0.38
Cyanide	S3 ponds	(mg/kg)	2	20	0.39	1.40	0.07	0.51
Di-n-butylphthalate	Boneyard/Burnyard	(mg/kg)	1	12	0.41	2.50	0.19	0.75
Di-n-butylphthalate	Oil Land Farm	(mg/kg)	2	5	0.18	0.11	0.03	0.25
Di-n-octylphthalate	Burial Ground	(mg/kg)	1	15	0.21	0.06	0.02	0.24
Dibenzo(ah)anthracene	Boneyard/Burnyard	(mg/kg)	13	14	2.06	12.00	0.84	3.54
Dibenzo(ah)anthracene	Oil Land Farm	(mg/kg)	1	5	0.37	1.00	0.16	0.71
Dibenzofuran	Boneyard/Burnyard	(mg/kg)	13	14	1.14	10.00	0.69	2.37
Dibenzofuran	Oil Land Farm	(mg/kg)	1	5	0.20	0.13	0.02	0.24
Diethylphthalate	Boneyard/Burnyard	(mg/kg)	1	12	0.21	0.07	0.02	0.25
Fluoranthene	Burial Ground	(mg/kg)	1	15	0.22	0.23	0.01	0.24
Fluoranthene	Boneyard/Burnyard	(mg/kg)	14	14	31.80	270.00	18.80	64.98
Fluoranthene	Oil Land Farm	(mg/kg)	4	5	2.41	11.00	2.15	6.99
Fluorene	Boneyard/Burnyard	(mg/kg)	13	14	2.04	17.00	1.18	4.14
Fluorene	Oil Land Farm	(mg/kg)	2	5	0.22	0.41	0.05	0.33
Gallium	Boneyard/Burnyard	(mg/kg)	2	5	14.00	20.00	2.45	19.22
GrossAlpha	Burial Ground	(pCi/g)	20	34	9.90	140.00	4.12	16.86
GrossAlpha	Boneyard/Burnyard	(pCi/g)	17	17	198.00	710.00	57.40	298.58
GrossAlpha	Oil Land Farm	(pCi/g)	11	13	9.28	35.00	2.97	14.57
GrossAlpha	S3 ponds	(pCi/g)	11	20	7.58	23.00	1.51	10.18
GrossBeta	Burial Ground	(pCi/g)	22	34	12.60	71.00	2.52	16.83
GrossBeta	Boneyard/Burnyard	(pCi/g)	16	17	279.00	1600.00	109.00	469.77

Table G.42 (continued)

Analyte	Location	Units	OBS	Detects	Mean	Maximum	Standard error	UCL95
GrossBeta	Oil Land Farm	(pCi/g)	7	13	12.70	51.00	3.55	19.07
GrossBeta	S3 ponds	(pCi/g)	12	20	14.00	47.00	2.56	18.45
Indeno(1,2,3-cd)pyr	Oil Land Farm	(mg/kg)	3	5	0.41	1.50	0.27	1.00
Indeno(123cd)pyren	Boneyard/Burnyard	(mg/kg)	14	14	4.62	31.00	2.17	8.47
Iron	Burial Ground	(mg/kg)	70	70	26500.00	45500.00	1040.00	28261.44
Iron	Boneyard/Burnyard	(mg/kg)	32	32	32300.00	102000.00	3240.00	37824.91
Iron	Oil Land Farm	(mg/kg)	32	32	30200.00	49400.00	1610.00	32965.43
Iron	S3 ponds	(mg/kg)	20	20	26400.00	48300.00	2360.00	30475.90
Lead	Burial Ground	(mg/kg)	42	42	13.90	30.70	0.98	15.52
Lead	Boneyard/Burnyard	(mg/kg)	23	23	426.00	1870.00	119.00	629.86
Lead	Oil Land Farm	(mg/kg)	29	29	35.80	201.00	7.05	47.80
Lead	S3 ponds	(mg/kg)	20	20	19.90	82.30	3.88	26.59
Lead-212	Oil Land Farm	(pCi/g)	1	13	1.01	6.20	0.47	1.83
Lithium	Burial Ground	(mg/kg)	35	36	28.00	50.00	1.43	30.41
Lithium	Boneyard/Burnyard	(mg/kg)	16	17	28.80	50.00	2.70	33.53
Lithium	Oil Land Farm	(mg/kg)	19	19	40.00	120.00	5.46	49.47
Magnesium	Burial Ground	(mg/kg)	70	70	4370.00	35700.00	606.00	5382.40
Magnesium	Boneyard/Burnyard	(mg/kg)	32	32	7190.00	20600.00	929.00	8764.04
Magnesium	Oil Land Farm	(mg/kg)	32	32	3810.00	7400.00	376.00	4442.09
Magnesium	S3 ponds	(mg/kg)	20	20	7060.00	33900.00	1790.00	10152.55
Manganese	Burial Ground	(mg/kg)	70	70	541.00	2450.00	57.00	636.32
Manganese	Boneyard/Burnyard	(mg/kg)	32	32	918.00	2980.00	124.00	1128.19
Manganese	Oil Land Farm	(mg/kg)	32	32	781.00	4900.00	151.00	1036.56
Manganese	S3 ponds	(mg/kg)	20	20	614.00	2000.00	88.60	766.88
Mercury	Burial Ground	(mg/kg)	16	34	0.11	0.47	0.02	0.14
Mercury	Boneyard/Burnyard	(mg/kg)	15	15	31.70	77.70	6.57	43.24
Mercury	Oil Land Farm	(mg/kg)	8	13	4.00	41.50	3.15	9.61
Mercury	S3 ponds	(mg/kg)	17	20	14.80	82.90	5.42	24.19
Methoxychlor	S3 ponds	(mg/kg)	1	6	0.01	0.01	0.00	0.01
Methylenechloride	Oil Land Farm	(mg/kg)	2	13	0.00	0.00	0.00	0.00
Methylenechloride	S3 ponds	(mg/kg)	1	18	0.01	0.18	0.01	0.03
Molybdenum	Burial Ground	(mg/kg)	1	69	1.66	3.40	0.14	1.89
Molybdenum	Boneyard/Burnyard	(mg/kg)	3	28	6.81	50.30	2.50	11.07
Molybdenum	Oil Land Farm	(mg/kg)	2	32	2.18	4.40	0.20	2.51
Molybdenum	S3 ponds	(mg/kg)	1	20	0.64	3.70	0.17	0.94
Naphthalene	Boneyard/Burnyard	(mg/kg)	13	14	0.55	5.00	0.35	1.16
Neptunium-237	S3 ponds	(pCi/g)	5	20	0.03	0.13	0.01	0.04
Nickel	Burial Ground	(mg/kg)	69	70	22.00	206.00	2.90	26.79
Nickel	Boneyard/Burnyard	(mg/kg)	31	32	415.00	10600.00	329.00	972.82

Table G.42 (continued)

Analyte	Location	Units	OBS	Detects	Mean	Maximum	Standard error	UCL95
Nickel	Oil Land Farm	(mg/kg)	32	32	31.80	123.00	3.51	37.74
Nickel	S3 ponds	(mg/kg)	20	20	25.50	128.00	5.65	35.27
Niobium	Burial Ground	(mg/kg)	5	36	5.03	11.00	0.31	5.55
Niobium	Boneyard/Burnyard	(mg/kg)	5	17	6.76	20.00	1.02	8.54
Niobium	Oil Land Farm	(mg/kg)	3	19	5.34	10.00	0.36	5.97
PCB-1232	Oil Land Farm	(mg/kg)	1	13	0.12	1.30	0.10	0.29
PCB-1248	S3 ponds	(mg/kg)	3	20	0.03	0.14	0.01	0.04
PCB-1248	Burial Ground	(ug/kg)	1	33	33.00	400.00	11.50	52.46
PCB-1254	Burial Ground	(mg/kg)	11	33	0.36	10.00	0.30	0.87
PCB-1254	Boneyard/Burnyard	(mg/kg)	11	11	1.66	5.80	0.51	2.58
PCB-1254	Oil Land Farm	(mg/kg)	2	13	0.21	1.70	0.14	0.45
PCB-1254	S3 ponds	(mg/kg)	12	20	0.07	0.37	0.02	0.10
PCB-1260	Burial Ground	(mg/kg)	4	33	1.18	36.00	1.09	3.03
PCB-1260	Boneyard/Burnyard	(mg/kg)	3	10	0.27	1.60	0.16	0.56
PCB-1260	Oil Land Farm	(mg/kg)	4	12	0.05	0.22	0.02	0.08
PCB-1260	S3 ponds	(mg/kg)	5	20	0.04	0.21	0.01	0.06
Phenanthrene	Burial Ground	(mg/kg)	2	15	0.21	0.15	0.01	0.23
Phenanthrene	Boneyard/Burnyard	(mg/kg)	14	14	20.30	180.00	12.50	42.49
Phenanthrene	Oil Land Farm	(mg/kg)	4	5	1.16	4.90	0.94	3.16
Phenol	Boneyard/Burnyard	(mg/kg)	9	12	0.13	0.28	0.02	0.17
Phenol	Oil Land Farm	(mg/kg)	1	5	0.18	0.05	0.03	0.26
Plutonium-239/240	S3 ponds	(pCi/g)	1	19	0.00	0.02	0.00	0.00
Potassium	Burial Ground	(mg/kg)	70	70	8280.00	31500.00	901.00	9778.72
Potassium	Boneyard/Burnyard	(mg/kg)	32	32	8940.00	30900.00	1440.00	11375.29
Potassium	Oil Land Farm	(mg/kg)	32	32	11600.00	43400.00	2150.00	15227.18
Potassium	S3 ponds	(mg/kg)	20	20	1660.00	3100.00	163.00	1940.34
Potassium-40	Burial Ground	(pCi/g)	2	34	33.70	20.00	5.39	42.85
Potassium-40	Oil Land Farm	(pCi/g)	2	13	15.60	20.00	5.40	25.18
Pyrene	Burial Ground	(mg/kg)	3	15	0.21	0.24	0.02	0.24
Pyrene	Boneyard/Burnyard	(mg/kg)	14	14	25.50	210.00	14.60	51.24
Pyrene	Oil Land Farm	(mg/kg)	4	5	2.00	9.00	1.75	5.73
Selenium	Burial Ground	(mg/kg)	10	34	0.56	2.80	0.10	0.72
Selenium	Boneyard/Burnyard	(mg/kg)	4	13	10.90	132.00	10.10	28.88
Silver	Burial Ground	(mg/kg)	23	70	2.25	4.00	0.11	2.43
Silver	Boneyard/Burnyard	(mg/kg)	14	32	11.80	61.50	3.03	16.97
Silver	Oil Land Farm	(mg/kg)	10	32	2.82	7.60	0.23	3.20
Silver	S3 ponds	(mg/kg)	12	20	1.91	4.30	0.29	2.42
Sodium	Burial Ground	(mg/kg)	44	71	500.00	9300.00	142.00	737.25
Sodium	Boneyard/Burnyard	(mg/kg)	31	32	648.00	2720.00	107.00	829.28

Table G.42 (continued)

Analyte	Location	Units	OBS	Detects	Mean	Maximum	Standard error	UCL95
Sodium	Oil Land Farm	(mg/kg)	29	32	410.00	1210.00	61.70	514.34
Sodium	S3 ponds	(mg/kg)	14	20	88.60	214.00	12.70	110.52
Strontium	Burial Ground	(mg/kg)	36	36	47.20	167.00	5.14	55.85
Strontium	Boneyard/Burnyard	(mg/kg)	17	17	79.60	303.00	17.70	110.46
Strontium	Oil Land Farm	(mg/kg)	19	19	35.50	61.60	2.99	40.73
Strontium-90	Boneyard/Burnyard	(pCi/g)	3	14	0.32	1.90	0.14	0.57
Technetium-99	Burial Ground	(pCi/g)	6	31	8.28	130.00	4.48	15.88
Technetium-99	Boneyard/Burnyard	(pCi/g)	6	14	21.90	77.00	7.75	35.61
Technetium-99	S3 ponds	(pCi/g)	2	20	2.05	6.80	0.55	3.00
Tetrachloroethene	Burial Ground	(mg/kg)	2	33	0.01	0.08	0.00	0.01
Tetrachloroethene	Boneyard/Burnyard	(mg/kg)	1	16	0.00	0.01	0.00	0.00
Tetrachloroethene	S3 ponds	(mg/kg)	4	20	0.00	0.02	0.00	0.01
Thallium	Boneyard/Burnyard	(mg/kg)	1	15	0.25	0.87	0.04	0.33
Thallium	Oil Land Farm	(mg/kg)	1	13	0.23	0.48	0.02	0.26
Thallium	S3 ponds	(mg/kg)	1	20	0.23	0.75	0.03	0.27
Thallium-208	Burial Ground	(pCi/g)	1	34	3.18	3.70	0.50	4.03
Thallium-208	Oil Land Farm	(pCi/g)	1	13	3.48	4.60	0.71	4.75
Thorium	Burial Ground	(mg/kg)	7	36	5.25	10.00	0.33	5.80
Thorium	Boneyard/Burnyard	(mg/kg)	3	17	5.53	11.00	0.53	6.45
Thorium	Oil Land Farm	(mg/kg)	8	19	6.95	12.00	0.65	8.08
Thorium-228	Burial Ground	(pCi/g)	30	31	0.62	1.30	0.05	0.71
Thorium-228	Boneyard/Burnyard	(pCi/g)	12	16	0.54	2.40	0.13	0.77
Thorium-228	Oil Land Farm	(pCi/g)	12	13	0.59	1.10	0.07	0.71
Thorium-228	S3 ponds	(pCi/g)	15	20	0.68	1.70	0.09	0.83
Thorium-230	Burial Ground	(pCi/g)	28	31	0.49	1.20	0.04	0.56
Thorium-230	Boneyard/Burnyard	(pCi/g)	16	16	1.01	7.10	0.42	1.74
Thorium-230	Oil Land Farm	(pCi/g)	10	13	0.36	0.82	0.06	0.46
Thorium-230	S3 ponds	(pCi/g)	15	20	0.56	2.70	0.12	0.77
Thorium-232	Burial Ground	(pCi/g)	27	31	0.38	1.10	0.04	0.45
Thorium-232	Boneyard/Burnyard	(pCi/g)	10	16	0.41	1.90	0.11	0.61
Thorium-232	Oil Land Farm	(pCi/g)	9	13	0.36	0.72	0.06	0.47
Thorium-232	S3 ponds	(pCi/g)	13	20	0.41	1.50	0.08	0.55
Tin	Burial Ground	(mg/kg)	6	34	2.15	9.40	0.33	2.71
Tin	Boneyard/Burnyard	(mg/kg)	10	14	34.30	102.00	8.50	49.32
Tin	Oil Land Farm	(mg/kg)	3	13	2.27	4.80	0.50	3.16
Tin	S3 ponds	(mg/kg)	3	20	2.05	7.70	0.44	2.81
Titanium	Burial Ground	(mg/kg)	36	36	2090.00	3150.00	105.00	2267.04
Titanium	Boneyard/Burnyard	(mg/kg)	17	17	2130.00	3110.00	159.00	2412.38
Titanium	Oil Land Farm	(mg/kg)	19	19	2240.00	2800.00	85.60	2392.04

Table G.42 (continued)

Analyte	Location	Units	OBS	Detects	Mean	Maximum	Standard error	UCL95
Toluene	Burial Ground	(mg/kg)	17	34	0.04	0.36	0.01	0.06
Toluene	Boneyard/Burnyard	(mg/kg)	12	16	0.12	0.59	0.05	0.21
Toluene	Oil Land Farm	(mg/kg)	10	13	0.02	0.11	0.01	0.03
Toluene	S3 ponds	(mg/kg)	12	19	0.01	0.02	0.00	0.01
Trichloroethene	Burial Ground	(mg/kg)	1	34	0.00	0.01	0.00	0.00
Uranium	Burial Ground	(pCi/g)	42	42	0.00	0.00	0.00	0.00
Uranium	Boneyard/Burnyard	(pCi/g)	21	21	0.00	0.03	0.00	0.00
Uranium	Oil Land Farm	(pCi/g)	24	24	0.00	0.00	0.00	0.00
Uranium-234	Burial Ground	(pCi/g)	32	34	0.93	5.80	0.27	1.39
Uranium-234	Boneyard/Burnyard	(pCi/g)	17	17	95.20	260.00	23.50	136.31
Uranium-234	Oil Land Farm	(pCi/g)	13	13	2.55	14.00	1.21	4.71
Uranium-234	S3 ponds	(pCi/g)	20	20	1.87	7.70	0.49	2.72
Uranium-235	Burial Ground	(pCi/g)	48	76	0.03	0.04	0.01	0.05
Uranium-235	Boneyard/Burnyard	(pCi/g)	36	38	2.25	17.00	0.73	3.47
Uranium-235	Oil Land Farm	(pCi/g)	30	37	0.04	0.70	0.02	0.08
Uranium-235	S3 ponds	(pCi/g)	11	20	0.11	0.54	0.03	0.16
Uranium-238	Burial Ground	(pCi/g)	33	34	3.03	36.00	1.27	5.19
Uranium-238	Boneyard/Burnyard	(pCi/g)	17	17	149.00	880.00	59.70	253.12
Uranium-238	Oil Land Farm	(pCi/g)	13	13	3.35	22.00	1.70	6.39
Uranium-238	S3 ponds	(pCi/g)	20	20	3.74	18.00	1.05	5.56
Vanadium	Burial Ground	(mg/kg)	70	70	38.40	82.00	2.10	41.92
Vanadium	Boneyard/Burnyard	(mg/kg)	32	32	40.50	97.00	3.23	45.99
Vanadium	Oil Land Farm	(mg/kg)	32	32	45.20	90.00	3.26	50.73
Vanadium	S3 ponds	(mg/kg)	20	20	27.90	91.90	4.52	35.71
Vinylchloride	Burial Ground	(mg/kg)	1	34	0.01	0.01	0.00	0.01
Zinc	Burial Ground	(mg/kg)	69	70	55.50	199.00	4.32	62.73
Zinc	Boneyard/Burnyard	(mg/kg)	32	32	615.00	4380.00	178.00	916.41
Zinc	Oil Land Farm	(mg/kg)	32	32	100.00	470.00	17.10	129.10
Zinc	S3 ponds	(mg/kg)	20	20	52.10	163.00	8.52	66.83
Zirconium	Burial Ground	(mg/kg)	36	36	91.00	175.00	4.78	99.07
Zirconium	Boneyard/Burnyard	(mg/kg)	17	17	90.70	153.00	8.77	106.01
Zirconium	Oil Land Farm	(mg/kg)	19	19	94.50	168.00	7.21	106.98

Table G.43. Summary statistics for Bear Creek browse vegetation contaminant data

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Aluminum	BY17	3	3	22.83	0.64	24.69	24.10
Aluminum	BY22	3	3	32.07	3.21	41.45	38.30
Aluminum	TS1	6	6	22.75	1.08	24.92	25.10
Aluminum	TS2	3	3	22.93	1.82	28.25	25.00
Aluminum	TS3	6	6	41.30	3.08	47.50	52.60
Aluminum	TS4	6	6	25.65	1.30	28.27	31.10
Aluminum	TS7	6	6	33.58	8.46	50.62	68.10
Aluminum	TS9	3	3	94.17	21.76	157.71	135.00
Aluminum	R	9	9	25.34	1.98	29.03	36.80
Americium-241	R	3	3	0.09	0.02	0.15	0.13
Americium-241	BY17	1	1	0.04			0.04
Americium-241	TS1	1	1	0.04			0.04
Americium-241	TS2	1	1	0.06			0.06
Americium-241	TS4	1	1	0.09			0.09
Americium-241	TS7	1	1	0.07			0.07
Antimony	BY17	3	3	0.01	0.00	0.02	0.02
Antimony	BY22	3	3	0.01	0.00	0.02	0.01
Antimony	TS1	6	5	0.01	0.00	0.01	0.01
Antimony	TS2	3	2	0.05	0.05	0.19	0.15
Antimony	TS3	6	2	0.01	0.00	0.01	0.01
Antimony	TS4	6	6	0.01	0.00	0.01	0.01
Antimony	TS7	6	6	0.01	0.00	0.02	0.03
Antimony	TS9	3	3	0.01	0.00	0.02	0.02
Antimony	R	9	5	0.01	0.00	0.01	0.02
Arsenic	R	9	4	0.03	0.01	0.06	0.13
Arsenic	BY17	3	1	0.01	0.00	0.02	0.02
Arsenic	BY22	3	1	0.02	0.01	0.04	0.03
Arsenic	TS1	6	6	0.10	0.01	0.12	0.14
Arsenic	TS2	3	1	0.04	0.03	0.12	0.09
Arsenic	TS4	6	2	0.01	0.00	0.02	0.02
Arsenic	TS7	6	2	0.01	0.00	0.02	0.02
Barium	R	9	9	36.76	4.72	45.52	53.60

Table G.43 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Barium	BY17	3	3	6.27	1.11	9.52	8.40
Barium	BY22	3	3	32.00	1.15	35.37	34.30
Barium	TS1	6	6	24.10	2.51	29.15	32.60
Barium	TS2	3	3	16.13	3.32	25.83	22.70
Barium	TS3	6	6	7.71	0.90	9.51	11.20
Barium	TS4	6	6	3.33	0.19	3.71	3.84
Barium	TS7	6	6	6.57	0.88	8.34	9.96
Barium	TS9	3	3	10.97	0.96	13.76	12.30
Beryllium	R	9	6	0.01	0.00	0.01	0.01
Beryllium	TS4	6	1	0.00	0.00	0.00	0.01
Beryllium	TS9	3	1	0.00	0.00	0.01	0.01
Beryllium-7	TS3	1	1	0.38			0.38
Beryllium-7	TS7	1	1	0.55			0.55
Cadmium	R	9	8	0.06	0.03	0.11	0.27
Cadmium	BY17	3	3	0.13	0.06	0.30	0.25
Cadmium	BY22	3	3	0.11	0.05	0.24	0.20
Cadmium	TS1	6	5	0.03	0.01	0.04	0.06
Cadmium	TS2	3	3	0.20	0.06	0.36	0.29
Cadmium	TS3	6	6	1.43	0.29	2.02	2.19
Cadmium	TS4	6	6	0.06	0.02	0.10	0.12
Cadmium	TS7	6	6	2.40	0.31	3.03	3.70
Cadmium	TS9	3	3	1.47	0.38	2.58	2.20
Calcium	R	9	9	4766.67	345.56	5409.25	6280.00
Calcium	BY17	3	3	4506.67	156.24	4962.89	4740.00
Calcium	BY22	3	3	4173.33	157.20	4632.35	4480.00
Calcium	TS1	6	6	3663.33	295.68	4259.14	4660.00
Calcium	TS2	3	3	2980.00	553.38	4595.87	4050.00
Calcium	TS3	6	6	3510.00	302.21	4118.98	4670.00
Calcium	TS4	6	6	4153.33	279.58	4716.70	5030.00
Calcium	TS7	6	6	2990.00	256.46	3506.79	3980.00
Calcium	TS9	3	3	2863.33	339.62	3855.03	3500.00
Chromium	R	9	9	0.18	0.02	0.21	0.27

Table G.43 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Chromium	BY17	3	3	0.42	0.04	0.53	0.49
Chromium	BY22	3	3	0.41	0.03	0.51	0.46
Chromium	TS1	6	6	0.38	0.04	0.46	0.55
Chromium	TS2	3	3	0.27	0.02	0.34	0.31
Chromium	TS3	6	6	0.38	0.07	0.52	0.60
Chromium	TS4	6	6	0.61	0.14	0.89	1.28
Chromium	TS7	6	6	0.30	0.02	0.34	0.40
Chromium	TS9	3	3	0.21	0.00	0.22	0.21
Cobalt	R	9	9	0.03	0.00	0.04	0.05
Cobalt	BY17	3	3	0.16	0.07	0.37	0.28
Cobalt	BY22	3	3	0.03	0.00	0.04	0.04
Cobalt	TS1	6	6	0.09	0.01	0.11	0.12
Cobalt	TS2	3	3	0.03	0.00	0.04	0.04
Cobalt	TS3	6	6	0.02	0.00	0.02	0.02
Cobalt	TS4	6	6	0.05	0.01	0.06	0.07
Cobalt	TS7	6	6	0.02	0.00	0.02	0.02
Cobalt	TS9	3	3	0.02	0.00	0.03	0.02
Copper	R	9	8	1.53	0.22	1.94	2.32
Copper	BY17	3	3	3.55	0.12	3.89	3.73
Copper	BY22	3	3	3.11	0.35	4.12	3.80
Copper	TS1	6	6	5.44	0.35	6.14	7.01
Copper	TS2	3	3	2.32	0.10	2.62	2.43
Copper	TS3	6	6	3.30	0.25	3.81	4.36
Copper	TS4	6	6	2.96	0.22	3.40	3.37
Copper	TS7	6	6	3.93	0.40	4.73	5.42
Copper	TS9	3	3	3.87	0.17	4.35	4.19
Curium-244	R	3	2	0.02	0.01	0.05	0.04
Curium-244	BY17	1	1	0.02			0.02
Curium-244	TS7	1	1	0.05			0.05
Iron	R	9	9	20.52	1.00	22.39	25.60
Iron	BY17	3	3	32.03	4.08	43.96	40.20
Iron	BY22	3	3	30.67	5.32	46.21	41.30

Table G.43 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Iron	TS1	6	6	21.97	1.60	25.19	26.00
Iron	TS2	3	3	15.20	0.21	15.81	15.50
Iron	TS3	6	6	17.88	0.88	19.66	21.00
Iron	TS4	6	6	21.48	1.70	24.90	28.50
Iron	TS7	6	6	20.05	0.52	21.11	21.60
Iron	TS9	3	3	20.53	0.37	21.62	21.00
Lead	R	9	9	0.11	0.01	0.14	0.18
Lead	BY17	3	3	0.17	0.02	0.24	0.20
Lead	BY22	3	3	0.21	0.05	0.36	0.30
Lead	TS1	6	6	0.13	0.03	0.18	0.25
Lead	TS2	3	3	0.12	0.03	0.20	0.16
Lead	TS3	6	6	0.09	0.01	0.11	0.12
Lead	TS4	6	6	0.21	0.09	0.38	0.62
Lead	TS7	6	6	0.20	0.04	0.28	0.37
Lead	TS9	3	3	0.18	0.05	0.33	0.27
Lithium	R	9	8	0.04	0.01	0.05	0.06
Lithium	BY17	3	3	0.05	0.01	0.06	0.06
Lithium	BY22	3	3	0.09	0.01	0.12	0.10
Lithium	TS1	6	6	0.10	0.03	0.17	0.27
Lithium	TS2	3	3	0.04	0.01	0.07	0.06
Lithium	TS3	6	6	0.04	0.00	0.05	0.05
Lithium	TS4	6	6	0.16	0.06	0.28	0.45
Lithium	TS7	6	6	0.06	0.01	0.08	0.08
Lithium	TS9	3	3	0.04	0.00	0.05	0.05
Magnesium	R	9	9	1497.78	83.21	1652.52	1980.00
Magnesium	BY17	3	3	574.00	37.82	684.43	640.00
Magnesium	BY22	3	3	1313.33	106.51	1624.34	1470.00
Magnesium	TS1	6	6	603.83	29.65	663.58	715.00
Magnesium	TS2	3	3	946.67	132.07	1332.30	1150.00
Magnesium	TS3	6	6	923.67	36.62	997.45	1040.00
Magnesium	TS4	6	6	759.17	46.41	852.68	895.00
Magnesium	TS7	6	6	785.33	84.85	956.31	998.00

Table G.43 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Magnesium	TS9	3	3	689.67	114.14	1022.94	841.00
Manganese	R	9	9	109.32	19.63	145.83	186.00
Manganese	BY17	3	3	24.07	10.17	53.76	44.20
Manganese	BY22	3	3	28.73	3.47	38.86	32.30
Manganese	TS1	6	6	43.32	7.79	59.01	76.70
Manganese	TS2	3	3	44.07	13.23	82.70	70.20
Manganese	TS3	6	6	66.12	4.18	74.54	82.40
Manganese	TS4	6	6	283.65	53.76	391.97	390.00
Manganese	TS7	6	6	84.92	15.66	116.48	138.00
Manganese	TS9	3	3	241.33	86.16	492.93	406.00
Mercury	R	9	9	0.02	0.00	0.02	0.03
Mercury	BY17	3	3	0.03	0.00	0.04	0.04
Mercury	BY22	3	3	0.06	0.01	0.10	0.09
Mercury	TS1	6	6	0.04	0.00	0.05	0.05
Mercury	TS2	3	3	0.01	0.00	0.02	0.02
Mercury	TS3	6	6	0.02	0.00	0.02	0.02
Mercury	TS4	6	6	0.03	0.01	0.04	0.06
Mercury	TS7	6	6	0.02	0.00	0.02	0.02
Mercury	TS9	3	3	0.02	0.00	0.03	0.02
Molybdenum	R	9	9	0.03	0.00	0.03	0.04
Molybdenum	BY17	3	3	4.27	1.52	8.71	7.29
Molybdenum	BY22	3	3	0.51	0.13	0.89	0.74
Molybdenum	TS1	6	6	0.08	0.01	0.11	0.15
Molybdenum	TS2	3	3	0.06	0.00	0.07	0.06
Molybdenum	TS3	6	6	0.07	0.01	0.09	0.10
Molybdenum	TS4	6	6	0.51	0.19	0.89	1.25
Molybdenum	TS7	6	6	0.10	0.02	0.14	0.17
Molybdenum	TS9	3	3	0.04	0.00	0.06	0.05
Nickel	R	9	9	1.70	0.24	2.14	2.72
Nickel	BY17	3	3	1.83	1.12	5.09	4.06
Nickel	BY22	3	3	0.87	0.07	1.08	0.98
Nickel	TS1	6	6	0.54	0.07	0.68	0.82

Table G.43 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Nickel	TS2	3	3	0.73	0.09	0.99	0.91
Nickel	TS3	6	6	0.83	0.16	1.14	1.43
Nickel	TS4	6	6	0.29	0.03	0.36	0.43
Nickel	TS7	6	6	0.63	0.11	0.85	1.00
Nickel	TS9	3	3	1.87	0.18	2.39	2.20
Phosphorus	R	9	9	688.89	39.25	761.87	878.00
Phosphorus	BY17	3	3	975.33	20.74	1035.89	999.00
Phosphorus	BY22	3	3	999.00	44.40	1128.64	1080.00
Phosphorus	TS1	6	6	453.33	10.45	474.39	478.00
Phosphorus	TS2	3	3	307.67	29.06	392.52	361.00
Phosphorus	TS3	6	6	348.17	29.73	408.07	446.00
Phosphorus	TS4	6	6	456.83	70.33	598.54	710.00
Phosphorus	TS7	6	6	273.17	15.19	303.77	320.00
Phosphorus	TS9	3	3	361.00	8.54	385.95	378.00
Plutonium-238	BY17	1	1	0.01			0.01
Plutonium-239/240	R	3	2	0.04	0.02	0.10	0.07
Plutonium-239/240	BY17	1	1	0.05			0.05
Plutonium-239/240	TS1	1	1	0.03			0.03
Plutonium-239/240	TS2	1	1	0.04			0.04
Plutonium-239/240	TS3	1	1	0.06			0.06
Plutonium-239/240	TS4	1	1	0.05			0.05
Potassium	R	9	9	6280.00	247.98	6741.13	7520.00
Potassium	BY17	3	3	3650.00	202.32	4240.77	3990.00
Potassium	BY22	3	3	5520.00	851.96	8007.71	6970.00
Potassium	TS1	6	6	4086.67	229.12	4548.36	5010.00
Potassium	TS2	3	3	4390.00	377.23	5491.50	5120.00
Potassium	TS3	6	6	4380.00	318.66	5022.12	5240.00
Potassium	TS4	6	6	5038.33	411.01	5866.54	6940.00
Potassium	TS7	6	6	3951.67	149.56	4253.05	4270.00
Potassium	TS9	3	3	4613.33	169.54	5108.39	4950.00
Potassium-40	R	2	2	2.30	0.20	3.56	2.50
Potassium-40	TS3	1	1	2.20			2.20

Table G.43 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Selenium	BY17	3	1	0.02	0.01	0.06	0.05
Selenium	BY22	3	1	0.02	0.01	0.05	0.04
Selenium	TS1	6	2	0.02	0.01	0.03	0.04
Selenium	TS2	3	1	0.01	0.00	0.03	0.02
Selenium	TS3	6	5	0.03	0.01	0.04	0.05
Selenium	TS4	6	1	0.02	0.01	0.03	0.04
Selenium	TS7	6	4	0.30	0.27	0.85	1.65
Selenium	TS9	3	2	0.03	0.01	0.07	0.05
Silver	R	9	3	0.01	0.00	0.01	0.01
Silver	BY22	3	3	0.02	0.00	0.03	0.02
Silver	TS2	3	1	0.00	0.00	0.01	0.01
Silver	TS4	6	4	0.01	0.00	0.01	0.01
Silver	TS7	6	6	0.03	0.01	0.05	0.06
Sodium	R	9	9	72.12	2.53	76.82	81.80
Sodium	BY17	3	3	60.33	2.09	66.42	64.50
Sodium	BY22	3	3	58.83	1.98	64.61	62.00
Sodium	TS1	6	6	70.23	3.41	77.11	81.30
Sodium	TS2	3	3	77.70	2.82	85.93	83.10
Sodium	TS3	6	6	62.25	1.89	66.07	67.30
Sodium	TS4	6	6	70.15	5.25	80.73	88.70
Sodium	TS7	6	6	96.70	3.49	103.72	109.00
Sodium	TS9	3	3	70.03	3.95	81.57	77.80
Strontium	R	9	9	15.60	1.39	18.19	21.30
Strontium	BY17	3	3	10.84	1.13	14.13	13.00
Strontium	BY22	3	3	13.07	0.45	14.38	13.70
Strontium	TS1	6	6	9.14	1.18	11.52	13.20
Strontium	TS2	3	3	7.95	1.17	11.36	9.69
Strontium	TS3	6	6	7.82	0.64	9.11	9.54
Strontium	TS4	6	6	7.07	0.54	8.14	8.55
Strontium	TS7	6	6	6.31	0.54	7.39	8.33
Strontium	TS9	3	3	6.71	0.25	7.43	7.11
Technetium	BY17	1	1	0.00			0.00

Table G.43 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Thallium	BY22	3	1	0.00	0.00	0.01	0.01
Thallium	TS1	6	3	0.01	0.00	0.01	0.01
Thallium	TS2	3	1	0.00	0.00	0.01	0.00
Thallium	TS4	6	2	0.01	0.01	0.03	0.04
Thallium	TS7	6	1	0.00	0.00	0.00	0.01
Thorium-234	TS1	1	1	0.81			0.81
Thorium-234	TS2	1	1	1.30			1.30
Uranium	R	3	3	0.00	0.00	0.01	0.00
Uranium	BY17	1	1	0.21			0.21
Uranium	TS1	1	1	0.06			0.06
Uranium	TS2	1	1	0.01			0.01
Uranium	TS3	1	1	0.12			0.12
Uranium	TS4	1	1	0.09			0.09
Uranium	TS7	1	1	0.62			0.62
Vanadium	TS1	6	1	0.28	0.04	0.37	0.50
Vanadium	TS3	6	1	0.28	0.04	0.37	0.49
Zinc	R	9	9	8.58	0.73	9.94	12.10
Zinc	BY17	3	3	9.94	0.55	11.54	10.80
Zinc	BY22	3	3	41.87	7.84	64.76	54.90
Zinc	TS1	6	6	13.20	0.39	13.98	14.70
Zinc	TS2	3	3	10.01	0.87	12.55	11.70
Zinc	TS3	6	6	15.62	1.22	18.08	20.30
Zinc	TS4	6	6	12.26	1.25	14.77	16.10
Zinc	TS7	6	6	20.65	1.22	23.11	24.00
Zinc	TS9	3	3	22.37	4.15	34.47	29.90

Table G.44. Summary statistics for Bear Creek canopy vegetation contaminant data

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Aluminum	BY17	3	3	19.43	0.62	21.25	20.20
Aluminum	BY22	3	3	27.97	1.27	31.68	30.20
Aluminum	TS1	6	6	32.07	2.25	36.59	40.40
Aluminum	TS2	3	3	77.83	19.67	135.25	113.00
Aluminum	TS3	6	6	27.93	2.31	32.58	38.60
Aluminum	TS4	5	5	38.62	11.34	62.80	78.50
Aluminum	TS7	6	6	55.08	7.02	69.23	76.80
Aluminum	TS9	3	3	92.20	11.06	124.48	114.00
Aluminum	R	9	9	115.58	27.53	166.77	235.00
Americium-241	R	3	3	0.05	0.01	0.07	0.06
Americium-241	BY17	1	1	0.07			0.07
Americium-241	TS1	1	1	0.05			0.05
Americium-241	TS2	1	1	0.04			0.04
Americium-241	TS3	2	2	0.42	0.37	2.73	0.79
Americium-241	TS4	1	1	0.05			0.05
Americium-241	TS7	1	1	0.05			0.05
Antimony	BY17	3	3	0.02	0.00	0.03	0.03
Antimony	BY22	3	3	0.01	0.00	0.02	0.01
Antimony	TS1	6	3	0.01	0.00	0.01	0.02
Antimony	TS2	3	1	0.00	0.00	0.01	0.01
Antimony	TS3	6	4	0.01	0.00	0.01	0.01
Antimony	TS4	5	5	0.01	0.00	0.01	0.01
Antimony	TS7	6	6	0.01	0.00	0.02	0.02
Antimony	TS9	3	3	0.01	0.00	0.01	0.01
Antimony	R	9	7	0.01	0.00	0.01	0.01
Arsenic	R	9	6	0.04	0.02	0.07	0.16
Arsenic	BY17	3	2	0.03	0.01	0.06	0.04
Arsenic	BY22	3	1	0.02	0.01	0.03	0.03
Arsenic	TS1	6	6	0.70	0.50	1.71	3.17
Arsenic	TS3	6	2	0.04	0.03	0.09	0.17
Arsenic	TS4	5	4	0.05	0.03	0.10	0.15

Table G.44 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Barium	R	9	9	29.66	4.36	37.77	48.60
Barium	BY17	3	3	6.14	1.29	9.92	8.59
Barium	BY22	3	3	13.93	4.17	26.10	20.10
Barium	TS1	6	6	8.70	2.02	12.78	18.50
Barium	TS2	3	3	13.67	3.20	23.01	19.80
Barium	TS3	6	6	22.89	8.05	39.12	54.70
Barium	TS4	5	5	7.39	1.22	9.98	9.85
Barium	TS7	6	6	21.69	5.73	33.23	43.90
Barium	TS9	3	3	9.80	0.95	12.59	10.90
Beryllium	R	9	7	0.01	0.00	0.01	0.01
Beryllium	TS1	6	2	0.02	0.01	0.04	0.07
Beryllium	TS3	6	1	0.00	0.00	0.00	0.01
Beryllium	TS4	5	2	0.01	0.01	0.03	0.05
Beryllium	TS7	6	4	0.01	0.00	0.02	0.03
Beryllium	TS9	3	3	0.01	0.00	0.01	0.01
Beryllium-7	R	1	1	0.48			0.48
Beryllium-7	TS2	1	1	0.74			0.74
Cadmium	R	9	9	0.06	0.02	0.09	0.15
Cadmium	BY17	3	3	7.21	2.21	13.67	10.90
Cadmium	BY22	3	3	0.60	0.17	1.10	0.90
Cadmium	TS1	6	6	0.19	0.04	0.27	0.34
Cadmium	TS2	3	2	0.05	0.01	0.08	0.07
Cadmium	TS3	6	6	0.11	0.02	0.15	0.16
Cadmium	TS4	5	3	0.02	0.01	0.03	0.04
Cadmium	TS7	6	4	0.10	0.05	0.21	0.32
Cadmium	TS9	3	3	0.07	0.02	0.11	0.09
Calcium	R	9	9	4534.44	372.09	5226.36	6320.00
Calcium	BY17	3	3	3480.00	126.62	3849.74	3720.00
Calcium	BY22	3	3	6706.67	959.90	9509.57	8270.00
Calcium	TS1	6	6	5118.33	461.78	6048.85	7170.00
Calcium	TS2	3	3	3853.33	691.19	5871.60	5220.00

Table G.44 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Calcium	TS3	6	6	6118.33	878.67	7888.91	9330.00
Calcium	TS4	5	5	5676.00	953.10	7707.87	9070.00
Calcium	TS7	6	6	4503.33	937.87	6393.19	8580.00
Calcium	TS9	3	3	2740.00	158.75	3203.53	3040.00
Chromium	R	9	9	0.26	0.03	0.32	0.40
Chromium	BY17	3	3	0.36	0.02	0.43	0.41
Chromium	BY22	3	3	0.35	0.10	0.64	0.55
Chromium	TS1	6	6	0.97	0.24	1.46	2.16
Chromium	TS2	3	3	0.46	0.01	0.49	0.47
Chromium	TS3	6	6	0.36	0.05	0.46	0.59
Chromium	TS4	5	5	0.42	0.09	0.61	0.74
Chromium	TS7	6	6	0.26	0.05	0.36	0.47
Chromium	TS9	3	3	0.25	0.02	0.30	0.27
Cobalt	R	9	9	0.02	0.00	0.03	0.03
Cobalt	BY17	3	3	0.18	0.05	0.32	0.27
Cobalt	BY22	3	3	0.03	0.01	0.04	0.04
Cobalt	TS1	6	6	0.05	0.00	0.06	0.07
Cobalt	TS2	3	3	0.02	0.00	0.03	0.02
Cobalt	TS3	6	6	0.02	0.00	0.02	0.03
Cobalt	TS4	5	5	0.03	0.01	0.04	0.05
Cobalt	TS7	6	5	0.02	0.00	0.02	0.03
Cobalt	TS9	3	3	0.02	0.00	0.02	0.02
Copper	R	9	9	2.36	0.53	3.34	4.97
Copper	BY17	3	3	5.25	0.60	6.99	6.05
Copper	BY22	3	3	4.12	0.71	6.18	4.94
Copper	TS1	6	6	2.87	0.38	3.62	4.40
Copper	TS2	3	3	1.41	0.18	1.92	1.75
Copper	TS3	6	6	2.87	0.79	4.45	6.74
Copper	TS4	5	5	1.67	0.37	2.44	2.90
Copper	TS7	6	6	1.26	0.11	1.48	1.59
Copper	TS9	3	3	1.42	0.14	1.82	1.69

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Table G.44 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Curium-244	R	3	3	0.03	0.00	0.05	0.04
Curium-244	BY17	1	1	0.05			0.05
Curium-244	TS1	1	1	0.05			0.05
Curium-244	TS2	1	1	0.04			0.04
Curium-244	TS4	1	1	0.04			0.04
Curium-244	TS7	1	1	0.04			0.04
Iron	R	9	9	18.01	1.41	20.62	27.60
Iron	BY17	3	3	23.97	2.74	31.98	28.80
Iron	BY22	3	3	22.00	1.65	26.82	24.30
Iron	TS1	6	6	36.53	2.25	41.07	47.10
Iron	TS2	3	3	15.33	0.81	17.70	16.70
Iron	TS3	6	6	30.37	5.25	40.95	55.60
Iron	TS4	5	5	78.16	56.23	198.04	303.00
Iron	TS7	6	6	17.25	1.26	19.79	23.20
Iron	TS9	3	3	14.10	0.52	15.62	15.00
Lead	R	9	9	0.27	0.06	0.38	0.62
Lead	BY17	3	3	0.13	0.02	0.17	0.16
Lead	BY22	3	3	0.26	0.08	0.49	0.41
Lead	TS1	6	6	0.33	0.10	0.53	0.79
Lead	TS2	3	3	1.64	0.12	1.99	1.83
Lead	TS3	6	6	0.28	0.07	0.41	0.51
Lead	TS4	5	4	1.40	0.65	2.79	3.28
Lead	TS7	6	6	0.41	0.26	0.94	1.71
Lead	TS9	3	3	0.78	0.16	1.25	1.09
Lithium	R	9	9	0.04	0.00	0.04	0.05
Lithium	BY17	3	2	0.03	0.01	0.05	0.04
Lithium	BY22	3	3	0.42	0.22	1.05	0.79
Lithium	TS1	6	6	0.19	0.12	0.43	0.78
Lithium	TS2	3	3	0.03	0.00	0.04	0.03
Lithium	TS3	6	6	0.05	0.01	0.07	0.08
Lithium	TS4	5	5	2.14	1.03	4.33	4.88

Table G.44 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Lithium	TS7	6	6	0.04	0.01	0.05	0.06
Lithium	TS9	3	3	0.04	0.00	0.04	0.04
Magnesium	R	9	9	1070.89	128.26	1309.39	1840.00
Magnesium	BY17	3	3	664.67	86.17	916.28	837.00
Magnesium	BY22	3	3	1227.67	129.96	1607.14	1400.00
Magnesium	TS1	6	6	767.83	89.70	948.59	1070.00
Magnesium	TS2	3	3	735.33	124.98	1100.27	984.00
Magnesium	TS3	6	6	757.00	134.29	1027.60	1400.00
Magnesium	TS4	5	5	823.80	108.22	1054.51	1190.00
Magnesium	TS7	6	6	768.83	56.81	883.31	951.00
Magnesium	TS9	3	3	835.67	37.55	945.32	908.00
Manganese	R	9	9	505.44	59.44	615.98	717.00
Manganese	BY17	3	3	197.93	110.38	520.23	417.00
Manganese	BY22	3	3	39.77	15.39	84.69	61.40
Manganese	TS1	6	6	24.95	3.20	31.39	35.40
Manganese	TS2	3	3	164.97	68.49	364.96	286.00
Manganese	TS3	6	6	151.70	49.47	251.39	360.00
Manganese	TS4	5	5	80.94	26.99	138.48	159.00
Manganese	TS7	6	6	156.33	25.93	208.59	255.00
Manganese	TS9	3	3	191.00	31.47	282.89	245.00
Mercury	R	9	9	0.03	0.00	0.03	0.04
Mercury	BY17	3	3	0.08	0.02	0.13	0.11
Mercury	BY22	3	3	0.10	0.00	0.11	0.10
Mercury	TS1	6	6	0.03	0.01	0.04	0.05
Mercury	TS2	3	3	0.02	0.00	0.02	0.02
Mercury	TS3	6	6	0.04	0.00	0.04	0.04
Mercury	TS4	5	5	0.02	0.00	0.02	0.03
Mercury	TS7	6	6	0.02	0.00	0.02	0.02
Mercury	TS9	3	3	0.02	0.00	0.02	0.02
Molybdenum	R	9	9	0.02	0.00	0.03	0.03
Molybdenum	BY17	3	3	0.37	0.16	0.84	0.69

Table G.44 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Molybdenum	BY22	3	3	0.15	0.10	0.43	0.34
Molybdenum	TS1	6	6	0.19	0.11	0.41	0.68
Molybdenum	TS2	3	3	0.02	0.00	0.03	0.03
Molybdenum	TS3	6	6	0.03	0.01	0.04	0.05
Molybdenum	TS4	5	5	0.08	0.03	0.14	0.18
Molybdenum	TS7	6	6	0.02	0.00	0.03	0.03
Molybdenum	TS9	3	3	0.02	0.00	0.02	0.02
Nickel	R	9	9	2.53	0.61	3.67	5.75
Nickel	BY17	3	3	1.46	0.14	1.86	1.73
Nickel	BY22	3	3	0.69	0.11	1.01	0.91
Nickel	TS1	6	6	1.11	0.15	1.40	1.59
Nickel	TS2	3	3	1.43	0.42	2.67	2.22
Nickel	TS3	6	6	0.50	0.08	0.65	0.71
Nickel	TS4	5	5	0.35	0.07	0.49	0.59
Nickel	TS7	6	6	1.73	0.09	1.92	2.01
Nickel	TS9	3	3	2.18	0.21	2.79	2.60
Phosphorus	R	9	9	485.44	31.62	544.24	632.00
Phosphorus	BY17	3	3	652.00	47.00	789.25	746.00
Phosphorus	BY22	3	3	766.67	179.29	1290.19	1080.00
Phosphorus	TS1	6	6	309.00	21.99	353.32	403.00
Phosphorus	TS2	3	3	281.67	25.44	355.95	311.00
Phosphorus	TS3	6	6	427.17	24.15	475.82	537.00
Phosphorus	TS4	5	5	494.60	118.77	747.79	826.00
Phosphorus	TS7	6	6	273.50	26.37	326.64	394.00
Phosphorus	TS9	3	3	231.00	1.53	235.46	233.00
Plutonium-239/240	R	3	2	0.07	0.03	0.16	0.12
Plutonium-239/240	BY17	1	1	0.04			0.04
Plutonium-239/240	TS1	1	1	0.08			0.08
Plutonium-239/240	TS2	1	1	0.04			0.04
Plutonium-239/240	TS4	1	1	0.04			0.04
Plutonium-239/240	TS7	1	1	0.06			0.06

Table G.44 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Potassium	R	9	9	2865.56	311.03	3443.92	4940.00
Potassium	BY17	3	3	3110.00	85.05	3358.34	3240.00
Potassium	BY22	3	3	2340.00	153.95	2789.53	2640.00
Potassium	TS1	6	6	2945.00	261.21	3471.35	3510.00
Potassium	TS2	3	3	1790.00	147.31	2220.14	2040.00
Potassium	TS3	6	6	2750.00	247.08	3247.87	3390.00
Potassium	TS4	5	5	2056.60	430.41	2974.17	3080.00
Potassium	TS7	6	6	2546.67	405.21	3363.19	4020.00
Potassium	TS9	3	3	1930.00	90.74	2194.95	2110.00
Potassium-40	R	1	1	1.60			1.60
Selenium	R	9	2	0.02	0.01	0.02	0.05
Selenium	BY17	3	2	0.03	0.01	0.06	0.05
Selenium	BY22	3	3	0.04	0.01	0.05	0.04
Selenium	TS1	6	3	0.56	0.40	1.37	2.46
Selenium	TS3	6	6	0.04	0.00	0.04	0.05
Selenium	TS4	5	1	0.02	0.01	0.04	0.05
Selenium	TS7	6	4	0.04	0.01	0.05	0.06
Selenium	TS9	3	1	0.03	0.02	0.08	0.06
Silver	R	9	4	0.01	0.00	0.01	0.01
Silver	BY17	3	2	0.01	0.00	0.02	0.02
Silver	BY22	3	3	0.03	0.01	0.07	0.05
Silver	TS1	6	2	0.01	0.01	0.04	0.07
Silver	TS3	6	5	0.01	0.00	0.01	0.01
Silver	TS4	5	4	0.01	0.00	0.01	0.01
Silver	TS7	6	6	0.04	0.01	0.06	0.07
Silver	TS9	3	1	0.00	0.00	0.01	0.01
Sodium	R	9	9	74.38	4.63	82.99	90.20
Sodium	BY17	3	3	63.20	1.19	66.66	65.30
Sodium	BY22	3	3	56.20	0.31	57.09	56.60
Sodium	TS1	6	6	81.05	10.40	102.01	130.00
Sodium	TS2	3	3	73.30	3.54	83.63	78.80

Table G.44 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Sodium	TS3	6	6	62.25	1.22	64.71	65.90
Sodium	TS4	5	5	61.94	0.89	63.83	64.30
Sodium	TS7	6	6	92.53	3.41	99.40	103.00
Sodium	TS9	3	3	65.60	1.12	68.88	67.80
Strontium	R	9	9	10.71	1.03	12.63	16.70
Strontium	BY17	3	3	16.43	2.20	22.85	20.10
Strontium	BY22	3	3	15.27	4.07	27.16	22.10
Strontium	TS1	6	6	12.33	1.27	14.90	16.40
Strontium	TS2	3	3	8.82	1.15	12.18	11.10
Strontium	TS3	6	6	13.08	1.59	16.27	17.60
Strontium	TS4	5	5	9.89	1.40	12.87	14.50
Strontium	TS7	6	6	11.34	3.03	17.44	23.50
Strontium	TS9	3	3	4.49	0.25	5.22	4.91
Technetium	BY17	1	1	0.00			0.00
Technetium	TS7	1	1	0.00			0.00
Thallium	TS1	6	2	0.50	0.42	1.34	2.55
Thorium-234	R	1	1	1.20			1.20
Thorium-234	TS3	1	1	0.46			0.46
Uranium	R	3	3	0.00	0.00	0.01	0.01
Uranium	BY17	1	1	0.88			0.88
Uranium	TS1	1	1	0.06			0.06
Uranium	TS2	1	1	0.01			0.01
Uranium	TS3	1	1	0.00			0.00
Uranium	TS4	1	1	0.30			0.30
Uranium	TS7	1	1	0.01			0.01
Vanadium	TS1	6	2	0.74	0.42	1.59	2.82
Vanadium	TS2	3	1	0.33	0.10	0.64	0.54
Vanadium	TS3	6	1	0.29	0.05	0.39	0.54
Zinc	R	9	9	12.64	0.85	14.22	15.90
Zinc	BY17	3	3	341.00	33.25	438.08	407.00
Zinc	BY22	3	3	34.23	4.71	47.98	43.60

Table G.44 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Zinc	TS1	6	6	6.76	0.32	7.40	8.12
Zinc	TS2	3	3	12.71	3.95	24.25	20.50
Zinc	TS3	6	6	12.40	1.75	15.93	18.70
Zinc	TS4	5	5	8.13	1.76	11.89	13.80
Zinc	TS7	6	6	6.83	1.13	9.10	10.70
Zinc	TS9	3	3	9.38	0.37	10.45	10.10

Table G.45. Summary statistics for Bear Creek herbaceous vegetation contaminant data

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Aluminum	BY17	3	3	50.80	15.77	96.86	81.00
Aluminum	BY22	3	3	263.67	49.27	407.53	362.00
Aluminum	TS1	6	6	330.00	148.39	629.02	925.00
Aluminum	TS2	3	3	55.47	3.78	66.50	63.00
Aluminum	TS3	6	6	306.58	79.45	466.68	562.00
Aluminum	TS4	6	6	117.92	24.17	166.63	196.00
Aluminum	TS7	6	6	287.85	97.24	483.79	742.00
Aluminum	TS9	3	3	282.00	88.15	539.41	458.00
Aluminum	R	9	9	173.20	41.44	250.26	386.00
Americium-241	R	3	3	0.05	0.00	0.05	0.05
Americium-241	BY17	1	1	0.05			0.05
Americium-241	TS2	1	1	0.05			0.05
Americium-241	TS3	1	1	0.06			0.06
Americium-241	TS4	1	1	0.06			0.06
Antimony	BY17	3	3	0.02	0.01	0.04	0.04
Antimony	BY22	3	3	0.08	0.05	0.24	0.19
Antimony	TS1	6	3	0.01	0.00	0.01	0.02
Antimony	TS2	3	1	0.00	0.00	0.01	0.01
Antimony	TS3	6	4	0.01	0.00	0.01	0.01
Antimony	TS4	6	6	0.01	0.00	0.01	0.01
Antimony	TS7	6	6	0.01	0.00	0.01	0.02
Antimony	TS9	3	3	0.01	0.00	0.01	0.01
Antimony	R	9	8	0.01	0.00	0.01	0.01
Arsenic	R	9	5	0.03	0.01	0.05	0.08
Arsenic	BY22	3	3	0.18	0.12	0.53	0.42
Arsenic	TS1	6	6	0.14	0.05	0.25	0.40
Arsenic	TS2	3	3	0.13	0.01	0.16	0.14
Arsenic	TS3	6	5	0.08	0.02	0.13	0.16
Arsenic	TS4	6	5	0.04	0.01	0.06	0.08
Arsenic	TS7	6	6	0.05	0.02	0.08	0.13
Arsenic	TS9	3	3	0.05	0.01	0.09	0.07

Table G.45 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Barium	R	9	9	16.46	1.75	19.70	27.20
Barium	BY17	3	3	11.53	0.77	13.78	13.00
Barium	BY22	3	3	17.40	4.25	29.80	25.80
Barium	TS1	6	6	12.48	1.27	15.04	17.60
Barium	TS2	3	3	10.72	0.68	12.71	11.50
Barium	TS3	6	6	10.19	0.71	11.63	13.60
Barium	TS4	6	6	9.18	2.10	13.41	19.30
Barium	TS7	6	6	10.20	0.47	11.14	12.10
Barium	TS9	3	3	10.51	1.78	15.72	13.70
Beryllium	R	9	5	0.01	0.00	0.01	0.02
Beryllium	BY22	3	3	0.01	0.01	0.02	0.02
Beryllium	TS1	6	2	0.01	0.01	0.02	0.04
Beryllium	TS3	6	4	0.01	0.00	0.02	0.02
Beryllium	TS4	6	3	0.01	0.00	0.01	0.02
Beryllium	TS7	6	5	0.01	0.00	0.02	0.03
Beryllium	TS9	3	3	0.01	0.00	0.02	0.02
Beryllium-7	R	1	1	0.74			0.74
Beryllium-7	BY17	1	1	0.40			0.40
Cadmium	R	9	9	0.05	0.01	0.07	0.11
Cadmium	BY17	3	3	0.40	0.18	0.91	0.72
Cadmium	BY22	3	3	0.81	0.40	1.98	1.61
Cadmium	TS1	6	6	0.33	0.13	0.59	0.66
Cadmium	TS2	3	3	0.24	0.05	0.38	0.33
Cadmium	TS3	6	6	0.25	0.06	0.37	0.46
Cadmium	TS4	6	5	0.02	0.01	0.03	0.04
Cadmium	TS7	6	6	0.21	0.04	0.28	0.38
Cadmium	TS9	3	3	0.05	0.01	0.07	0.06
Calcium	R	9	9	1325.22	81.32	1476.44	1740.00
Calcium	BY17	3	3	1225.00	135.31	1620.10	1420.00
Calcium	BY22	3	3	3113.33	387.18	4243.90	3800.00
Calcium	TS1	6	6	1776.67	66.27	1910.19	1940.00

Table G.45 (continued)

Analyte	Transect	OBS	Defects	Mean	Standard error	UCL95	Maximum
Calcium	TS2	3	3	1253.33	92.62	1523.77	1420.00
Calcium	TS3	6	6	991.67	49.34	1091.09	1160.00
Calcium	TS4	6	6	1757.67	432.29	2628.75	3750.00
Calcium	TS7	6	6	1206.67	57.77	1323.08	1450.00
Calcium	TS9	3	3	1036.00	107.93	1351.16	1190.00
Chromium	R	9	9	1.22	0.26	1.71	3.17
Chromium	BY17	3	3	0.82	0.12	1.16	0.95
Chromium	BY22	3	3	1.36	0.22	2.01	1.65
Chromium	TS1	6	6	2.04	1.02	4.10	7.01
Chromium	TS2	3	3	0.70	0.04	0.82	0.76
Chromium	TS3	6	6	0.95	0.18	1.30	1.55
Chromium	TS4	6	6	0.71	0.17	1.05	1.46
Chromium	TS7	6	6	1.11	0.25	1.62	2.20
Chromium	TS9	3	3	0.72	0.09	0.98	0.87
Cobalt	R	9	9	0.09	0.02	0.14	0.21
Cobalt	BY17	3	3	0.06	0.02	0.11	0.09
Cobalt	BY22	3	3	0.15	0.04	0.26	0.23
Cobalt	TS1	6	6	0.18	0.09	0.36	0.62
Cobalt	TS2	3	3	0.04	0.00	0.05	0.04
Cobalt	TS3	6	6	0.19	0.05	0.29	0.37
Cobalt	TS4	6	6	0.06	0.01	0.08	0.11
Cobalt	TS7	6	6	0.16	0.05	0.26	0.40
Cobalt	TS9	3	3	0.14	0.03	0.23	0.20
Cobalt-57	TS7	1	1	0.84			0.84
Copper	R	9	9	1.68	0.05	1.76	1.91
Copper	BY17	3	3	2.94	0.54	4.52	4.00
Copper	BY22	3	3	5.01	1.22	8.56	7.29
Copper	TS1	6	6	2.14	0.09	2.32	2.40
Copper	TS2	3	3	1.76	0.05	1.91	1.86
Copper	TS3	6	6	1.82	0.06	1.94	2.08
Copper	TS4	6	6	1.53	0.19	1.92	2.43

Table G.45 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Copper	TS7	6	6	1.52	0.13	1.79	2.12
Copper	TS9	3	3	1.45	0.15	1.88	1.65
Curium-244	R	3	3	0.06	0.01	0.11	0.09
Curium-244	TS1	1	1	0.02			0.02
Curium-244	TS2	1	1	0.04			0.04
Curium-244	TS3	1	1	0.06			0.06
Curium-244	TS4	1	1	0.04			0.04
Iron	R	9	9	127.66	29.00	181.58	276.00
Iron	BY17	3	3	50.63	17.14	100.67	84.80
Iron	BY22	3	3	191.33	25.26	265.09	239.00
Iron	TS1	6	6	190.57	77.55	346.83	494.00
Iron	TS2	3	3	42.93	1.06	46.03	45.00
Iron	TS3	6	6	217.60	58.82	336.12	397.00
Iron	TS4	6	6	94.62	18.34	131.58	158.00
Iron	TS7	6	6	208.53	68.79	347.14	531.00
Iron	TS9	3	3	184.67	55.10	345.56	293.00
Lead	R	9	9	0.28	0.06	0.39	0.59
Lead	BY17	3	3	0.44	0.27	1.23	0.98
Lead	BY22	3	3	1.20	0.73	3.33	2.64
Lead	TS1	6	6	0.30	0.12	0.54	0.85
Lead	TS2	3	3	0.61	0.20	1.21	0.88
Lead	TS3	6	6	0.48	0.09	0.66	0.83
Lead	TS4	6	6	0.37	0.18	0.73	1.26
Lead	TS7	6	6	0.36	0.06	0.49	0.57
Lead	TS9	3	3	0.38	0.07	0.59	0.52
Lithium	R	9	9	0.15	0.04	0.22	0.34
Lithium	BY17	3	3	0.08	0.03	0.18	0.15
Lithium	BY22	3	3	0.85	0.34	1.86	1.45
Lithium	TS1	6	6	0.25	0.12	0.49	0.82
Lithium	TS2	3	3	0.22	0.06	0.40	0.30
Lithium	TS3	6	6	0.32	0.07	0.47	0.53

Table G.45 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Lithium	TS4	6	6	0.26	0.04	0.34	0.41
Lithium	TS7	6	6	0.34	0.11	0.56	0.87
Lithium	TS9	3	3	0.29	0.07	0.48	0.42
Magnesium	R	9	9	687.00	60.41	799.34	1060.00
Magnesium	BY17	3	3	768.00	121.23	1122.00	1010.00
Magnesium	BY22	3	3	935.33	62.23	1117.04	1020.00
Magnesium	TS1	6	6	646.17	30.72	708.06	773.00
Magnesium	TS2	3	3	498.67	42.15	621.74	572.00
Magnesium	TS3	6	6	489.17	14.99	519.38	542.00
Magnesium	TS4	6	6	535.50	90.96	718.80	964.00
Magnesium	TS7	6	6	497.67	20.19	538.36	561.00
Magnesium	TS9	3	3	391.33	23.91	461.14	438.00
Manganese	R	9	9	104.32	14.47	131.22	157.00
Manganese	BY17	3	3	12.58	2.96	21.21	18.30
Manganese	BY22	3	3	33.47	8.59	58.55	45.70
Manganese	TS1	6	6	26.50	5.59	37.77	50.70
Manganese	TS2	3	3	15.23	0.73	17.35	16.40
Manganese	TS3	6	6	28.98	5.55	40.17	49.60
Manganese	TS4	6	6	42.54	23.38	89.66	158.00
Manganese	TS7	6	6	35.62	5.75	47.21	52.90
Manganese	TS9	3	3	39.87	5.15	54.89	50.10
Mercury	R	9	9	0.01	0.00	0.02	0.02
Mercury	BY17	3	3	0.04	0.02	0.11	0.08
Mercury	BY22	3	3	0.17	0.06	0.35	0.29
Mercury	TS1	6	6	0.04	0.01	0.06	0.09
Mercury	TS2	3	3	0.01	0.00	0.02	0.02
Mercury	TS3	6	5	0.02	0.00	0.02	0.02
Mercury	TS4	6	4	0.01	0.00	0.02	0.02
Mercury	TS7	6	6	0.02	0.00	0.02	0.02
Mercury	TS9	3	3	0.01	0.00	0.02	0.01
Molybdenum	R	9	9	0.05	0.01	0.06	0.09

Table G.45 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Molybdenum	BY17	3	3	1.56	0.90	4.18	3.31
Molybdenum	BY22	3	3	0.85	0.36	1.91	1.56
Molybdenum	TS1	6	6	0.23	0.02	0.27	0.30
Molybdenum	TS2	3	3	0.33	0.06	0.51	0.44
Molybdenum	TS3	6	6	0.23	0.03	0.28	0.32
Molybdenum	TS4	6	6	0.40	0.12	0.64	0.79
Molybdenum	TS7	6	6	0.17	0.03	0.24	0.29
Molybdenum	TS9	3	3	0.07	0.01	0.10	0.09
Nickel	R	9	9	0.45	0.06	0.55	0.67
Nickel	BY17	3	3	0.47	0.03	0.56	0.51
Nickel	BY22	3	3	1.47	0.18	2.00	1.70
Nickel	TS1	6	6	1.01	0.35	1.71	2.14
Nickel	TS2	3	3	0.31	0.01	0.34	0.33
Nickel	TS3	6	6	0.59	0.11	0.81	0.88
Nickel	TS4	6	5	0.13	0.04	0.21	0.25
Nickel	TS7	6	6	0.46	0.09	0.64	0.88
Nickel	TS9	3	3	0.39	0.07	0.58	0.51
Phosphorus	R	9	9	545.11	46.20	631.02	744.00
Phosphorus	BY17	3	3	1061.67	213.04	1683.74	1410.00
Phosphorus	BY22	3	3	739.33	121.06	1092.82	972.00
Phosphorus	TS1	6	6	299.83	16.76	333.61	375.00
Phosphorus	TS2	3	3	254.67	18.80	309.56	286.00
Phosphorus	TS3	6	6	256.00	7.78	271.68	277.00
Phosphorus	TS4	6	6	596.17	60.42	717.91	772.00
Phosphorus	TS7	6	6	234.83	18.58	272.27	300.00
Phosphorus	TS9	3	3	228.67	6.89	248.78	242.00
Plutonium-239/240	R	3	3	0.05	0.01	0.07	0.06
Plutonium-239/240	BY17	1	1	0.08			0.08
Plutonium-239/240	TS1	1	1	0.08			0.08
Plutonium-239/240	TS2	1	1	0.05			0.05
Plutonium-239/240	TS3	1	1	0.05			0.05

Table G.45 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Plutonium-239/240	TS4	1	1	0.04			0.04
Plutonium-239/240	TS7	1	1	0.07			0.07
Potassium	R	9	9	2766.67	214.86	3166.21	3610.00
Potassium	BY17	3	3	4136.67	439.75	5420.72	4810.00
Potassium	BY22	3	3	2900.00	225.46	3558.35	3150.00
Potassium	TS1	6	6	3341.67	179.86	3704.09	4000.00
Potassium	TS2	3	3	1893.33	89.51	2154.69	2070.00
Potassium	TS3	6	6	2233.33	88.38	2411.42	2620.00
Potassium	TS4	6	6	3146.67	339.37	3830.51	3920.00
Potassium	TS7	6	5	1837.50	228.44	2297.81	2530.00
Potassium	TS9	3	3	2056.67	108.68	2374.01	2180.00
Potassium-40	BY17	1	1	1.50			1.50
Potassium-40	TS4	1	1	1.80			1.80
Selenium	R	9	2	0.03	0.02	0.08	0.21
Selenium	TS2	3	1	0.02	0.02	0.07	0.05
Selenium	TS3	6	2	0.01	0.00	0.02	0.02
Selenium	TS4	6	2	0.01	0.00	0.02	0.02
Selenium	TS7	6	4	0.03	0.01	0.06	0.08
Selenium	TS9	3	1	0.02	0.01	0.03	0.03
Silver	R	9	2	0.00	0.00	0.01	0.01
Silver	BY17	3	3	0.02	0.01	0.04	0.03
Silver	BY22	3	3	0.05	0.03	0.13	0.10
Silver	TS1	6	1	0.00	0.00	0.00	0.01
Silver	TS3	6	3	0.00	0.00	0.01	0.01
Silver	TS4	6	4	0.00	0.00	0.01	0.01
Silver	TS7	6	6	0.20	0.15	0.51	0.95
Silver	TS9	3	2	0.09	0.06	0.27	0.21
Sodium	R	9	9	69.86	2.73	74.93	82.00
Sodium	BY17	3	3	74.03	1.97	79.80	76.30
Sodium	BY22	3	3	62.40	1.40	66.49	65.20
Sodium	TS1	6	6	68.87	3.52	75.96	81.70

Table G.45 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Sodium	TS2	3	3	66.73	5.22	81.96	77.00
Sodium	TS3	6	6	65.48	4.80	75.15	78.30
Sodium	TS4	6	6	65.38	2.82	71.06	74.60
Sodium	TS7	6	6	97.52	2.17	101.89	103.00
Sodium	TS9	3	3	83.93	6.02	101.50	92.90
Strontium	R	9	9	4.46	0.37	5.15	6.63
Strontium	BY17	3	3	5.31	0.17	5.80	5.63
Strontium	BY22	3	3	9.19	1.54	13.69	11.70
Strontium	TS1	6	6	4.98	0.52	6.02	6.57
Strontium	TS2	3	3	3.46	0.27	4.24	3.84
Strontium	TS3	6	6	2.73	0.14	3.01	3.12
Strontium	TS4	6	6	3.92	0.76	5.46	7.24
Strontium	TS7	6	6	3.23	0.19	3.61	4.02
Strontium	TS9	3	3	3.06	0.57	4.71	3.75
Technetium	TS3	1	1	0.00			0.00
Technetium	TS4	1	1	0.00			0.00
Technetium	TS7	1	1	0.00			0.00
Thallium	BY22	3	1	0.00	0.00	0.01	0.01
Thallium	TS1	6	1	0.00	0.00	0.01	0.01
Thallium	TS2	3	2	0.01	0.01	0.04	0.03
Thallium	TS3	6	1	0.00	0.00	0.00	0.01
Thallium	TS7	6	2	0.00	0.00	0.00	0.01
Thorium-234	TS3	1	1	1.30			1.30
Thorium-234	TS7	1	1	0.80			0.80
Uranium	R	3	3	0.01	0.00	0.02	0.01
Uranium	BY17	1	1	2.44			2.44
Uranium	TS1	1	1	0.48			0.48
Uranium	TS2	1	1	0.14			0.14
Uranium	TS3	1	1	0.92			0.92
Uranium	TS4	1	1	0.82			0.82
Uranium	TS7	1	1	0.28			0.28

Table G.45 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Vanadium	TS1	6	1	0.49	0.22	0.92	1.57
Vanadium	TS2	3	1	0.35	0.11	0.65	0.55
Vanadium	TS3	6	6	0.69	0.08	0.85	0.97
Vanadium	TS7	6	4	0.44	0.07	0.58	0.62
Vanadium	TS9	3	1	0.42	0.19	0.96	0.79
Zinc	R	9	9	17.92	1.71	21.10	27.30
Zinc	BY17	3	3	26.70	4.48	39.77	35.60
Zinc	BY22	3	3	43.60	4.70	57.33	48.50
Zinc	TS1	6	6	19.87	1.94	23.76	24.10
Zinc	TS2	3	3	20.13	2.05	26.13	23.80
Zinc	TS3	6	6	15.07	0.87	16.81	17.30
Zinc	TS4	6	6	14.32	2.50	19.35	25.70
Zinc	TS7	6	6	15.87	0.71	17.29	18.80
Zinc	TS9	3	3	11.76	1.15	15.10	13.00

Table G.46. Summary statistics for Bear Creek earthworm contaminant data

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Aluminum	BY17	1	1	461.00			
Aluminum	BY22	1	1	860.00			860.00
Aluminum	TS1	2	2	678.00	123.00	1454.59	801.00
Aluminum	TS2	1	1	194.00			194.00
Aluminum	TS3	2	2	556.50	95.50	1159.46	652.00
Aluminum	TS4	2	2	452.00	18.00	565.65	470.00
Aluminum	TS7	2	2	785.00	38.00	1024.92	823.00
Aluminum	TS9	1	1	503.00			503.00
Aluminum	R	3	3	960.00	105.04	1266.71	1070.00
Americium-241	R	3	3	0.07	0.01	0.10	0.08
Americium-241	BY17	1	1	0.04			0.04
Americium-241	BY22	1	1	0.09			0.09
Americium-241	TS1	2	2	0.07	0.00	0.07	0.07
Americium-241	TS2	1	1	0.08			0.08
Americium-241	TS3	2	1	0.05	0.00	0.05	0.05
Americium-241	TS4	2	1	0.05	0.02	0.18	0.07
Americium-241	TS7	2	2	0.06	0.01	0.09	0.07
Americium-241	TS9	1	1	0.09			0.09
Antimony	BY17	1	1	0.08			0.08
Antimony	BY22	1	1	0.38			0.38
Antimony	TS1	2	2	0.04	0.01	0.13	0.06
Antimony	TS2	1	1	0.03			0.03
Antimony	TS3	2	2	0.04	0.01	0.08	0.05
Antimony	TS4	2	2	0.04	0.01	0.10	0.05
Antimony	TS7	2	2	0.04	0.01	0.07	0.04
Antimony	TS9	1	1	0.04			0.04
Antimony	R	3	3	0.04	0.01	0.06	0.05
Arsenic	R	3	2	0.30	0.13	0.67	0.45
Arsenic	BY17	1	1	0.22			0.22
Arsenic	BY22	1	1	0.82			0.82
Arsenic	TS1	2	2	0.32	0.21	1.66	0.53

Table G.46 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Arsenic	TS3	2	2	0.39	0.09	0.97	0.48
Arsenic	TS4	2	2	0.29	0.02	0.41	0.31
Arsenic	TS7	2	2	0.42	0.04	0.64	0.46
Arsenic	TS9	1	1	0.24			0.24
Barium	R	3	3	14.32	7.25	35.47	28.80
Barium	BY17	1	1	3.03			3.03
Barium	BY22	1	1	5.15			5.15
Barium	TS1	2	2	9.27	2.14	22.74	11.40
Barium	TS2	1	1	26.60			26.60
Barium	TS3	2	2	12.08	6.93	55.80	19.00
Barium	TS4	2	2	16.72	6.89	60.19	23.60
Barium	TS7	2	2	6.13	0.78	11.05	6.91
Barium	TS9	1	1	5.00			5.00
Beryllium	R	3	2	0.05	0.02	0.11	0.08
Beryllium	BY17	1	1	0.03			0.03
Beryllium	BY22	1	1	0.04			0.04
Beryllium	TS1	2	2	0.04	0.00	0.06	0.04
Beryllium	TS3	2	1	0.03	0.02	0.13	0.04
Beryllium	TS4	2	1	0.02	0.01	0.07	0.03
Beryllium	TS7	2	2	0.04	0.00	0.06	0.04
Cadmium	R	3	3	1.46	0.41	2.66	2.00
Cadmium	BY17	1	1	24.40			24.40
Cadmium	BY22	1	1	4.05			4.05
Cadmium	TS1	2	2	8.39	3.51	30.55	11.90
Cadmium	TS2	1	1	1.57			1.57
Cadmium	TS3	2	2	12.50	0.30	14.39	12.80
Cadmium	TS4	2	2	1.16	0.03	1.31	1.18
Cadmium	TS7	2	2	10.32	3.39	31.69	13.70
Cadmium	TS9	1	1	3.22			3.22
Calcium	R	3	3	754.67	103.81	1057.78	895.00
Calcium	BY17	1	1	929.00			929.00

Table G.46 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Calcium	BY22	1	1	736.00			736.00
Calcium	TS1	2	2	967.00	8.00	1017.51	975.00
Calcium	TS2	1	1	672.00			672.00
Calcium	TS3	2	2	677.50	159.50	1684.54	837.00
Calcium	TS4	2	2	1365.00	55.00	1712.26	1420.00
Calcium	TS7	2	2	603.00	107.00	1278.57	710.00
Calcium	TS9	1	1	1250.00			1250.00
Chromium	R	3	3	108.33	31.06	199.03	156.00
Chromium	BY17	1	1	39.90			39.90
Chromium	BY22	1	1	18.50			18.50
Chromium	TS1	2	2	10.86	8.44	64.15	19.30
Chromium	TS2	1	1	28.00			28.00
Chromium	TS3	2	2	84.45	56.55	441.49	141.00
Chromium	TS4	2	2	75.70	31.30	273.32	107.00
Chromium	TS7	2	2	81.15	47.85	383.26	129.00
Chromium	TS9	1	1	7.53			7.53
Cobalt	R	3	3	2.12	0.54	3.68	2.80
Cobalt	BY17	1	1	0.89			0.89
Cobalt	BY22	1	1	0.77			0.77
Cobalt	TS1	2	2	1.07	0.20	2.33	1.27
Cobalt	TS2	1	1	1.14			1.14
Cobalt	TS3	2	2	1.82	0.58	5.48	2.40
Cobalt	TS4	2	2	1.89	0.36	4.13	2.24
Cobalt	TS7	2	2	1.81	0.03	2.00	1.84
Cobalt	TS9	1	1	1.37			1.37
Copper	R	3	3	4.16	0.64	6.02	5.21
Copper	BY17	1	1	6.72			6.72
Copper	BY22	1	1	10.80			10.80
Copper	TS1	2	2	2.16	0.72	6.71	2.88
Copper	TS2	1	1	2.14			2.14
Copper	TS3	2	2	3.35	1.28	11.40	4.62

Table G.46 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Copper	TS4	2	2	2.60	0.80	7.65	3.40
Copper	TS7	2	2	16.71	12.29	94.31	29.00
Copper	TS9	1	1	0.44			0.44
Curium-244	R	3	2	0.03	0.01	0.07	0.05
Curium-244	BY22	1	1	0.02			0.02
Curium-244	TS1	2	1	0.02	0.01	0.07	0.02
Curium-244	TS2	1	1	0.03			0.03
Curium-244	TS3	2	1	0.05	0.04	0.32	0.09
Curium-244	TS4	2	1	0.03	0.00	0.03	0.03
Curium-244	TS7	2	1	0.02	0.01	0.06	0.03
Curium-244	TS9	1	1	0.05			0.05
Iron	R	3	3	1024.33	181.11	1553.18	1300.00
Iron	BY17	1	1	446.00			446.00
Iron	BY22	1	1	773.00			773.00
Iron	TS1	2	2	429.50	186.50	1607.01	616.00
Iron	TS2	1	1	245.00			245.00
Iron	TS3	2	2	755.00	315.00	2743.83	1070.00
Iron	TS4	2	2	706.50	171.50	1789.31	878.00
Iron	TS7	2	2	893.50	236.50	2386.70	1130.00
Iron	TS9	1	1	502.00			502.00
Lead	R	3	3	1.13	0.39	2.28	1.85
Lead	BY17	1	1	0.86			0.86
Lead	BY22	1	1	4.45			4.45
Lead	TS1	2	2	1.24	0.87	6.75	2.11
Lead	TS2	1	1	0.50			0.50
Lead	TS3	2	2	0.73	0.21	2.07	0.94
Lead	TS4	2	2	15.46	14.54	107.25	30.00
Lead	TS7	2	2	1.19	0.58	4.86	1.77
Lead	TS9	1	1	0.84			0.84
Lithium	R	3	3	1.20	0.12	1.56	1.36
Lithium	BY17	1	1	0.72			0.72

Table G.46 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Lithium	BY22	1	1	1.00			1.00
Lithium	TS1	2	2	0.91	0.31	2.88	1.22
Lithium	TS2	1	1	10.40			10.40
Lithium	TS3	2	2	2.66	1.25	10.52	3.90
Lithium	TS4	2	2	0.94	0.37	3.27	1.31
Lithium	TS7	2	2	1.14	0.03	1.33	1.17
Lithium	TS9	1	1	0.49			0.49
Magnesium	R	3	3	234.33	19.03	289.90	270.00
Magnesium	BY17	1	1	210.00			210.00
Magnesium	BY22	1	1	200.00			200.00
Magnesium	TS1	2	2	165.50	3.50	187.60	169.00
Magnesium	TS2	1	1	125.00			125.00
Magnesium	TS3	2	2	176.00	5.00	207.57	181.00
Magnesium	TS4	2	2	176.50	5.50	211.23	182.00
Magnesium	TS7	2	2	214.00	15.00	308.71	229.00
Magnesium	TS9	1	1	186.00			186.00
Manganese	R	3	3	39.33	3.65	50.00	45.30
Manganese	BY17	1	1	22.70			22.70
Manganese	BY22	1	1	25.60			25.60
Manganese	TS1	2	2	47.35	3.75	71.03	51.10
Manganese	TS2	1	1	13.30			13.30
Manganese	TS3	2	2	52.00	5.30	85.46	57.30
Manganese	TS4	2	2	54.35	0.85	59.72	55.20
Manganese	TS7	2	2	54.30	10.20	118.70	64.50
Manganese	TS9	1	1	39.50			39.50
Mercury	R	3	3	0.24	0.07	0.44	0.33
Mercury	BY17	1	1	0.83			0.83
Mercury	BY22	1	1	1.00			1.00
Mercury	TS1	2	2	0.23	0.11	0.93	0.34
Mercury	TS2	1	1	0.18			0.18
Mercury	TS3	2	2	0.26	0.04	0.48	0.30

Table G.46 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Mercury	TS4	2	2	0.32	0.12	1.10	0.44
Mercury	TS7	2	2	0.31	0.09	0.86	0.40
Mercury	TS9	1	1	0.13			0.13
Molybdenum	R	3	3	19.28	6.77	39.05	27.40
Molybdenum	BY17	1	1	4.87			4.87
Molybdenum	BY22	1	1	2.06			2.06
Molybdenum	TS1	2	2	1.64	1.29	9.77	2.93
Molybdenum	TS2	1	1	4.37			4.37
Molybdenum	TS3	2	2	11.75	8.06	62.60	19.80
Molybdenum	TS4	2	2	10.30	2.70	27.35	13.00
Molybdenum	TS7	2	2	9.45	2.86	27.47	12.30
Molybdenum	TS9	1	1	6.80			6.80
Nickel	R	3	3	75.57	20.97	136.80	107.00
Nickel	BY17	1	1	27.40			27.40
Nickel	BY22	1	1	11.40			11.40
Nickel	TS1	2	2	12.82	5.89	49.97	18.70
Nickel	TS2	1	1	20.10			20.10
Nickel	TS3	2	2	59.80	38.80	304.77	98.60
Nickel	TS4	2	2	53.55	23.25	200.34	76.80
Nickel	TS7	2	2	63.90	22.70	207.22	86.60
Nickel	TS9	1	1	37.60			37.60
PCB-1254	BY22	1	1	0.08			0.08
PCB-1254	TS1	2	2	0.13	0.09	0.66	0.21
PCB-1254	TS3	2	2	0.05	0.02	0.15	0.07
PCB-1254	TS9	1	1	0.05			0.05
PCB-1260	BY17	1	1	0.21			0.21
PCB-1260	TS1	2	1	0.03	0.02	0.17	0.05
PCB-1260	TS3	2	2	0.07	0.02	0.18	0.09
PCB-1260	TS7	2	2	1.01	0.10	1.60	1.10
PCB-1260	TS9	1	1	0.07			0.07
Phosphorus	R	3	3	1386.67	146.21	1813.60	1580.00

Table G.46 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Phosphorus	BY17	1	1	1700.00			1700.00
Phosphorus	BY22	1	1	1340.00			1340.00
Phosphorus	TS1	2	2	1340.00	50.00	1655.69	1390.00
Phosphorus	TS2	1	1	1300.00			1300.00
Phosphorus	TS3	2	2	1280.00	80.00	1785.10	1360.00
Phosphorus	TS4	2	2	1590.00	90.00	2158.24	1680.00
Phosphorus	TS7	2	2	1060.00	50.00	1375.69	1110.00
Phosphorus	TS9	1	1	1630.00			1630.00
Plutonium-238	R	3	2	0.07	0.02	0.11	0.10
Plutonium-238	BY17	1	1	0.06			0.06
Plutonium-239/240	BY17	1	1	0.02			0.02
Plutonium-239/240	TS7	2	1	0.03	0.02	0.16	0.05
Potassium	R	3	3	1550.00	50.33	1696.97	1610.00
Potassium	BY17	1	1	1460.00			1460.00
Potassium	BY22	1	1	1390.00			1390.00
Potassium	TS1	2	2	1330.00	40.00	1582.55	1370.00
Potassium	TS2	1	1	1120.00			1120.00
Potassium	TS3	2	2	1290.00	50.00	1605.69	1340.00
Potassium	TS4	2	2	1295.00	145.00	2210.49	1440.00
Potassium	TS7	2	2	1220.00	60.00	1598.83	1280.00
Potassium	TS9	1	1	1460.00			1460.00
Selenium	R	3	3	2.13	0.15	2.56	2.31
Selenium	BY17	1	1	0.64			0.64
Selenium	BY22	1	1	1.17			1.17
Selenium	TS1	2	2	1.50	0.86	6.93	2.36
Selenium	TS2	1	1	0.84			0.84
Selenium	TS3	2	2	1.86	0.86	7.29	2.72
Selenium	TS4	2	2	1.60	0.08	2.07	1.67
Selenium	TS7	2	2	1.46	0.04	1.71	1.50
Selenium	TS9	1	1	1.25			1.25
Silver	BY17	1	1	0.04			0.04

Table G.46 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Silver	BY22	1	1	0.24			0.24
Silver	TS1	2	1	0.19	0.18	1.29	0.36
Silver	TS2	1	1	0.09			0.09
Silver	TS3	2	1	0.22	0.20	1.51	0.42
Silver	TS4	2	1	0.20	0.19	1.38	0.39
Silver	TS7	2	2	0.09	0.02	0.20	0.11
Silver	TS9	1	1	0.11			0.11
Sodium	R	3	3	821.00	13.43	860.21	846.00
Sodium	BY17	1	1	762.00			762.00
Sodium	BY22	1	1	738.00			738.00
Sodium	TS1	2	2	776.50	46.50	1070.09	823.00
Sodium	TS2	1	1	933.00			933.00
Sodium	TS3	2	2	835.50	11.50	908.11	847.00
Sodium	TS4	2	2	828.50	37.50	1065.27	866.00
Sodium	TS7	2	2	1540.00	910.00	7285.51	2450.00
Sodium	TS9	1	1	715.00			715.00
Strontium	R	3	3	3.97	0.93	6.69	5.81
Strontium	BY17	1	1	2.47			2.47
Strontium	BY22	1	1	2.31			2.31
Strontium	TS1	2	2	3.33	0.07	3.74	3.39
Strontium	TS2	1	1	2.30			2.30
Strontium	TS3	2	2	1.95	0.11	2.61	2.05
Strontium	TS4	2	2	2.90	0.26	4.54	3.16
Strontium	TS7	2	2	2.11	0.45	4.95	2.56
Technetium	R	3	1	0.00	0.00	0.00	0.00
Technetium	TS1	2	1	0.00	0.00	0.00	0.00
Technetium	TS3	2	1	0.00	0.00	0.00	0.00
Technetium	TS7	2	2	0.00	0.00	0.00	0.00
Uranium	R	3	3	0.18	0.06	0.35	0.27
Uranium	BY17	1	1	5.31			5.31
Uranium	BY22	1	1	11.40			11.40

Table G.46 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard error	UCL95	Maximum
Uranium	TS1	2	2	0.89	0.02	1.02	0.91
Uranium	TS2	1	1	0.39			0.39
Uranium	TS3	2	2	3.46	0.84	8.76	4.30
Uranium	TS4	2	2	0.35	0.05	0.67	0.40
Uranium	TS7	2	2	2.20	0.16	3.21	2.36
Uranium	TS9	1	1	0.43			0.43
Vanadium	R	3	3	1.33	0.25	2.05	1.75
Vanadium	TS1	2	1	0.78	0.40	3.32	1.18
Vanadium	TS3	2	1	0.79	0.41	3.36	1.20
Vanadium	TS4	2	1	0.68	0.29	2.50	0.96
Vanadium	TS7	2	1	0.79	0.41	3.39	1.20
Zinc	R	3	3	35.50	12.47	71.90	60.10
Zinc	BY17	1	1	86.20			86.20
Zinc	BY22	1	1	71.90			71.90
Zinc	TS1	2	2	57.15	1.15	64.41	58.30
Zinc	TS2	1	1	53.50			53.50
Zinc	TS3	2	2	59.90	6.10	98.41	66.00
Zinc	TS4	2	2	46.95	7.15	92.09	54.10
Zinc	TS7	2	2	31.65	0.45	34.49	32.10
Zinc	TS9	1	1	54.90			54.90

Table G.47. Summary statistics for Bear Creek small mammal contaminant data

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Aluminum	BY17	4	4	51.88	16.74	91.27	91.00
Aluminum	TS1	5	5	41.26	5.40	52.78	56.20
Aluminum	TS2	5	5	56.86	12.97	84.52	97.60
Aluminum	TS3	3	3	34.13	7.02	54.63	42.60
Aluminum	TS4	4	4	40.15	5.80	53.80	55.70
Aluminum	TS7	3	3	25.90	4.13	37.96	32.90
Aluminum	R	16	16	54.49	9.21	70.63	178.00
Americium-241	R	16	9	0.11	0.04	0.17	0.18
Americium-241	BY17	4	3	0.08	0.02	0.13	0.13
Americium-241	TS1	5	5	0.05	0.02	0.09	0.12
Americium-241	TS2	5	4	0.04	0.01	0.06	0.07
Americium-241	TS3	3	2	0.05	0.01	0.09	0.07
Americium-241	TS4	4	3	0.06	0.01	0.08	0.07
Antimony	BY17	4	4	0.01	0.00	0.02	0.02
Antimony	TS1	5	5	0.02	0.01	0.03	0.05
Antimony	TS2	5	5	0.02	0.00	0.03	0.03
Antimony	TS3	3	3	0.02	0.00	0.02	0.02
Antimony	TS4	4	4	0.02	0.01	0.04	0.05
Antimony	TS7	3	3	0.01	0.00	0.02	0.02
Antimony	R	16	16	0.02	0.00	0.03	0.04
Arsenic	R	16	13	0.02	0.00	0.02	0.03
Arsenic	BY17	4	4	0.03	0.01	0.05	0.05
Arsenic	TS1	5	5	0.03	0.01	0.04	0.05
Arsenic	TS2	5	5	0.02	0.01	0.04	0.05
Arsenic	TS3	3	3	0.02	0.00	0.03	0.03
Arsenic	TS4	4	4	0.04	0.01	0.06	0.06
Arsenic	TS7	3	3	0.02	0.00	0.02	0.02
Barium	R	16	16	4.57	1.05	6.40	18.00
Barium	BY17	4	4	2.05	0.37	2.92	2.77
Barium	TS1	5	5	5.01	1.05	7.25	8.09
Barium	TS2	5	5	3.63	0.65	5.02	5.27

Table G.47 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Barium	TS3	3	3	6.36	3.48	16.52	13.30
Barium	TS4	4	4	2.55	0.41	3.52	3.73
Barium	TS7	3	3	3.36	0.31	4.26	3.92
Cadmium	R	16	14	0.04	0.01	0.06	0.16
Cadmium	BY17	4	4	0.15	0.07	0.32	0.33
Cadmium	TS1	5	5	0.09	0.03	0.16	0.19
Cadmium	TS2	5	5	0.04	0.01	0.07	0.09
Cadmium	TS3	3	3	0.06	0.03	0.15	0.12
Cadmium	TS4	4	4	0.04	0.01	0.06	0.05
Cadmium	TS7	3	3	0.05	0.01	0.08	0.07
Calcium	R	16	16	10528.75	828.35	11980.89	17200.00
Calcium	BY17	4	4	10315.00	540.27	11586.45	11200.00
Calcium	TS1	5	5	12680.00	897.44	14593.21	15600.00
Calcium	TS2	5	5	9300.00	951.84	11329.18	11000.00
Calcium	TS3	3	3	8516.67	1245.32	12152.97	10100.00
Calcium	TS4	4	4	8637.50	897.87	10750.52	10500.00
Calcium	TS7	3	3	11710.00	3592.69	22200.61	17500.00
Chromium	R	16	16	0.72	0.12	0.93	1.49
Chromium	BY17	4	4	0.91	0.25	1.49	1.61
Chromium	TS1	5	5	0.45	0.06	0.58	0.64
Chromium	TS2	5	5	1.72	1.14	4.15	6.27
Chromium	TS3	3	3	0.74	0.25	1.49	1.25
Chromium	TS4	4	4	2.18	1.03	4.60	3.96
Chromium	TS7	3	3	0.82	0.37	1.90	1.55
Cobalt	R	16	12	0.07	0.01	0.09	0.15
Cobalt	BY17	4	4	0.13	0.05	0.25	0.28
Cobalt	TS1	5	5	0.07	0.02	0.10	0.12
Cobalt	TS2	5	5	0.13	0.03	0.19	0.21
Cobalt	TS3	3	3	0.08	0.01	0.10	0.09
Cobalt	TS4	4	4	0.11	0.04	0.21	0.23
Cobalt	TS7	3	2	0.03	0.01	0.05	0.04

Table G.47 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Copper	R	16	16	13.56	5.78	23.69	98.30
Copper	BY17	4	4	3.94	1.30	7.00	7.82
Copper	TS1	5	5	4.02	0.32	4.71	4.85
Copper	TS2	5	5	5.20	0.62	6.52	6.59
Copper	TS3	3	3	9.34	3.33	19.06	15.60
Copper	TS4	4	4	140.34	136.89	462.49	551.00
Copper	TS7	3	3	4.42	0.72	6.52	5.86
Curium-244	R	16	4	0.07	0.02	0.11	0.19
Curium-244	BY17	4	3	0.10	0.04	0.20	0.17
Curium-244	TS1	5	5	0.07	0.02	0.12	0.16
Curium-244	TS2	5	3	0.04	0.02	0.08	0.10
Curium-244	TS3	3	3	0.06	0.02	0.13	0.11
Curium-244	TS4	4	1	0.04	0.01	0.06	0.06
Curium-244	TS7	3	2	0.03	0.02	0.08	0.06
Iron	R	16	16	75.04	3.05	80.39	98.40
Iron	BY17	4	4	71.45	6.98	87.88	91.40
Iron	TS1	5	5	75.52	2.56	80.98	83.30
Iron	TS2	5	5	73.18	5.55	85.02	86.50
Iron	TS3	3	3	93.73	16.13	140.82	118.00
Iron	TS4	4	4	76.25	7.04	92.81	97.00
Iron	TS7	3	3	72.13	3.91	83.54	79.90
Lead	R	16	15	0.19	0.03	0.24	0.43
Lead	BY17	4	4	0.20	0.05	0.31	0.32
Lead	TS1	5	5	0.19	0.08	0.35	0.50
Lead	TS2	5	5	0.12	0.02	0.16	0.17
Lead	TS3	3	3	0.26	0.20	0.86	0.67
Lead	TS4	4	4	4.36	3.91	13.57	16.10
Lead	TS7	3	3	0.10	0.03	0.20	0.17
Lithium	R	16	16	0.06	0.01	0.07	0.12
Lithium	BY17	4	4	0.16	0.04	0.26	0.27
Lithium	TS1	5	5	0.22	0.16	0.57	0.87

Table G.47 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Lithium	TS2	5	5	0.33	0.20	0.75	1.09
Lithium	TS3	3	3	0.08	0.02	0.14	0.12
Lithium	TS4	4	4	0.21	0.13	0.50	0.58
Lithium	TS7	3	3	0.02	0.00	0.03	0.03
Magnesium	R	16	16	466.31	19.67	500.80	588.00
Magnesium	BY17	4	4	480.25	25.64	540.58	541.00
Magnesium	TS1	5	5	526.00	38.49	608.05	679.00
Magnesium	TS2	5	5	466.20	29.09	528.22	512.00
Magnesium	TS3	3	3	448.00	43.66	575.49	535.00
Magnesium	TS4	4	4	452.50	31.01	525.47	505.00
Magnesium	TS7	3	3	462.33	71.63	671.49	584.00
Manganese	R	16	16	3.60	0.43	4.35	8.04
Manganese	BY17	4	4	2.80	0.54	4.06	4.00
Manganese	TS1	5	5	3.04	0.51	4.12	3.94
Manganese	TS2	5	5	2.30	0.36	3.06	3.66
Manganese	TS3	3	3	3.52	1.25	7.18	5.73
Manganese	TS4	4	4	3.92	0.47	5.02	4.64
Manganese	TS7	3	3	2.42	0.38	3.53	3.01
Mercury	R	16	15	0.02	0.00	0.03	0.05
Mercury	BY17	4	4	0.06	0.02	0.11	0.11
Mercury	TS1	5	5	0.06	0.01	0.07	0.07
Mercury	TS2	5	5	0.05	0.02	0.09	0.10
Mercury	TS3	3	3	0.02	0.00	0.03	0.03
Mercury	TS4	4	4	0.15	0.05	0.25	0.24
Mercury	TS7	3	3	0.04	0.01	0.05	0.05
Molybdenum	R	16	16	0.16	0.02	0.19	0.29
Molybdenum	BY17	4	4	0.34	0.18	0.76	0.87
Molybdenum	TS1	5	5	0.22	0.05	0.33	0.43
Molybdenum	TS2	5	5	0.18	0.02	0.21	0.23
Molybdenum	TS3	3	3	0.23	0.03	0.31	0.27
Molybdenum	TS4	4	4	0.31	0.09	0.52	0.57

Table G.47 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Molybdenum	TS7	3	3	0.21	0.06	0.38	0.28
Nickel	R	16	16	3.79	1.20	5.90	15.50
Nickel	BY17	4	4	1.31	0.27	1.94	1.71
Nickel	TS1	5	5	1.32	0.13	1.58	1.64
Nickel	TS2	5	5	1.48	0.26	2.04	2.48
Nickel	TS3	3	3	5.66	4.87	19.88	15.40
Nickel	TS4	4	4	12.63	11.46	39.60	47.00
Nickel	TS7	3	3	1.39	0.42	2.60	2.18
PCB-1260	BY17	4	3	0.06	0.03	0.13	0.15
PCB-1260	TS1	5	4	0.11	0.05	0.21	0.27
PCB-1260	TS2	5	2	0.15	0.13	0.43	0.67
PCB-1260	TS3	3	1	0.03	0.01	0.06	0.05
PCB-1260	TS4	4	4	5.23	1.03	7.65	7.70
PCB-1260	TS7	3	3	0.27	0.12	0.63	0.51
Phosphorus	R	16	16	7210.00	418.73	7944.05	10500.00
Phosphorus	BY17	4	4	7585.00	293.67	8276.11	8060.00
Phosphorus	TS1	5	5	9138.00	563.15	10338.54	11100.00
Phosphorus	TS2	5	5	7512.00	552.36	8689.55	8330.00
Phosphorus	TS3	3	3	7043.33	759.83	9262.03	8130.00
Phosphorus	TS4	4	4	6807.50	509.96	8007.61	7820.00
Phosphorus	TS7	3	3	8160.00	1884.68	13663.25	11200.00
Plutonium-239/240	R	16	16	0.07	0.01	0.08	0.13
Plutonium-239/240	BY17	4	4	0.04	0.01	0.06	0.07
Plutonium-239/240	TS1	5	5	0.06	0.01	0.08	0.10
Plutonium-239/240	TS2	5	5	0.04	0.01	0.05	0.06
Plutonium-239/240	TS3	3	3	0.04	0.00	0.05	0.04
Plutonium-239/240	TS4	4	4	0.04	0.01	0.05	0.05
Plutonium-239/240	TS7	3	3	0.04	0.00	0.04	0.04
Potassium	R	16	16	3075.63	70.92	3199.95	3580.00
Potassium	BY17	4	4	2795.00	113.47	3062.03	3090.00
Potassium	TS1	5	5	3356.00	108.24	3586.75	3660.00

Table G.47 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Potassium	TS2	5	5	3142.00	134.66	3429.08	3510.00
Potassium	TS3	3	3	3160.00	65.06	3349.99	3290.00
Potassium	TS4	4	4	3022.50	38.16	3112.31	3070.00
Potassium	TS7	3	3	3230.00	356.42	4270.73	3940.00
Selenium	R	16	16	0.27	0.02	0.31	0.44
Selenium	BY17	4	4	0.19	0.03	0.25	0.25
Selenium	TS1	5	5	0.31	0.02	0.35	0.36
Selenium	TS2	5	5	0.24	0.02	0.27	0.27
Selenium	TS3	3	3	0.27	0.03	0.35	0.32
Selenium	TS4	4	4	0.27	0.04	0.37	0.34
Selenium	TS7	3	3	0.35	0.03	0.44	0.39
Silver	BY17	4	2	0.01	0.00	0.02	0.02
Silver	TS4	4	1	0.02	0.01	0.03	0.04
Sodium	R	16	16	1496.25	42.37	1570.52	1840.00
Sodium	BY17	4	4	1410.00	41.23	1507.03	1520.00
Sodium	TS1	5	5	1498.00	73.10	1653.84	1740.00
Sodium	TS2	5	5	1428.00	52.86	1540.69	1630.00
Sodium	TS3	3	3	1356.67	88.76	1615.84	1460.00
Sodium	TS4	4	4	1305.00	55.45	1435.50	1430.00
Sodium	TS7	3	3	1626.67	188.89	2178.21	2000.00
Strontium	R	16	16	4.11	0.54	5.06	11.30
Strontium	BY17	4	4	3.74	0.37	4.60	4.20
Strontium	TS1	5	5	4.48	0.25	5.02	5.24
Strontium	TS2	5	5	3.13	0.72	4.67	5.53
Strontium	TS3	3	3	3.64	1.29	7.41	6.09
Strontium	TS4	4	4	2.78	0.26	3.38	3.46
Strontium	TS7	3	3	2.66	0.40	3.83	3.31
Technetium	R	16	2	0.00	0.00	0.00	0.00
Technetium	BY17	4	3	0.00	0.00	0.00	0.00
Technetium	TS1	5	2	0.00	0.00	0.00	0.00
Technetium	TS2	5	1	0.00	0.00	0.00	0.00

Table G.47 (continued)

Analyte	Transect	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Technetium	TS3	3	3	0.00	0.00	0.00	0.00
Technetium	TS4	4	4	0.00	0.00	0.00	0.00
Technetium	TS7	3	1	0.00	0.00	0.00	0.00
Thallium	TS2	5	1	0.01	0.01	0.02	0.03
Uranium	R	16	16	0.00	0.00	0.01	0.01
Uranium	BY17	4	4	0.16	0.10	0.40	0.45
Uranium	TS1	5	5	0.02	0.00	0.02	0.03
Uranium	TS2	5	5	0.02	0.00	0.02	0.03
Uranium	TS3	3	3	0.04	0.02	0.10	0.08
Uranium	TS4	4	4	0.06	0.02	0.10	0.09
Uranium	TS7	3	3	0.01	0.00	0.01	0.01
Vanadium	R	16	2	0.25	0.03	0.30	0.56
Zinc	R	16	16	45.60	4.63	53.72	102.00
Zinc	BY17	4	4	48.58	8.71	69.07	73.90
Zinc	TS1	5	5	56.40	8.07	73.59	80.50
Zinc	TS2	5	5	49.68	11.21	73.57	92.50
Zinc	TS3	3	3	50.53	13.81	90.85	75.90
Zinc	TS4	4	4	124.18	84.00	321.85	376.00
Zinc	TS7	3	3	51.00	10.90	82.83	72.80

Table G.48. Summary statistics for Bear Creek whole fish contaminant data

Analyte	Location	OBS	Detects	Mean	Standard Error	UCL95	Maximum
Antimony	BCK 3.3	8	8	0.003	0.001	0.005	0.007
Antimony	BCK 9.4	8	3	0.003	0.002	0.006	0.013
Antimony	BCK 12.4	8	2	0.008	0.001	0.010	0.014
Arsenic	BCK 3.3	8	8	0.312	0.002	0.375	0.401
Arsenic	BCK 9.4	8	8	0.433	0.002	0.536	0.573
Arsenic	BCK 12.4	8	8	0.003	0.001	0.005	0.007
Beryllium	BCK 3.3	8	8	0.011	0.002	0.017	0.024
Beryllium	BCK 9.4	8	8	0.020	0.003	0.027	0.033
Beryllium	BCK 12.4	8	8	0.016	0.003	0.029	0.051
Cadmium	BCK 3.3	8	8	0.194	0.003	0.243	0.315
Cadmium	BCK 9.4	8	8	0.480	0.004	0.595	0.694
Cadmium	BCK 12.4	8	8	1.730	0.003	2.085	2.740
Chromium (+6)	BCK 3.3	8	8	0.793	0.004	0.929	1.120
Chromium (+6)	BCK 9.4	8	8	0.975	0.004	1.131	1.260
Chromium (+6)	BCK 12.4	8	8	0.696	0.093	0.873	1.170
Copper	BCK 3.3	8	8	1.004	0.039	1.078	1.140
Copper	BCK 9.4	8	8	1.029	0.096	1.212	1.300
Copper	BCK 12.4	8	8	0.826	0.060	0.939	1.150
Lead	BCK 3.3	8	8	0.226	0.057	0.334	0.520
Lead	BCK 9.4	8	8	0.532	0.091	0.704	0.840
Lead	BCK 12.4	8	8	0.756	0.116	0.664	1.100
Lithium	BCK 9.4	8	8	0.756	0.144	1.029	1.500
Lithium	BCK 12.4	8	8	0.238	0.081	0.392	0.652
Mercury	BCK 0.6	24	24	0.355	0.036	0.417	0.884
Mercury	BCK 3.3	8	8	0.060	0.006	0.071	0.086
Mercury	BCK 4.5	11	11	0.231	0.034	0.292	0.469
Mercury	BCK 9.4	8	8	0.079	0.006	0.090	0.110
Mercury	BCK 12.4	8	8	0.120	0.010	0.139	0.170
Nickel	BCK 3.3	8	8	0.574	0.075	0.716	0.896
Nickel	BCK 9.4	8	8	0.849	0.107	1.052	1.190
Nickel	BCK 12.4	8	8	2.449	0.573	3.535	5.240

Table G.48 (continued)

Analyte	Location	OBS	Detects	Mean	Standard Error	UCL95	Maximum
PCB total	BCK 0.6			1.396	0.174	1.693	3.370
PCB total	BCK 4.5			4.005	0.782	5.423	7.793
PCB, total	BCK 3.3	8	8	0.978	0.150	1.262	1.750
PCB, total	BCK 9.4	8	8	2.855	0.494	3.791	4.500
PCB, total	BCK 12.4	8	8	0.275	0.066	0.399	0.610
Selenium	BCK 3.3	8	8	0.564	0.044	0.648	0.786
Selenium	BCK 9.4	8	8	0.609	0.080	0.761	1.120
Selenium	BCK 12.4	8	8	0.436	0.031	0.494	0.538
Silver	BCK 3.3	8	8	0.025	0.003	0.030	0.038
Silver	BCK 9.4	8	8	0.013	0.002	0.016	0.021
Silver	BCK 12.4	8	8	0.015	0.002	0.019	0.029
Thallium	BCK 3.3	8	8	0.006	0.001	0.008	0.010
Thallium	BCK 9.4	8	8	0.012	0.003	0.017	0.029
Thallium	BCK 12.4	8	8	0.008	0.001	0.009	0.012
Uranium	BCK 3.3	8	8	0.415	0.041	0.492	0.557
Uranium	BCK 9.4	8	8	0.982	0.092	1.157	1.400
Uranium	BCK 12.4	8	8	0.733	0.108	0.937	1.220
Zinc	BCK 3.3	8	8	57.875	4.185	65.803	81.400
Zinc	BCK 9.4	8	8	48.313	2.842	53.696	59.200
Zinc	BCK 12.4	8	8	40.463	1.258	42.846	43.700

Table G.49. Life history parameters for short-tailed shrew
(*Blarina brevicauda*)

Parameter	Value ^a	Comments	Reference
Body weight	0.015 ± 0.00078 kg	New Hampshire (field)	Schlessinger and Potter 1974
Food consumption rate	0.01 kg/d	Larch sawfly diet (lab)	Buckner 1964
	0.00795 ± 0.00017 kg/d	Mealworm diet (lab)	Barrett and Stueck 1976
	Mean = 0.009 kg/d		
Water consumption rate	0.223 ml/g bw/d		Chew 1951
	0.033 L/d	Assuming a 0.015 kg bw	
Soil consumption rate	13% of diet		Talmage and Walton 1993
	0.00117 kg/d	Assuming diet of 0.009 kg/d	
Diet composition	Earthworms 31.4% Slugs/snails 27.1% Soil/litter invert 13.2% Fungi 8.4% Misc. animals 8.1% Voleoptera 5.9% Vegetation 5.4%	Percent volume in diet in summer in New York	Whitaker and Ferraro 1963
Home range	0.39 ± 0.036 ha	Manitoba bog	Buckner 1966
Habitat requirements	Broad and variable but requires >50% herbaceous cover		Miller and Getz 1977
	Forest, wetlands, and grasslands: most abundant in hardwood forests with deep litter and humus		van Zyll de Jong 1983
Population density	2.3 /ha – winter 5.2 /ha – spring 9.3 /ha – summer 8.1 /ha – fall	Illinois - alfalfa, tallgrass, and bluegrass; means derived from graph.	Getz 1989
	2.5–45 /ha	Depending on habitat	
Behavior	Nocturnal, semifossorial, spends little time above surface		George et al. 1986
	Active year-round — does not hibernate		EPA 1993a
Other	Appear to be unpalatable to most predators due to lateral gland		van Zyll de Jong 1983

^aSuggested values for use in exposure assessment are in bold.

**Table G.50. Life history parameters for white-footed mice
(*Peromyscus leucopus*)**

Parameter	Value ^a	Comments	Reference
Body weight	0.022 kg		Green and Millar 1987
Food consumption rate	0.0034 kg/d	Lab study	Green and Millar 1987
Water consumption rate	0.0066 L/d	Nonreproductive ♀ (lab)	Oswald et al. 1993
Soil consumption rate	<2%		Beyer et al. 1994
	0.000068 kg/d	Assuming diet of 0.0034 kg/d and a 2% soil consumption rate	
Diet composition	Omnivorous and opportunistic		
	Arthropods — 57% Seeds, fruit, vegetation — 34%	Virginia	Wolff et al. 1985
	Arthropods — 30% Seeds, fruit, vegetation — 67%	Indiana	Whitaker 1966
	Arthropods — 50% Seeds, fruit, vegetation — 48%	Illinois	Batzli 1977
Home range	0.059 ha	Mean: ♂+♀; Virginia, mixed deciduous forest	Wolff 1985
Habitat requirements	Wooded, brushy areas; sometimes open areas		Burt and Grossenheider 1976
Population density	6 – 57 /ha	Virginia, mixed deciduous forest	Wolff 1985
Behavior	While semi-arboreal, spends most of time on ground		Lackey et al. 1985
	Primarily nocturnal		
	Enters torpor to reduce metabolic demands in winter and during food stress		EPA 1993a

^aSuggested values for use in exposure assessment are in bold.

Table G.51. Life history parameters for white-tailed deer
(*Odocoileus virginianus*)

Parameter	Value ^a	Comments	Reference
Body weight	68 kg (♂) 45 kg (♀) 56.5 kg (mean♂+♀)		Smith 1991
Food consumption rate	1.74 kg/d		Mautz et al. 1976
Water consumption rate	3.7 L/d	Estimated using allometric equation ^b assuming 56.5 kg bw	
Soil consumption rate	<2% 0.0348 kg/d	Assuming 2% soil and 1.74 kg/d food consumption rates	Beyer et al. 1994
Diet composition	Exclusively herbivorous Diet diverse and variable, depends on availability Major foods: — buds and twigs of trees and shrubs — grasses and forbs (summer) — mast and fruits (fall)		Zim et al. 1951 Smith 1991
Home range	59 – 520 ha		Marchinton and Hirth 1984
Habitat requirements	Uses a wide variety of habitats; favors forest-field-farmland mosaic; population density directly related to number and distribution of forest openings		Smith 1991
Population density	0.06 /ha 0.39 – 0.78 /ha 0.1704/ha	Eastern mixed deciduous forest — Tennessee Oak-hickory forest — midwest (Calculated based upon 2000 deer on the ORR and available habitat)	Barber 1984 Torgerson and Porath 1984 J. Evans (personal communication, 1995)
Behavior	Generally crepuscular Active year-round; does not hibernate		Smith 1991

^aSuggested values for use in exposure assessment are in bold.

^bAllometric equation for estimation of water consumption by mammals is:

$$W = 0.099(bw)^{0.90}$$

where: W = water consumption (L/d)
bw = body weight (kg).

Table G.52. Life history parameters for red fox
(*Vulpes fulva*)

Parameter	Value ^a	Comments	Reference
Body weight	5.25 ± 0.18 kg (♂)	Illinois	Storm et al. 1976
	4.13 ± 0.11 kg (♀)		
	4.82 ± 0.081 kg (♂)	Iowa	
	3.94 ± 0.079 kg (♀)		
	4.5 kg	Mean ♂+♀ for both Illinois and Iowa	
Food consumption rate	0.596 kg/d	See calculation below ^b	Vogtsberger and Barret 1973
	0.31 kg/d	0.069 g/g/d for nonbreeding adult times 4.5 kg bw	Sargeant 1978
	0.45 kg/d	Mean of both estimates	
Water consumption rate	0.38 L/d	Estimated using allometric equation ^c ; assuming 4.5 kg bw	
Soil consumption rate	2.8%		Beyer et al. 1994
	0.0126 kg/d	assuming diet of 0.45 kg/d	
Diet composition	Mammals — 68.8%	Maryland, Appalachian region	
	Birds — 12.0%		
	Plants — 10.4%		
	Insects — 0.9%		
	Misc. - 5.5%—		
Home range	699 ± 137 ha (♀ spring)	Minnesota — forest, field, swamp	Sargeant 1972
	717 ha (♂ all year)	Wisconsin — multiple habitats	Ables 1969
	96 ha (♀ all year)		
Habitat requirements	Wide and diverse — occur in many habitats		Voigt 1987
	Prefer mixture of forest and open habitat		Burt and Grossenheider 1976
Population density	0.046 – 0.077 /ha	"Good fox range" in North America	EPA 1993a
Behavior	Active year-round — does not hibernate		EPA 1993a

^aSuggested values for use in exposure assessment are in bold.

^bThe following parameters were presented by Vogtsberger and Barret (1973):

food ingestion = 223 kcal/kg bw/d

energy content of vertebrate food = 5.606 kcal/g dry wt.

wet-dry weight conversion = 1 g wet wt = 0.3 g dry wt;

therefore: 223 kcal/kg bw/d x 4.5 kg bw = 1003.5 kcal/d

1003.5 kcal/d x 1 g dry wt./5.606 kcal = 179 g dry/d

179 g dry/d x 1 g wet/0.3 g dry (wet-dry conversion) = 596 g/d.

^cAllometric equation for estimation

of water consumption by mammals is: $W = 0.099(bw)^{0.90}$

where: W = water consumption (L/d)

bw = body weight (kg).

Table G.53. Life history parameters for red-tailed hawks
(*Buteo jamaicensis*)

Parameter	Value ^a	Comments	Reference
Body weight	1.028 kg (♂) 1.224 kg (♀) 1.126 kg (mean ♂+♀)		Dunning 1984
Food consumption rate	0.109 kg/d		Craighead and Craighead 1969
Water consumption rate	0.064 L/d	Estimated using allometric equation ^b ; assuming 1.126 kg bw	
Soil consumption rate	While some soil attached to prey may be ingested, amount is assumed to negligible		
Diet composition	Predominantly small mammals		EPA 1993a
	Small mammal — 78.5 % Bird — 8.5 % Snake — 13.0 %	Oregon — pasture and wheat fields	Janes 1984
Home range	233 ha	Oregon — pasture and wheat fields	Janes 1984
	1936 ha (957 – 2465 ha range)	Colorado — prairie-pinyon/juniper woodland; mean of 4 birds; 95% ellipse and systematic relocation	Anderson and Rongstad 1989
Habitat requirements	Use wide range of habitats. prefer landscapes containing mixture of oldfields, wetlands and pasture for foraging with trees interspersed for perching and nesting		EPA 1993a DeGraaf et al. 1981
Population density	0.03 – >0.005 pairs/ha		EPA 1993a
Behavior	Territorial throughout year		Brown and Amadon 1968 ^b
	Northerly populations migrate; those in the south do not		National Geographic Society 1987

^aSuggested values for use in exposure assessment are in bold.

^bAllometric equation for estimation of water consumption by birds is: $W=0.059(bw)^{0.67}$

where: W = water consumption (L/d)
bw = body weight (kg).

Table G.54. Life history parameters for mink
(*Mustela vison*)

Parameter	Value	Comments	Reference
Body weight	1.0 kg (mean ♂+♀)		EPA 1993b
Food consumption rate	0.137 kg/d (mean ♂+♀)		Bleavins and Aulerich 1981
Water consumption rate	0.099 L/d	Estimated using allometric equation ^a assuming 1.0 kg bw	After Calder and Braun 1983
Diet composition	Diverse diet includes: mammals, fish, aquatic invertebrates, amphibians, and birds		Hamilton 1940, Sealander 1943, Korschgen 1958, Burgess and Bider 1980, Alexander 1977
	Proportion of aquatic prey (fish, amphibians, inverts, etc.) = 0.546±0.21	Proportion represents means of values from five studies	
	Fish sizes: 0–10 cm=72% 11–20 cm=28%		
Home range	2.63 km (♂) 1.85 km (♀)	Stream — Sweden	Gerell 1970
	770 ha (♂)	Prairie potholes, Manitoba	Arnold and Fritzell 1987
		Range size and shape depends on habitat — linear along streams, circular in marshes	EPA 1993a
Habitat requirements	Aquatic habitats — streams, lakes, marshes;		Burt and Grossenheider 1976
Population density	0.03 – 0.085 /ha	River — Montana	Mitchell 1961
	0.6/km	River — Michigan	EPA 1993a
Behavior	Nocturnal active year-round, does not hibernate		EPA 1993a

^a Allometric equation for estimation of water consumption by mammals is: $W=0.099(bw)^{0.90}$

where: W = water consumption (L/d)

bw = body weight (kg).

**Table G.55. Life history parameters for belted kingfisher
(*Ceryle alcyon*)**

Parameter	Value	Comments	Reference
Body weight	0.148 kg		Dunning 1984
Food consumption rate	50% bw		Alexander 1977
	0.075 kg/d	Assuming 0.148 kg bw	
Water consumption rate	0.016 L/d	Estimated using allometric equation ^a assuming 0.148 kg bw	
Soil consumption rate	As a piscivore, assumed to be negligible		
Diet composition	Cyprinids — 76.4% Other fish — 10.2% Crayfish — 13.3%	Ohio — creek	Davis 1982
	Lizards, small snakes, frogs, salamanders, and insects may be consumed if fish are unavailable		Landrum et al. 1993
Home range	1.03 km (breeding) 0.39 km (non-breeding)	Ohio — creek	Davis 1982
	2.19 km (breeding)	Pennsylvania — stream summer	Brooks and Davis 1987
Habitat requirements	Uses a diverse aquatic habitats (stream, river, lake, marsh, coastline)		Brooks and Davis 1987
	Require high vertical banks composed of >75% sand and <7% clay for nest construction		
	Prefer relatively clear waters free of thick vegetation		Bent 1940
Population density	0.11 - 0.19 pairs/km shore	Pennsylvania — stream summer	Brooks and Davis 1987
Behavior	While most migrate from northern parts of range, some may stay in areas where water remains ice-free		Bent 1940

^aAllometric equation for estimation of water consumption by birds is: $W=0.059(bw)^{0.67}$

where: W = water consumption (L/d)
bw = body weight (kg).

Table G.56. Point estimates of contaminant exposure for short-tailed shrew in the Bear Creek watershed

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
111 Trichloroethane	Burial Ground	0.000	0.00	
1,1-Dichloroethene	Burial Ground	0.000	0.00	
1,2-Dichloroethane	Burial Ground	0.000	0.00	
1,2-Dichloroethene	Burial Ground	0.000	0.00	
2378-TCDD	Boneyard/Burnyard	0.000	0.03	0.00
2-Butanone	S-3 Ponds	0.000	0.00	0.00
2-Butanone	Burial Ground	0.000	0.00	0.00
4-Methyl2pentanone	S-3 Ponds	0.000	0.00	
4-Methyl2pentanone	Burial Ground	0.000	0.00	
Acetone	S-3 Ponds	0.007	0.00	0.00
Acetone	Oil Landfarm	0.001	0.00	0.00
Acetone	Boneyard/Burnyard	0.000	0.00	0.00
Acetone	Burial Ground	0.000	0.00	0.00
Aldrin	TS04	0.000	0.00	0.00
Aluminum	TS13	144.622	63.02	6.30
Aluminum	TS10	193.086	84.13	8.41
Aluminum	TS09	72.456	31.57	3.16
Aluminum	TS08	138.292	60.26	6.03
Aluminum	TS07	232.446	101.28	10.13
Aluminum	TS06	96.996	42.26	4.23
Aluminum	TS05	112.683	49.10	4.91
Aluminum	TS04	203.238	88.56	8.85
Aluminum	TS03	239.747	104.47	10.45
Aluminum	TS02	63.354	27.61	2.76
Aluminum	TS01	718.795	313.20	31.32
Aluminum	S-3 Ponds	234.384	102.13	10.21
Aluminum	Oil Landfarm	616.310	268.54	26.85
Aluminum	Boneyard/Burnyard	339.163	147.78	14.78
Aluminum	Burial Ground	511.727	222.97	22.30
Antimony	TS09	0.002	0.02	0.00

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Antimony	TS07	0.004	0.03	0.00
Antimony	TS04	0.006	0.04	0.00
Antimony	TS03	0.005	0.03	0.00
Antimony	TS02	0.002	0.01	0.00
Antimony	TS01	0.008	0.05	0.01
Antimony	S-3 Ponds	0.003	0.02	0.00
Antimony	Oil Landfarm	0.005	0.03	0.00
Antimony	Boneyard/Burnyard	3.042	20.41	2.05
Antimony	Burial Ground	0.005	0.03	0.00
Arsenic	TS13	0.072	0.48	0.05
Arsenic	TS10	0.048	0.32	0.03
Arsenic	TS09	0.044	0.29	0.03
Arsenic	TS08	0.087	0.58	0.06
Arsenic	TS07	0.085	0.57	0.06
Arsenic	TS06	0.036	0.24	0.02
Arsenic	TS05	0.097	0.65	0.07
Arsenic	TS04	0.411	2.74	0.27
Arsenic	TS03	0.219	1.46	0.15
Arsenic	TS02	0.050	0.33	0.03
Arsenic	TS01	0.304	2.02	0.20
Arsenic	S-3 Ponds	0.103	0.69	0.07
Arsenic	Oil Landfarm	0.189	1.26	0.13
Arsenic	Boneyard/Burnyard	0.206	1.38	0.14
Arsenic	Burial Ground	0.167	1.11	0.11
Barium	TS13	2.048	0.17	0.05
Barium	TS10	1.660	0.14	0.04
Barium	TS09	0.754	0.06	0.02
Barium	TS08	1.262	0.11	0.03
Barium	TS07	2.142	0.18	0.05
Barium	TS06	1.278	0.11	0.03
Barium	TS05	1.377	0.12	0.03

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Barium	TS04	5.579	0.47	0.13
Barium	TS03	4.312	0.36	0.10
Barium	TS02	2.274	0.19	0.05
Barium	TS01	3.092	0.26	0.07
Barium	S-3 Ponds	2.367	0.20	0.05
Barium	Oil Landfarm	3.544	0.30	0.08
Barium	Boneyard/Burnyard	2.850	0.24	0.07
Barium	Burial Ground	2.922	0.25	0.07
Benzo(a)pyrene	TS03	0.011	0.01	0.00
Benzo(a)pyrene	TS01	0.002	0.00	0.00
Benzo(a)pyrene	Oil Landfarm	0.021	0.02	0.00
Benzo(a)pyrene	Boneyard/Burnyard	0.150	0.13	0.01
Beryllium	TS13	0.008	0.01	
Beryllium	TS10	0.006	0.00	
Beryllium	TS09	0.004	0.00	
Beryllium	TS08	0.006	0.00	
Beryllium	TS07	0.014	0.01	
Beryllium	TS06	0.006	0.00	
Beryllium	TS05	0.010	0.01	
Beryllium	TS04	0.030	0.02	
Beryllium	TS03	0.015	0.01	
Beryllium	TS02	0.005	0.00	
Beryllium	TS01	0.047	0.03	
Beryllium	S-3 Ponds	0.011	0.01	
Beryllium	Oil Landfarm	0.016	0.01	
Beryllium	Boneyard/Burnyard	0.013	0.01	
Beryllium	Burial Ground	0.014	0.01	
Bis(2-ethylhexyl)phthalate	TS09	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS08	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS07	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS06	0.012	0.00	0.00

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Bis(2-ethylhexyl)phthalate	TS04	0.014	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS03	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS02	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS01	0.002	0.00	0.00
Bis(2-ethylhexyl)phthalate	Oil Landfarm	0.016	0.00	0.00
Bis(2-ethylhexyl)phthalate	Boneyard/Burnyard	0.003	0.00	0.00
Bis(2-ethylhexyl)phthalate	Burial Ground	0.004	0.00	0.00
Cadmium	TS10	0.735	40.81	33.39
Cadmium	TS09	0.193	10.73	8.78
Cadmium	TS08	0.284	15.79	12.92
Cadmium	TS07	1.984	110.25	90.20
Cadmium	TS06	1.455	80.83	66.14
Cadmium	TS05	1.973	109.58	89.66
Cadmium	TS04	0.079	4.37	3.57
Cadmium	TS03	0.933	51.85	42.43
Cadmium	TS02	0.102	5.65	4.62
Cadmium	TS01	2.086	115.91	94.84
Cadmium	S-3 Ponds	0.487	27.06	22.14
Cadmium	Oil Landfarm	1.925	106.92	87.48
Cadmium	Boneyard/Burnyard	2.117	117.64	96.25
Chlordane	TS13	0.000	0.00	0.00
Chlordane	TS10	0.000	0.00	0.00
Chlordane	TS09	0.000	0.00	0.00
Chlordane	TS08	0.000	0.00	0.00
Chlordane	TS07	0.000	0.00	0.00
Chlordane	TS06	0.000	0.00	0.00
Chlordane	TS05	0.000	0.00	0.00
Chlordane	TS04	0.000	0.00	0.00
Chlordane	TS03	0.000	0.00	0.00
Chlordane	TS01	0.000	0.00	0.00
Chloroform	TS13	0.000	0.00	0.00

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Chloroform	Oil Landfarm	0.000	0.00	0.00
Chromium	TS13	4.820	0.67	0.17
Chromium	TS10	10.142	1.41	0.35
Chromium	TS09	0.544	0.08	0.02
Chromium	TS08	4.851	0.67	0.17
Chromium	TS07	23.251	3.23	0.81
Chromium	TS06	3.485	0.48	0.12
Chromium	TS05	18.238	2.53	0.63
Chromium	TS04	16.653	2.31	0.58
Chromium	TS03	26.912	3.73	0.93
Chromium	TS02	1.891	0.26	0.07
Chromium	TS01	4.181	0.58	0.14
Chromium	S-3 Ponds	10.036	1.39	0.35
Chromium	Oil Landfarm	15.243	2.11	0.53
Chromium	Boneyard/Burnyard	3.580	0.50	0.12
Chromium	Burial Ground	12.681	1.76	0.44
Copper	TS13	1.948	0.06	0.05
Copper	TS10	0.565	0.02	0.01
Copper	TS09	0.077	0.00	0.00
Copper	TS08	1.449	0.04	0.03
Copper	TS07	5.877	0.18	0.14
Copper	TS06	0.696	0.02	0.02
Copper	TS05	0.476	0.01	0.01
Copper	TS04	0.776	0.02	0.02
Copper	TS03	0.974	0.03	0.02
Copper	TS02	0.234	0.01	0.01
Copper	TS01	1.121	0.03	0.03
Copper	S-3 Ponds	2.816	0.08	0.07
Copper	Oil Landfarm	6.013	0.18	0.14
Copper	Boneyard/Burnyard	12.469	0.37	0.29
Copper	Burial Ground	1.722	0.05	0.04

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Cyanide	TS10	0.009	0.00	
Cyanide	S-3 Ponds	0.004	0.00	
Cyanide	Boneyard/Burnyard	0.003	0.00	
Cyanide	Burial Ground	0.090	0.00	
Dieldrin	TS10	0.000	0.00	0.00
Dieldrin	TS09	0.000	0.00	0.00
Dieldrin	TS08	0.000	0.00	0.00
Dieldrin	TS07	0.000	0.01	0.00
Dieldrin	TS06	0.000	0.00	0.00
Dieldrin	TS04	0.000	0.00	0.00
Dieldrin	TS03	0.000	0.00	0.00
Dieldrin	TS01	0.000	0.00	0.00
Diethylphthalate	TS04	0.015	0.00	
Diethylphthalate	Boneyard/Burnyard	0.002	0.00	
Di-n-butylphthalate	TS10	0.001	0.00	0.00
Di-n-butylphthalate	TS07	0.010	0.00	0.00
Di-n-butylphthalate	TS06	0.011	0.00	0.00
Di-n-butylphthalate	TS05	0.001	0.00	0.00
Di-n-butylphthalate	TS03	0.002	0.00	0.00
Di-n-butylphthalate	TS01	0.007	0.00	0.00
Di-n-butylphthalate	Oil Landfarm	0.002	0.00	0.00
Di-n-butylphthalate	Boneyard/Burnyard	0.006	0.00	0.00
Di-n-octylphthalate	Burial Ground	0.002		
Endosulfan	TS09	0.000	0.00	
Endosulfan	TS03	0.000	0.00	
Endosulfan	TS01	0.000	0.00	
Endrin	TS13	0.000	0.00	0.00
Endrin	TS10	0.000	0.00	0.00
Endrin	TS09	0.000	0.00	0.00
Endrin	TS08	0.000	0.00	0.00
Endrin	TS07	0.001	0.01	0.00

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Endrin	TS06	0.000	0.00	0.00
Endrin	TS04	0.000	0.00	0.00
Endrin	TS03	0.000	0.00	0.00
Endrin	TS02	0.000	0.00	0.00
Endrin	TS01	0.000	0.00	0.00
Heptachlor	TS10	0.000	0.00	0.00
Heptachlor	TS06	0.000	0.00	0.00
Lead	TS13	2.174	0.12	0.01
Lead	TS10	0.783	0.04	0.00
Lead	TS09	0.160	0.01	0.00
Lead	TS08	1.265	0.07	0.01
Lead	TS07	0.563	0.03	0.00
Lead	TS06	0.664	0.04	0.00
Lead	TS05	0.885	0.05	0.01
Lead	TS04	6.715	0.38	0.04
Lead	TS03	0.491	0.03	0.00
Lead	TS02	0.219	0.01	0.00
Lead	TS01	0.899	0.05	0.01
Lead	S-3 Ponds	1.084	0.06	0.01
Lead	Oil Landfarm	1.949	0.11	0.01
Lead	Boneyard/Burnyard	5.283	0.30	0.03
Lead	Burial Ground	0.633	0.04	0.00
Lindane	TS04	0.000	0.00	
Lithium	TS13	0.782	0.04	0.02
Lithium	TS10	0.808	0.04	0.02
Lithium	TS09	0.029	0.00	0.00
Lithium	TS08	0.910	0.04	0.02
Lithium	TS07	0.599	0.03	0.01
Lithium	TS06	0.316	0.02	0.01
Lithium	TS05	0.181	0.01	0.00
Lithium	TS04	1.234	0.06	0.03

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Lithium	TS03	0.913	0.04	0.02
Lithium	TS02	0.624	0.03	0.02
Lithium	TS01	1.203	0.06	0.03
Lithium	Oil Landfarm	1.870	0.09	0.05
Lithium	Boneyard/Burnyard	0.329	0.02	0.01
Lithium	Burial Ground	1.150	0.06	0.03
Manganese	TS13	12.806	0.07	0.02
Manganese	TS10	8.054	0.04	0.01
Manganese	TS09	7.791	0.04	0.01
Manganese	TS08	13.037	0.07	0.02
Manganese	TS07	27.884	0.14	0.04
Manganese	TS06	15.224	0.08	0.02
Manganese	TS05	5.589	0.03	0.01
Manganese	TS04	19.633	0.10	0.03
Manganese	TS03	23.488	0.12	0.04
Manganese	TS02	8.754	0.05	0.01
Manganese	TS01	13.829	0.07	0.02
Mercury	TS13	0.071	1.01	0.20
Mercury	TS10	0.002	0.03	0.01
Mercury	TS09	0.008	0.11	0.02
Mercury	TS08	0.003	0.05	0.01
Mercury	TS07	0.068	0.97	0.19
Mercury	TS06	0.060	0.86	0.17
Mercury	TS05	0.044	0.62	0.12
Mercury	TS04	0.066	0.94	0.19
Mercury	TS03	0.044	0.63	0.13
Mercury	TS02	0.023	0.33	0.07
Mercury	TS01	0.255	3.64	0.72
Mercury	S-3 Ponds	1.594	22.77	4.53
Mercury	Oil Landfarm	0.633	9.04	1.80
Mercury	Boneyard/Burnyard	0.402	5.74	1.14

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Mercury	Burial Ground	0.009	0.13	0.03
Methoxychlor	TS13	0.000	0.00	0.00
Methoxychlor	TS10	0.000	0.00	0.00
Methoxychlor	TS07	0.001	0.00	0.00
Methoxychlor	TS06	0.001	0.00	0.00
Methoxychlor	TS03	0.000	0.00	0.00
Methoxychlor	TS01	0.001	0.00	0.00
Methoxychlor	S-3 Ponds	0.000	0.00	0.00
Mixed-BHC	TS07	0.000	0.00	0.00
Mixed-BHC	TS06	0.000	0.00	0.00
Mixed-BHC	TS04	0.000	0.00	0.00
Mixed-BHC	TS01	0.000	0.00	0.00
Molybdenum	TS09	0.408	1.32	0.13
Molybdenum	TS07	1.648	5.33	0.53
Molybdenum	TS04	1.641	5.31	0.53
Molybdenum	TS03	3.756	12.16	1.21
Molybdenum	TS02	0.262	0.85	0.08
Molybdenum	TS01	0.586	1.90	0.19
Molybdenum	S-3 Ponds	0.007	0.02	0.00
Molybdenum	Oil Landfarm	0.020	0.06	0.01
Molybdenum	Boneyard/Burnyard	0.460	1.49	0.15
Molybdenum	Burial Ground	0.015	0.05	0.00
Nickel	TS13	11.020	0.13	0.06
Nickel	TS10	3.500	0.04	0.02
Nickel	TS09	2.310	0.03	0.01
Nickel	TS08	4.428	0.05	0.03
Nickel	TS07	12.843	0.15	0.07
Nickel	TS06	3.089	0.04	0.02
Nickel	TS05	5.189	0.06	0.03
Nickel	TS04	12.308	0.14	0.07
Nickel	TS03	18.876	0.21	0.11

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Nickel	TS02	1.327	0.02	0.01
Nickel	TS01	3.936	0.04	0.02
Nickel	S-3 Ponds	8.900	0.10	0.05
Nickel	Oil Landfarm	9.523	0.11	0.05
Nickel	Boneyard/Burnyard	9.693	0.11	0.06
Nickel	Burial Ground	6.760	0.08	0.04
PCB-1232	Oil Landfarm	0.002		
PCB-1248	S-3 Ponds	0.000	0.01	0.00
PCB-1248 (	Burial Ground	0.409	9.52	0.96
PCB-1254	TS10	0.073	1.09	0.11
PCB-1254	TS09	0.003	0.04	0.00
PCB-1254	TS07	0.007	0.10	0.01
PCB-1254	TS03	0.009	0.13	0.01
PCB-1254	TS01	0.060	0.90	0.09
PCB-1254	S-3 Ponds	0.006	0.08	0.01
PCB-1254	Oil Landfarm	0.025	0.37	0.04
PCB-1254	Boneyard/Burnyard	0.027	0.41	0.04
PCB-1254	Burial Ground	0.048	0.72	0.07
PCB-1260	TS13	0.049	0.73	0.07
PCB-1260	TS10	0.563	8.41	0.84
PCB-1260	TS09	0.004	0.07	0.01
PCB-1260	TS08	0.145	2.16	0.22
PCB-1260	TS07	0.129	1.92	0.19
PCB-1260	TS06	0.120	1.80	0.18
PCB-1260	TS04	0.008	0.12	0.01
PCB-1260	TS03	0.013	0.20	0.02
PCB-1260	TS02	0.000	0.00	0.00
PCB-1260	TS01	0.015	0.22	0.02
PCB-1260	S-3 Ponds	0.015	0.22	0.02
PCB-1260	Oil Landfarm	0.020	0.30	0.03
PCB-1260	Boneyard/Burnyard	0.023	0.34	0.03

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
PCB-1260	Burial Ground	0.750	11.20	1.12
Selenium	TS13	0.145	1.61	0.16
Selenium	TS10	0.099	1.10	0.11
Selenium	TS09	0.075	0.83	0.08
Selenium	TS08	0.316	3.51	0.35
Selenium	TS07	0.121	1.35	0.13
Selenium	TS06	0.103	1.14	0.11
Selenium	TS05	0.208	2.31	0.23
Selenium	TS04	0.152	1.68	0.17
Selenium	TS03	0.464	5.16	0.51
Selenium	TS02	0.075	0.84	0.08
Selenium	TS01	0.439	4.88	0.49
Selenium	Boneyard/Burnyard	0.310	3.45	0.34
Selenium	Burial Ground	0.051	0.56	0.06
Strontium	TS09	0.000	0.00	
Strontium	TS07	0.297	0.00	
Strontium	TS04	0.272	0.00	
Strontium	TS03	0.157	0.00	
Strontium	TS02	0.138	0.00	
Strontium	TS01	0.224	0.00	
Strontium	Oil Landfarm	0.318	0.00	
Strontium	Boneyard/Burnyard	1.015	0.00	
Strontium	Burial Ground	0.436	0.00	
Tetrachloroethene	S-3 Ponds	0.000	0.00	0.00
Tetrachloroethene	Boneyard/Burnyard	0.000	0.00	0.00
Tetrachloroethene	Burial Ground	0.000	0.00	0.00
Thallium	TS07	0.000	0.00	0.00
Thallium	TS04	0.000	0.00	0.00
Thallium	TS03	0.000	0.00	0.00
Thallium	TS02	0.015	0.93	0.09
Thallium	TS01	0.000	0.00	0.00

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Thallium	S-3 Ponds	0.002	0.13	0.01
Thallium	Oil Landfarm	0.002	0.13	0.01
Thallium	Boneyard/Burnyard	0.003	0.20	0.02
Tin	S-3 Ponds	0.022	0.00	0.00
Tin	Oil Landfarm	0.025	0.00	0.00
Tin	Boneyard/Burnyard	0.385	0.01	0.01
Tin	Burial Ground	0.021	0.00	0.00
Toluene	S-3 Ponds	0.000	0.00	0.00
Toluene	Oil Landfarm	0.000	0.00	0.00
Toluene	Boneyard/Burnyard	0.002	0.00	0.00
Toluene	Burial Ground	0.000	0.00	0.00
Total DDE	Burial Ground	0.000	0.00	0.00
Total DDT	Burial Ground	0.000	0.00	0.00
Total-DDT	TS13	0.000	0.00	0.00
Total-DDT	TS09	0.000	0.00	0.00
Total-DDT	TS08	0.000	0.00	0.00
Total-DDT	TS07	0.000	0.00	0.00
Total-DDT	TS06	0.000	0.00	0.00
Total-DDT	TS05	0.000	0.00	0.00
Total-DDT	TS04	0.000	0.00	0.00
Total-DDT	TS03	0.000	0.00	0.00
Total-DDT	TS01	0.000	0.00	0.00
Trichloroethene	Burial Ground	0.000	0.00	0.00
Uranium	TS09	0.026	0.01	0.00
Uranium	TS07	0.193	0.05	0.03
Uranium	TS04	0.040	0.01	0.01
Uranium	TS03	0.526	0.15	0.07
Uranium	TS02	0.023	0.01	0.00
Uranium	TS01	0.061	0.02	0.01
Uranium	Oil Landfarm	0.000	0.00	0.00
Uranium	Boneyard/Burnyard	0.684	0.19	0.10

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Uranium	Burial Ground	0.000	0.00	0.00
Vanadium	TS13	0.225	0.53	0.05
Vanadium	TS10	0.250	0.58	0.06
Vanadium	TS09	0.124	0.29	0.03
Vanadium	TS08	0.217	0.51	0.05
Vanadium	TS07	0.455	1.06	0.11
Vanadium	TS06	0.201	0.47	0.05
Vanadium	TS05	0.549	1.28	0.13
Vanadium	TS04	0.395	0.92	0.09
Vanadium	TS03	0.685	1.60	0.16
Vanadium	TS02	0.142	0.33	0.03
Vanadium	TS01	0.466	1.09	0.11
Vanadium	S-3 Ponds	0.510	1.19	0.12
Vanadium	Oil Landfarm	0.725	1.69	0.17
Vanadium	Boneyard/Burnyard	0.382	0.89	0.09
Vanadium	Burial Ground	0.599	1.40	0.14
Vinylchloride	Burial Ground	0.000	0.00	0.00
Zinc	TS13	2.809	0.01	0.00
Zinc	TS10	4.785	0.01	0.01
Zinc	TS09	3.489	0.01	0.00
Zinc	TS08	6.391	0.02	0.01
Zinc	TS07	2.995	0.01	0.00
Zinc	TS06	2.811	0.01	0.00
Zinc	TS05	2.844	0.01	0.00
Zinc	TS04	7.458	0.02	0.01
Zinc	TS03	6.690	0.02	0.01
Zinc	TS02	3.530	0.01	0.01
Zinc	TS01	5.650	0.02	0.01
Zinc	S-3 Ponds	6.491	0.02	0.01
Zinc	Oil Landfarm	12.539	0.04	0.02
Zinc	Boneyard/Burnyard	12.732	0.04	0.02

Table G.56 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Zinc	Burial Ground	6.093	0.02	0.01
Zirconium	Oil Landfarm	0.834	0.40	
Zirconium	Boneyard/Burnyard	0.827	0.40	
Zirconium	Burial Ground	0.773	0.37	

Table G.57. Point estimates of contaminant exposure for white-footed mice in the Bear Creek watershed

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
1,1,1-Trichloroethane	Burial Ground	0.000	0.0000	
1,1-Dichloroethene	Burial Ground	0.000	0.0000	
1,2-Dichloroethane	Burial Ground	0.000	0.0000	
1,2-Dichloroethene	Burial Ground	0.000	0.0000	
2,3,7,8-TCDD	Boneyard/Burnyard	0.000	0.02	0.00
2-Butanone	S-3 Ponds	0.000	0.00	0.00
2-Butanone	Burial Ground	0.000	0.00	0.00
4-Methyl-2-pentanone	S-3 Ponds	0.000	0.00	
4-Methyl-2-pentanone	Burial Ground	0.000	0.00	
Acetone	S-3 Ponds	0.003	0.00	0.00
Acetone	Oil Landfarm	0.001	0.00	0.00
Acetone	Boneyard/Burnyard	0.000	0.00	0.00
Acetone	Burial Ground	0.000	0.00	0.00
Aldrin	TS04	0.000	0.00	0.00
Aluminum	TS13	177.352	85.02	8.50
Aluminum	TS10	286.405	137.30	13.73
Aluminum	TS09	97.303	46.65	4.67
Aluminum	TS08	154.718	74.17	7.42
Aluminum	TS07	184.325	88.36	8.84
Aluminum	TS06	94.719	45.41	4.54
Aluminum	TS05	152.559	73.13	7.31
Aluminum	TS04	123.673	59.29	5.93
Aluminum	TS03	193.093	92.57	9.26
Aluminum	TS02	40.622	19.47	1.95
Aluminum	TS01	411.259	197.15	19.72
Aluminum	S-3 Ponds	227.453	109.04	10.91
Aluminum	Oil Landfarm	598.085	286.71	28.68
Aluminum	Boneyard/Burnyard	229.048	109.80	10.98
Aluminum	Burial Ground	496.594	238.06	23.81
Antimony	TS09	0.004	0.03	0.00

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Antimony	TS07	0.006	0.05	0.00
Antimony	TS04	0.009	0.06	0.01
Antimony	TS03	0.007	0.05	0.01
Antimony	TS02	0.003	0.02	0.00
Antimony	TS01	0.011	0.08	0.01
Antimony	S-3 Ponds	0.003	0.02	0.00
Antimony	Oil Landfarm	0.004	0.03	0.00
Antimony	Boneyard/Burnyard	1.236	9.16	0.92
Antimony	Burial Ground	0.005	0.03	0.00
Arsenic	TS13	0.086	0.63	0.06
Arsenic	TS10	0.052	0.39	0.04
Arsenic	TS09	0.037	0.27	0.03
Arsenic	TS08	0.100	0.73	0.07
Arsenic	TS07	0.074	0.55	0.05
Arsenic	TS06	0.033	0.24	0.02
Arsenic	TS05	0.136	1.00	0.10
Arsenic	TS04	0.189	1.39	0.14
Arsenic	TS03	0.149	1.09	0.11
Arsenic	TS02	0.032	0.24	0.02
Arsenic	TS01	0.228	1.68	0.17
Arsenic	S-3 Ponds	0.095	0.70	0.07
Arsenic	Oil Landfarm	0.174	1.28	0.13
Arsenic	Boneyard/Burnyard	0.189	1.39	0.14
Arsenic	Burial Ground	0.154	1.13	0.11
Barium	TS13	3.437	0.32	0.09
Barium	TS10	3.008	0.28	0.08
Barium	TS09	1.781	0.17	0.05
Barium	TS08	1.809	0.17	0.05
Barium	TS07	2.301	0.21	0.06
Barium	TS06	1.693	0.16	0.04
Barium	TS05	2.198	0.20	0.06

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Barium	TS04	6.467	0.60	0.16
Barium	TS03	5.593	0.52	0.14
Barium	TS02	3.306	0.31	0.08
Barium	TS01	3.604	0.34	0.09
Barium	S-3 Ponds	3.386	0.31	0.09
Barium	Oil Landfarm	5.070	0.47	0.13
Barium	Boneyard/Burnyard	2.612	0.24	0.07
Barium	Burial Ground	4.180	0.39	0.11
Benzo(a)pyrene	TS03	0.004	0.00	0.00
Benzo(a)pyrene	TS01	0.001	0.00	0.00
Benzo(a)pyrene	Oil Landfarm	0.008	0.01	0.00
Benzo(a)pyrene	Boneyard/Burnyard	0.059	0.05	0.01
Beryllium	TS13	0.007	0.01	
Beryllium	TS10	0.005	0.00	
Beryllium	TS09	0.003	0.00	
Beryllium	TS08	0.006	0.00	
Beryllium	TS07	0.010	0.01	
Beryllium	TS06	0.005	0.00	
Beryllium	TS05	0.013	0.01	
Beryllium	TS04	0.016	0.01	
Beryllium	TS03	0.014	0.01	
Beryllium	TS02	0.002	0.00	
Beryllium	TS01	0.024	0.02	
Beryllium	S-3 Ponds	0.009	0.01	
Beryllium	Oil Landfarm	0.013	0.01	
Beryllium	Boneyard/Burnyard	0.007	0.01	
Beryllium	Burial Ground	0.011	0.01	
Bis(2-ethylhexyl)phthalate	TS09	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS08	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS07	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS06	0.005	0.00	0.00

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Bis(2-ethylhexyl)phthalate	TS04	0.006	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS03	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS02	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS01	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	Oil Landfarm	0.006	0.00	0.00
Bis(2-ethylhexyl)phthalate	Boneyard/Burnyard	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	Burial Ground	0.002	0.00	0.00
Cadmium	TS10	0.960	59.98	47.98
Cadmium	TS09	0.254	15.89	12.71
Cadmium	TS08	0.371	23.21	18.57
Cadmium	TS07	2.503	156.46	125.17
Cadmium	TS06	1.881	117.58	94.06
Cadmium	TS05	2.582	161.39	129.12
Cadmium	TS04	0.104	6.47	5.18
Cadmium	TS03	1.168	73.02	58.41
Cadmium	TS02	0.154	9.60	7.68
Cadmium	TS01	2.507	156.67	125.33
Cadmium	S-3 Ponds	0.635	39.69	31.76
Cadmium	Oil Landfarm	2.509	156.84	125.47
Cadmium	Boneyard/Burnyard	2.731	170.70	136.56
Chlordane	TS13	0.000	0.00	0.00
Chlordane	TS10	0.000	0.00	0.00
Chlordane	TS09	0.000	0.00	0.00
Chlordane	TS08	0.000	0.00	0.00
Chlordane	TS07	0.000	0.00	0.00
Chlordane	TS06	0.000	0.00	0.00
Chlordane	TS05	0.000	0.00	0.00
Chlordane	TS04	0.000	0.00	0.00
Chlordane	TS03	0.000	0.00	0.00
Chlordane	TS01	0.000	0.00	0.00
Chloroform	TS13	0.000	0.00	0.00

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Chloroform	Oil Landfarm	0.000	0.00	0.00
Chromium	TS13	6.256	0.95	0.24
Chromium	TS10	13.243	2.02	0.50
Chromium	TS09	0.694	0.11	0.03
Chromium	TS08	6.276	0.96	0.24
Chromium	TS07	29.842	4.56	1.14
Chromium	TS06	4.473	0.68	0.17
Chromium	TS05	23.864	3.64	0.91
Chromium	TS04	21.302	3.25	0.81
Chromium	TS03	34.383	5.25	1.31
Chromium	TS02	2.311	0.35	0.09
Chromium	TS01	5.406	0.83	0.21
Chromium	S-3 Ponds	12.939	1.98	0.49
Chromium	Oil Landfarm	19.652	3.00	0.75
Chromium	Boneyard/Burnyard	4.240	0.65	0.16
Chromium	Burial Ground	16.350	2.50	0.62
Chromium VI	Background	0.00	0.00	0.00
Copper	TS13	2.724	0.09	0.07
Copper	TS10	0.765	0.03	0.02
Copper	TS09	0.199	0.01	0.01
Copper	TS08	2.018	0.07	0.05
Copper	TS07	7.512	0.25	0.19
Copper	TS06	0.931	0.03	0.02
Copper	TS05	0.646	0.02	0.02
Copper	TS04	0.865	0.03	0.02
Copper	TS03	1.146	0.04	0.03
Copper	TS02	0.355	0.01	0.01
Copper	TS01	0.983	0.03	0.03
Copper	S-3 Ponds	3.808	0.13	0.10
Copper	Oil Landfarm	8.130	0.27	0.21
Copper	Boneyard/Burnyard	6.002	0.20	0.15

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Copper	Burial Ground	2.328	0.08	0.06
Cyanide	TS10	0.003	0.00	
Cyanide	S-3 Ponds	0.002	0.00	
Cyanide	Boneyard/Burnyard	0.001	0.00	
Cyanide	Burial Ground	0.036	0.00	
Dieldrin	TS10	0.000	0.00	0.00
Dieldrin	TS09	0.000	0.00	0.00
Dieldrin	TS08	0.000	0.00	0.00
Dieldrin	TS07	0.000	0.00	0.00
Dieldrin	TS06	0.000	0.00	0.00
Dieldrin	TS04	0.000	0.00	0.00
Dieldrin	TS03	0.000	0.00	0.00
Dieldrin	TS01	0.000	0.00	0.00
Diethylphthalate	TS04	0.006	0.00	
Diethylphthalate	Boneyard/Burnyard	0.001	0.00	
Di-n-butylphthalate	TS10	0.000	0.00	0.00
Di-n-butylphthalate	TS07	0.004	0.00	0.00
Di-n-butylphthalate	TS06	0.005	0.00	0.00
Di-n-butylphthalate	TS05	0.000	0.00	0.00
Di-n-butylphthalate	TS03	0.001	0.00	0.00
Di-n-butylphthalate	TS01	0.003	0.00	0.00
Di-n-butylphthalate	Oil Landfarm	0.001	0.00	0.00
Di-n-butylphthalate	Boneyard/Burnyard	0.002	0.00	0.00
Di-n-octylphthalate	Burial Ground	0.001		
Endosulfan	TS09	0.000	0.00	
Endosulfan	TS03	0.000	0.00	
Endosulfan	TS01	0.000	0.00	
Endrin	TS13	0.000	0.00	0.00
Endrin	TS10	0.000	0.00	0.00
Endrin	TS09	0.000	0.00	0.00
Endrin	TS08	0.000	0.00	0.00

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Endrin	TS07	0.000	0.00	0.00
Endrin	TS06	0.000	0.00	0.00
Endrin	TS04	0.000	0.00	0.00
Endrin	TS03	0.000	0.00	0.00
Endrin	TS02	0.000	0.00	0.00
Endrin	TS01	0.000	0.00	0.00
Heptachlor	TS10	0.000	0.00	0.00
Heptachlor	TS06	0.000	0.00	0.00
Lead	TS13	2.758	0.17	0.02
Lead	TS10	0.955	0.06	0.01
Lead	TS09	0.154	0.01	0.00
Lead	TS08	1.578	0.10	0.01
Lead	TS07	0.521	0.03	0.00
Lead	TS06	0.770	0.05	0.00
Lead	TS05	1.114	0.07	0.01
Lead	TS04	8.455	0.53	0.05
Lead	TS03	0.356	0.02	0.00
Lead	TS02	0.207	0.01	0.00
Lead	TS01	0.759	0.05	0.00
Lead	S-3 Ponds	1.263	0.08	0.01
Lead	Oil Landfarm	2.270	0.14	0.01
Lead	Boneyard/Burnyard	2.510	0.16	0.02
Lead	Burial Ground	0.737	0.05	0.00
Lead	Background	0.00	0.00	0.00
Lindane	TS04	0.000	0.00	
Lithium	TS13	1.008	0.05	0.03
Lithium	TS10	1.063	0.06	0.03
Lithium	TS09	0.075	0.00	0.00
Lithium	TS08	1.150	0.06	0.03
Lithium	TS07	0.352	0.02	0.01
Lithium	TS06	0.364	0.02	0.01

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Lithium	TS05	0.214	0.01	0.01
Lithium	TS04	0.690	0.04	0.02
Lithium	TS03	0.961	0.05	0.03
Lithium	TS02	0.835	0.04	0.02
Lithium	TS01	0.669	0.04	0.02
Lithium	Oil Landfarm	2.172	0.12	0.06
Lithium	Boneyard/Burnyard	0.352	0.02	0.01
Lithium	Burial Ground	1.335	0.07	0.04
Manganese	TS13	17.741	0.10	0.03
Manganese	TS10	8.857	0.05	0.02
Manganese	TS09	9.442	0.05	0.02
Manganese	TS08	16.828	0.10	0.03
Manganese	TS07	21.048	0.12	0.04
Manganese	TS06	13.077	0.07	0.02
Manganese	TS05	7.078	0.04	0.01
Manganese	TS04	17.903	0.10	0.03
Manganese	TS03	16.984	0.10	0.03
Manganese	TS02	5.521	0.03	0.01
Manganese	TS01	12.198	0.07	0.02
Mercury	TS13	0.092	1.44	0.29
Mercury	TS10	0.001	0.01	0.00
Mercury	TS09	0.012	0.18	0.04
Mercury	TS08	0.001	0.02	0.00
Mercury	TS07	0.074	1.16	0.23
Mercury	TS06	0.072	1.12	0.22
Mercury	TS05	0.056	0.88	0.18
Mercury	TS04	0.087	1.35	0.27
Mercury	TS03	0.045	0.70	0.14
Mercury	TS02	0.020	0.32	0.06
Mercury	TS01	0.155	2.43	0.49
Mercury	S-3 Ponds	1.961	30.64	6.13

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Mercury	Oil Landfarm	0.779	12.17	2.43
Mercury	Boneyard/Burnyard	0.230	3.60	0.72
Mercury	Burial Ground	0.011	0.18	0.04
Mercury	Background	0.00	0.02	0.00
Methoxychlor	TS13	0.000	0.00	0.00
Methoxychlor	TS10	0.000	0.00	0.00
Methoxychlor	TS07	0.000	0.00	0.00
Methoxychlor	TS06	0.000	0.00	0.00
Methoxychlor	TS03	0.000	0.00	0.00
Methoxychlor	TS01	0.000	0.00	0.00
Methoxychlor	S-3 Ponds	0.000	0.00	0.00
Mixed-BHC	TS07	0.000	0.00	0.00
Mixed-BHC	TS06	0.000	0.00	0.00
Mixed-BHC	TS04	0.000	0.00	0.00
Mixed-BHC	TS01	0.000	0.00	0.00
Molybdenum	TS09	0.533	1.90	0.19
Molybdenum	TS07	2.141	7.62	0.76
Molybdenum	TS04	2.163	7.70	0.77
Molybdenum	TS03	4.859	17.29	1.73
Molybdenum	TS02	0.377	1.34	0.13
Molybdenum	TS01	0.776	2.76	0.28
Molybdenum	S-3 Ponds	0.003	0.01	0.00
Molybdenum	Oil Landfarm	0.008	0.03	0.00
Molybdenum	Boneyard/Burnyard	0.870	3.10	0.31
Molybdenum	Burial Ground	0.006	0.02	0.00
Nickel	TS13	14.202	0.18	0.09
Nickel	TS10	4.488	0.06	0.03
Nickel	TS09	2.972	0.04	0.02
Nickel	TS08	5.683	0.07	0.04
Nickel	TS07	16.224	0.20	0.10
Nickel	TS06	3.855	0.05	0.02

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Nickel	TS05	6.667	0.08	0.04
Nickel	TS04	15.611	0.20	0.10
Nickel	TS03	23.847	0.30	0.15
Nickel	TS02	1.627	0.02	0.01
Nickel	TS01	4.365	0.05	0.03
Nickel	S-3 Ponds	11.319	0.14	0.07
Nickel	Oil Landfarm	12.111	0.15	0.08
Nickel	Boneyard/Burnyard	5.894	0.07	0.04
Nickel	Burial Ground	8.597	0.11	0.05
Nickel	Background	0.00	0.00	0.00
PCB-1232	Oil Landfarm	0.001		
PCB-1248	S-3 Ponds	0.000	0.00	0.00
PCB-1248	Burial Ground	0.162	4.16	0.42
PCB-1254	TS10	0.092	1.50	0.15
PCB-1254	TS09	0.004	0.06	0.01
PCB-1254	TS07	0.003	0.05	0.00
PCB-1254	TS03	0.012	0.19	0.02
PCB-1254	TS01	0.059	0.97	0.10
PCB-1254	S-3 Ponds	0.006	0.11	0.01
PCB-1254	Oil Landfarm	0.029	0.48	0.05
PCB-1254	Boneyard/Burnyard	0.017	0.28	0.03
PCB-1254	Burial Ground	0.056	0.92	0.09
PCB-1260	TS13	0.062	1.02	0.10
PCB-1260	TS10	0.721	11.83	1.19
PCB-1260	TS09	0.006	0.09	0.01
PCB-1260	TS08	0.186	3.05	0.31
PCB-1260	TS07	0.137	2.24	0.23
PCB-1260	TS06	0.148	2.43	0.24
PCB-1260	TS04	0.003	0.05	0.01
PCB-1260	TS03	0.015	0.24	0.02
PCB-1260	TS02	0.000	0.00	0.00

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
PCB-1260	TS01	0.015	0.25	0.02
PCB-1260	S-3 Ponds	0.019	0.31	0.03
PCB-1260	Oil Landfarm	0.025	0.41	0.04
PCB-1260	Boneyard/Burnyard	0.026	0.42	0.04
PCB-1260	Burial Ground	0.945	15.49	1.56
Selenium	TS13	0.179	2.18	0.22
Selenium	TS10	0.119	1.46	0.15
Selenium	TS09	0.099	1.21	0.12
Selenium	TS08	0.405	4.94	0.49
Selenium	TS07	0.144	1.76	0.18
Selenium	TS06	0.126	1.54	0.15
Selenium	TS05	0.263	3.20	0.32
Selenium	TS04	0.172	2.10	0.21
Selenium	TS03	0.575	7.02	0.70
Selenium	TS02	0.080	0.98	0.10
Selenium	TS01	0.545	6.64	0.66
Selenium	Boneyard/Burnyard	0.200	2.44	0.24
Selenium	Burial Ground	0.061	0.75	0.07
Selenium	Background	0.00	0.00	0.00
Strontium	TS09	0.364	0.00	
Strontium	TS07	0.661	0.00	
Strontium	TS04	0.773	0.00	
Strontium	TS03	0.434	0.00	
Strontium	TS02	0.505	0.00	
Strontium	TS01	0.754	0.00	
Strontium	Oil Landfarm	0.126	0.00	
Strontium	Boneyard/Burnyard	1.435	0.00	
Strontium	Burial Ground	0.173	0.00	
Tetrachloroethene	S-3 Ponds	0.000	0.00	0.00
Tetrachloroethene	Boneyard/Burnyard	0.000	0.00	0.00
Tetrachloroethene	Burial Ground	0.000	0.00	0.00

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Thallium	TS07	0.000	0.00	0.00
Thallium	TS04	0.000	0.00	0.00
Thallium	TS03	0.000	0.00	0.00
Thallium	TS02	0.009	0.60	0.06
Thallium	TS01	0.001	0.05	0.01
Thallium	S-3 Ponds	0.001	0.07	0.01
Thallium	Oil Landfarm	0.001	0.07	0.01
Thallium	Boneyard/Burnyard	0.002	0.12	0.01
Tallium	Background	0.00	0.00	0.00
Tin	S-3 Ponds	0.009	0.00	0.00
Tin	Oil Landfarm	0.010	0.00	0.00
Tin	Boneyard/Burnyard	0.152	0.01	0.00
Tin	Burial Ground	0.008	0.00	0.00
Toluene	S-3 Ponds	0.000	0.00	0.00
Toluene	Oil Landfarm	0.000	0.00	0.00
Toluene	Boneyard/Burnyard	0.001	0.00	0.00
Toluene	Burial Ground	0.000	0.00	0.00
Total DDE	Burial Ground	0.000	0.00	0.00
Total DDT	Burial Ground	0.000	0.00	0.00
Total-DDT	TS13	0.000	0.00	0.00
Total-DDT	TS09	0.000	0.00	0.00
Total-DDT	TS08	0.000	0.00	0.00
Total-DDT	TS07	0.000	0.00	0.00
Total-DDT	TS06	0.000	0.00	0.00
Total-DDT	TS05	0.000	0.00	0.00
Total-DDT	TS04	0.000	0.00	0.00
Total-DDT	TS03	0.000	0.00	0.00
Total-DDT	TS01	0.000	0.00	0.00
Trichloroethene	Burial Ground	0.000	0.00	0.00
Uranium	TS09	0.033	0.01	0.01
Uranium	TS07	0.270	0.08	0.04

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Uranium	TS04	0.115	0.04	0.02
Uranium	TS03	0.748	0.23	0.12
Uranium	TS02	0.041	0.01	0.01
Uranium	TS01	0.116	0.04	0.02
Uranium	Oil Landfarm	0.000	0.00	0.00
Uranium	Boneyard/Burnyard	1.069	0.33	0.16
Uranium	Burial Ground	0.000	0.00	0.00
Uranium	Background	0.00	0.00	0.00
Vanadium	TS13	0.225	0.58	0.06
Vanadium	TS10	0.311	0.80	0.08
Vanadium	TS09	0.123	0.32	0.03
Vanadium	TS08	0.221	0.57	0.06
Vanadium	TS07	0.406	1.04	0.10
Vanadium	TS06	0.192	0.49	0.05
Vanadium	TS05	0.840	2.16	0.22
Vanadium	TS04	0.290	0.75	0.07
Vanadium	TS03	0.517	1.33	0.13
Vanadium	TS02	0.106	0.27	0.03
Vanadium	TS01	0.433	1.11	0.11
Vanadium	S-3 Ponds	0.507	1.30	0.13
Vanadium	Oil Landfarm	0.721	1.85	0.19
Vanadium	Boneyard/Burnyard	0.192	0.49	0.05
Vanadium	Burial Ground	0.595	1.53	0.15
Vinylchloride	Burial Ground	0.000	0.00	0.00
Zinc	TS13	4.456	0.01	0.01
Zinc	TS10	7.857	0.02	0.01
Zinc	TS09	5.486	0.02	0.01
Zinc	TS08	10.450	0.03	0.02
Zinc	TS07	4.368	0.01	0.01
Zinc	TS06	4.459	0.01	0.01
Zinc	TS05	4.576	0.01	0.01

Table G.57 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Zinc	TS04	9.377	0.03	0.01
Zinc	TS03	9.214	0.03	0.01
Zinc	TS02	6.280	0.02	0.01
Zinc	TS01	7.521	0.02	0.01
Zinc	S-3 Ponds	10.286	0.03	0.02
Zinc	Oil Landfarm	19.870	0.06	0.03
Zinc	Boneyard/Burnyard	14.204	0.04	0.02
Zinc	Burial Ground	9.655	0.03	0.02
Zinc	Background	0.00	0.00	0.00
Zirconium	Oil Landfarm	0.331	0.18	
Zirconium	Boneyard/Burnyard	0.328	0.18	
Zirconium	Burial Ground	0.306	0.17	

Table G.58. Point estimates of contaminant exposure for white-tailed deer in the Bear Creek watershed

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
1,1,1-Trichloroethane	Burial Ground	0.000	0.00	
1,1-Dichloroethene	Burial Ground	0.000	0.00	
1,2-Dichloroethane	Burial Ground	0.000	0.00	
1,2-Dichloroethene	Burial Ground	0.000	0.00	
2378-TCDD	Boneyard/Burnyard	0.000	0.02	0.00
2-Butanone	S-3 Ponds	0.000	0.00	0.00
2-Butanone	Burial Ground	0.000	0.00	0.00
4-Methyl-2-pentanone	S-3 Ponds	0.000	0.00	
4-Methyl-2-pentanone	Burial Ground	0.000	0.00	
Acetone	S-3 Ponds	0.001	0.00	0.00
Acetone	Oil Landfarm	0.000	0.00	0.00
Acetone	Boneyard/Burnyard	0.000	0.00	0.00
Acetone	Burial Ground	0.000	0.00	0.00
Aldrin	TS04	0.000	0.00	0.00
Aluminum	TS13	11.719	40.00	4.00
Aluminum	TS10	15.769	53.82	5.38
Aluminum	TS09	11.688	39.89	3.99
Aluminum	TS08	11.169	38.12	3.81
Aluminum	TS07	19.634	67.01	6.70
Aluminum	TS06	7.799	26.62	2.66
Aluminum	TS05	9.166	31.28	3.13
Aluminum	TS04	15.988	54.57	5.46
Aluminum	TS03	18.995	64.83	6.48
Aluminum	TS02	6.421	21.91	2.19
Aluminum	TS01	56.886	194.15	19.41
Aluminum	S-3 Ponds	18.843	64.31	6.43
Aluminum	Oil Landfarm	49.547	169.10	16.91
Aluminum	Boneyard/Burnyard	27.683	94.48	9.45
Aluminum	Burial Ground	41.139	140.41	14.04
Antimony	TS09	0.000	0.02	0.00

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Antimony	TS07	0.001	0.03	0.00
Antimony	TS04	0.000	0.02	0.00
Antimony	TS03	0.000	0.02	0.00
Antimony	TS02	0.002	0.11	0.01
Antimony	TS01	0.000	0.02	0.00
Antimony	S-3 Ponds	0.000	0.02	0.00
Antimony	Oil Landfarm	0.001	0.03	0.00
Antimony	Boneyard/Burnyard	0.238	12.55	1.25
Antimony	Burial Ground	0.001	0.04	0.00
Arsenic	TS13	0.006	0.29	0.03
Arsenic	TS10	0.004	0.20	0.02
Arsenic	TS09	0.003	0.17	0.02
Arsenic	TS08	0.007	0.35	0.04
Arsenic	TS07	0.005	0.25	0.02
Arsenic	TS06	0.003	0.15	0.01
Arsenic	TS05	0.008	0.40	0.04
Arsenic	TS04	0.032	1.70	0.17
Arsenic	TS03	0.015	0.79	0.08
Arsenic	TS02	0.007	0.36	0.04
Arsenic	TS01	0.037	1.96	0.20
Arsenic	S-3 Ponds	0.008	0.42	0.04
Arsenic	Oil Landfarm	0.015	0.77	0.08
Arsenic	Boneyard/Burnyard	0.018	0.96	0.10
Arsenic	Burial Ground	0.013	0.69	0.07
Barium	TS13	0.746	0.49	0.13
Barium	TS10	0.654	0.43	0.12
Barium	TS09	0.463	0.31	0.08
Barium	TS08	0.391	0.26	0.07
Barium	TS07	0.652	0.43	0.12
Barium	TS06	0.365	0.24	0.07
Barium	TS05	0.476	0.32	0.09

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Barium	TS04	0.431	0.29	0.08
Barium	TS03	0.689	0.46	0.12
Barium	TS02	0.679	0.45	0.12
Barium	TS01	0.715	0.47	0.13
Barium	S-3 Ponds	0.731	0.40	0.13
Barium	Oil Landfarm	1.095	0.72	0.20
Barium	Boneyard/Burnyard	0.990	0.65	0.18
Barium	Burial Ground	0.903	0.60	0.16
Benzo(a)pyrene	TS03	0.001	0.01	0.00
Benzo(a)pyrene	TS01	0.000	0.00	0.00
Benzo(a)pyrene	Oil Landfarm	0.002	0.01	0.00
Benzo(a)pyrene	Boneyard/Burnyard	0.012	0.08	0.01
Beryllium	TS13	0.001	0.00	
Beryllium	TS10	0.001	0.00	
Beryllium	TS09	0.001	0.00	
Beryllium	TS08	0.001	0.00	
Beryllium	TS07	0.001	0.01	
Beryllium	TS06	0.001	0.00	
Beryllium	TS05	0.001	0.01	
Beryllium	TS04	0.002	0.01	
Beryllium	TS03	0.001	0.00	
Beryllium	TS02	0.000	0.00	
Beryllium	TS01	0.004	0.02	
Beryllium	S-3 Ponds	0.001	0.01	
Beryllium	Oil Landfarm	0.002	0.01	
Beryllium	Boneyard/Burnyard	0.001	0.00	
Beryllium	Burial Ground	0.001	0.01	
Bis(2-ethylhexyl)phthalate	TS09	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS08	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS07	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS06	0.001	0.00	0.00

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Bis(2-ethylhexyl)phthalate	TS04	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS03	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS02	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS01	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	Oil Landfarm	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	Boneyard/Burnyard	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	Burial Ground	0.000	0.00	0.00
Cadmium	TS10	0.033	16.34	10.89
Cadmium	TS09	0.028	14.02	9.35
Cadmium	TS08	0.013	6.32	4.21
Cadmium	TS07	0.042	21.17	14.11
Cadmium	TS06	0.065	32.72	21.82
Cadmium	TS05	0.088	43.76	29.17
Cadmium	TS04	0.002	0.81	0.54
Cadmium	TS03	0.031	15.67	10.45
Cadmium	TS02	0.009	4.46	2.97
Cadmium	TS01	0.029	14.58	9.72
Cadmium	S-3 Ponds	0.022	10.85	7.24
Cadmium	Oil Landfarm	0.086	42.89	28.59
Cadmium	Boneyard/Burnyard	0.060	30.25	20.16
Chlordane	TS13	0.000	0.00	0.00
Chlordane	TS10	0.000	0.00	0.00
Chlordane	TS09	0.000	0.00	0.00
Chlordane	TS08	0.000	0.00	0.00
Chlordane	TS07	0.000	0.00	0.00
Chlordane	TS06	0.000	0.00	0.00
Chlordane	TS05	0.000	0.00	0.00
Chlordane	TS04	0.000	0.00	0.00
Chlordane	TS03	0.000	0.00	0.00
Chlordane	TS01	0.000	0.00	0.00
Chloroform	TS13	0.000	0.00	0.00

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Chloroform	Oil Landfarm	0.000	0.00	0.00
Chromium	TS13	0.031	0.03	0.01
Chromium	TS10	0.058	0.06	0.02
Chromium	TS09	0.023	0.02	0.01
Chromium	TS08	0.033	0.04	0.01
Chromium	TS07	0.044	0.05	0.01
Chromium	TS06	0.026	0.03	0.01
Chromium	TS05	0.101	0.11	0.03
Chromium	TS04	0.046	0.05	0.01
Chromium	TS03	0.057	0.06	0.02
Chromium	TS02	0.033	0.04	0.01
Chromium	TS01	0.087	0.10	0.02
Chromium	S-3 Ponds	0.071	0.08	0.02
Chromium	Oil Landfarm	0.108	0.12	0.03
Chromium	Boneyard/Burnyard	0.074	0.08	0.02
Chromium	Burial Ground	0.090	0.10	0.02
Copper	TS13	0.164	0.04	0.03
Copper	TS10	0.048	0.01	0.01
Copper	TS09	0.086	0.02	0.02
Copper	TS08	0.122	0.03	0.02
Copper	TS07	0.099	0.02	0.02
Copper	TS06	0.059	0.01	0.01
Copper	TS05	0.040	0.01	0.01
Copper	TS04	0.104	0.02	0.02
Copper	TS03	0.127	0.03	0.02
Copper	TS02	0.074	0.02	0.01
Copper	TS01	0.180	0.04	0.03
Copper	S-3 Ponds	0.237	0.06	0.04
Copper	Oil Landfarm	0.506	0.12	0.09
Copper	Boneyard/Burnyard	1.084	0.25	0.20
Copper	Burial Ground	0.145	0.03	0.03

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Cyanide	TS10	0.001	0.00	
Cyanide	S-3 Ponds	0.000	0.00	
Cyanide	Boneyard/Burnyard	0.000	0.00	
Cyanide	Burial Ground	0.007	0.00	
Dieldrin	TS10	0.000	0.00	0.00
Dieldrin	TS09	0.000	0.00	0.00
Dieldrin	TS08	0.000	0.00	0.00
Dieldrin	TS07	0.000	0.00	0.00
Dieldrin	TS06	0.000	0.00	0.00
Dieldrin	TS04	0.000	0.00	0.00
Dieldrin	TS03	0.000	0.00	0.00
Dieldrin	TS01	0.000	0.00	0.00
Diethylphthalate	TS04	0.001	0.00	
Diethylphthalate	Boneyard/Burnyard	0.000	0.00	
Di-n-butylphthalate	TS10	0.000	0.00	0.00
Di-n-butylphthalate	TS07	0.001	0.00	0.00
Di-n-butylphthalate	TS06	0.001	0.00	0.00
Di-n-butylphthalate	TS05	0.000	0.00	0.00
Di-n-butylphthalate	TS03	0.000	0.00	0.00
Di-n-butylphthalate	TS01	0.001	0.00	0.00
Di-n-butylphthalate	Oil Landfarm	0.000	0.00	0.00
Di-n-butylphthalate	Boneyard/Burnyard	0.000	0.00	0.00
Di-n-octylphthalate	Burial Ground	0.000		
Endosulfan	TS09	0.000	0.00	
Endosulfan	TS03	0.000	0.00	
Endosulfan	TS01	0.000	0.00	
Endrin	TS13	0.000	0.00	0.00
Endrin	TS10	0.000	0.00	0.00
Endrin	TS09	0.000	0.00	0.00
Endrin	TS08	0.000	0.00	0.00
Endrin	TS07	0.000	0.01	0.00

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Endrin	TS06	0.000	0.00	0.00
Endrin	TS04	0.000	0.00	0.00
Endrin	TS03	0.000	0.00	0.00
Endrin	TS02	0.000	0.00	0.00
Endrin	TS01	0.000	0.00	0.00
Heptachlor	TS10	0.000	0.00	0.00
Heptachlor	TS06	0.000	0.00	0.00
Lead	TS13	0.069	0.03	0.00
Lead	TS10	0.027	0.01	0.00
Lead	TS09	0.031	0.01	0.00
Lead	TS08	0.041	0.02	0.00
Lead	TS07	0.039	0.02	0.00
Lead	TS06	0.025	0.01	0.00
Lead	TS05	0.028	0.01	0.00
Lead	TS04	0.062	0.03	0.00
Lead	TS03	0.041	0.02	0.00
Lead	TS02	0.049	0.02	0.00
Lead	TS01	0.052	0.02	0.00
Lead	S-3 Ponds	0.040	0.02	0.00
Lead	Oil Landfarm	0.073	0.03	0.00
Lead	Boneyard/Burnyard	0.409	0.18	0.02
Lead	Burial Ground	0.024	0.01	0.00
Lindane	TS04	0.000	0.00	
Lithium	TS13	0.021	0.01	0.00
Lithium	TS10	0.020	0.01	0.00
Lithium	TS09	0.006	0.00	0.00
Lithium	TS08	0.025	0.01	0.00
Lithium	TS07	0.048	0.02	0.01
Lithium	TS06	0.011	0.00	0.00
Lithium	TS05	0.006	0.00	0.00
Lithium	TS04	0.132	0.05	0.03

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Lithium	TS03	0.028	0.01	0.01
Lithium	TS02	0.005	0.00	0.00
Lithium	TS01	0.092	0.04	0.02
Lithium	Oil Landfarm	0.063	0.02	0.01
Lithium	Boneyard/Burnyard	0.055	0.02	0.01
Lithium	Burial Ground	0.039	0.01	0.01
Manganese	TS13	8.069	0.33	0.10
Manganese	TS10	3.793	0.15	0.05
Manganese	TS09	8.870	0.36	0.11
Manganese	TS08	7.528	0.30	0.09
Manganese	TS07	5.423	0.22	0.07
Manganese	TS06	5.127	0.21	0.06
Manganese	TS05	3.151	0.13	0.04
Manganese	TS04	7.569	0.31	0.10
Manganese	TS03	5.170	0.21	0.06
Manganese	TS02	5.354	0.22	0.07
Manganese	TS01	2.058	0.08	0.03
Mercury	TS13	0.002	0.24	0.05
Mercury	TS10	0.000	0.02	0.00
Mercury	TS09	0.001	0.08	0.02
Mercury	TS08	0.000	0.03	0.01
Mercury	TS07	0.002	0.21	0.04
Mercury	TS06	0.002	0.24	0.05
Mercury	TS05	0.001	0.15	0.03
Mercury	TS04	0.001	0.09	0.02
Mercury	TS03	0.002	0.23	0.05
Mercury	TS02	0.002	0.18	0.04
Mercury	TS01	0.017	1.92	0.38
Mercury	S-3 Ponds	0.055	6.11	1.22
Mercury	Oil Landfarm	0.022	2.43	0.49
Mercury	Boneyard/Burnyard	0.030	3.35	0.67

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Mercury	Burial Ground	0.000	0.04	0.01
Methoxychlor	TS13	0.000	0.00	0.00
Methoxychlor	TS10	0.000	0.00	0.00
Methoxychlor	TS07	0.000	0.00	0.00
Methoxychlor	TS06	0.000	0.00	0.00
Methoxychlor	TS03	0.000	0.00	0.00
Methoxychlor	TS01	0.000	0.00	0.00
Methoxychlor	S-3 Ponds	0.000	0.00	0.00
Mixed-BHC	TS07	0.000	0.00	0.00
Mixed-BHC	TS06	0.000	0.00	0.00
Mixed-BHC	TS04	0.000	0.00	0.00
Mixed-BHC	TS01	0.000	0.00	0.00
Molybdenum	TS09	0.002	0.05	0.00
Molybdenum	TS07	0.004	0.11	0.01
Molybdenum	TS04	0.017	0.44	0.04
Molybdenum	TS03	0.004	0.11	0.01
Molybdenum	TS02	0.006	0.16	0.02
Molybdenum	TS01	0.008	0.21	0.02
Molybdenum	S-3 Ponds	0.001	0.01	0.00
Molybdenum	Oil Landfarm	0.002	0.04	0.00
Molybdenum	Boneyard/Burnyard	0.099	2.53	0.25
Molybdenum	Burial Ground	0.001	0.03	0.00
Nickel	TS13	0.115	0.01	0.01
Nickel	TS10	0.038	0.00	0.00
Nickel	TS09	0.063	0.01	0.00
Nickel	TS08	0.048	0.00	0.00
Nickel	TS07	0.067	0.01	0.00
Nickel	TS06	0.042	0.00	0.00
Nickel	TS05	0.056	0.00	0.00
Nickel	TS04	0.033	0.00	0.00
Nickel	TS03	0.073	0.01	0.00

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Nickel	TS02	0.050	0.00	0.00
Nickel	TS01	0.113	0.01	0.01
Nickel	S-3 Ponds	0.105	0.01	0.00
Nickel	Oil Landfarm	0.112	0.01	0.00
Nickel	Boneyard/Burnyard	0.649	0.06	0.03
Nickel	Burial Ground	0.079	0.01	0.00
PCB-1232	Oil Landfarm	0.000		
PCB-1248	S-3 Ponds	0.000	0.00	0.00
PCB-1248	Burial Ground	0.032	6.46	0.59
PCB-1254	TS10	0.000	0.03	0.00
PCB-1254	TS09	0.000	0.00	0.00
PCB-1254	TS07	0.001	0.06	0.01
PCB-1254	TS03	0.000	0.00	0.00
PCB-1254	TS01	0.002	0.18	0.02
PCB-1254	S-3 Ponds	0.000	0.01	0.00
PCB-1254	Oil Landfarm	0.000	0.03	0.00
PCB-1254	Boneyard/Burnyard	0.002	0.18	0.02
PCB-1254	Burial Ground	0.001	0.06	0.01
PCB-1260	TS13	0.000	0.01	0.00
PCB-1260	TS10	0.000	0.04	0.00
PCB-1260	TS09	0.000	0.00	0.00
PCB-1260	TS08	0.000	0.01	0.00
PCB-1260	TS07	0.003	0.29	0.03
PCB-1260	TS06	0.001	0.07	0.01
PCB-1260	TS04	0.001	0.07	0.01
PCB-1260	TS03	0.000	0.02	0.00
PCB-1260	TS02	0.000	0.00	0.00
PCB-1260	TS01	0.000	0.04	0.00
PCB-1260	S-3 Ponds	0.000	0.00	0.00
PCB-1260	Oil Landfarm	0.000	0.01	0.00
PCB-1260	Boneyard/Burnyard	0.000	0.04	0.00

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
PCB-1260	Burial Ground	0.002	0.21	0.02
Selenium	TS13	0.007	0.59	0.06
Selenium	TS10	0.005	0.41	0.04
Selenium	TS09	0.002	0.15	0.02
Selenium	TS08	0.015	1.25	0.13
Selenium	TS07	0.011	0.94	0.10
Selenium	TS06	0.005	0.42	0.04
Selenium	TS05	0.010	0.83	0.09
Selenium	TS04	0.003	0.26	0.03
Selenium	TS03	0.003	0.26	0.03
Selenium	TS02	0.003	0.25	0.03
Selenium	TS01	0.016	1.34	0.14
Selenium	Boneyard/Burnyard	0.019	1.57	0.16
Selenium	Burial Ground	0.003	0.21	0.02
Strontium	TS09	0.176	0.00	
Strontium	TS07	0.289	0.00	
Strontium	TS04	0.269	0.00	
Strontium	TS03	0.289	0.00	
Strontium	TS02	0.282	0.00	
Strontium	TS01	0.330	0.00	
Strontium	Oil Landfarm	0.025	0.00	
Strontium	Boneyard/Burnyard	0.545	0.01	
Strontium	Burial Ground	0.034	0.00	
Tetrachloroethene	S-3 Ponds	0.000	0.00	0.00
Tetrachloroethene	Boneyard/Burnyard	0.000	0.00	0.00
Tetrachloroethene	Burial Ground	0.000	0.00	0.00
Thallium	TS07	0.000	0.00	0.00
Thallium	TS04	0.000	0.15	0.01
Thallium	TS03	0.000	0.00	0.00
Thallium	TS02	0.002	0.84	0.08
Thallium	TS01	0.014	6.91	0.66

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Thallium	S-3 Ponds	0.004	2.08	0.20
Thallium	Oil Landfarm	0.004	2.01	0.19
Thallium	Boneyard/Burnyard	0.000	0.10	0.01
Tin	S-3 Ponds	0.002	0.00	0.00
Tin	Oil Landfarm	0.002	0.00	0.00
Tin	Boneyard/Burnyard	0.030	0.01	0.01
Tin	Burial Ground	0.002	0.00	0.00
Toluene	S-3 Ponds	0.000	0.00	0.00
Toluene	Oil Landfarm	0.000	0.00	0.00
Toluene	Boneyard/Burnyard	0.000	0.00	0.00
Toluene	Burial Ground	0.000	0.00	0.00
Total DDE	Burial Ground	0.000	0.00	0.00
Total DDT	Burial Ground	0.000	0.00	0.00
Total-DDT	TS13	0.000	0.00	0.00
Total-DDT	TS09	0.000	0.00	0.00
Total-DDT	TS08	0.000	0.00	0.00
Total-DDT	TS07	0.000	0.00	0.00
Total-DDT	TS06	0.000	0.00	0.00
Total-DDT	TS05	0.000	0.00	0.00
Total-DDT	TS04	0.000	0.00	0.00
Total-DDT	TS03	0.000	0.00	0.00
Total-DDT	TS01	0.000	0.00	0.00
Trichloroethene	Burial Ground	0.000	0.00	0.00
Uranium	TS09	0.000	0.00	0.00
Uranium	TS07	0.009	0.02	0.01
Uranium	TS04	0.012	0.03	0.01
Uranium	TS03	0.011	0.02	0.01
Uranium	TS02	0.002	0.00	0.00
Uranium	TS01	0.006	0.01	0.01
Uranium	Oil Landfarm	0.000	0.00	0.00
Uranium	Boneyard/Burnyard	0.036	0.08	0.04

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Uranium	Burial Ground	0.000	0.00	0.00
Vanadium	TS13	0.026	0.47	0.05
Vanadium	TS10	0.032	0.59	0.06
Vanadium	TS09	0.020	0.36	0.04
Vanadium	TS08	0.025	0.46	0.05
Vanadium	TS07	0.026	0.47	0.05
Vanadium	TS06	0.023	0.41	0.04
Vanadium	TS05	0.080	1.46	0.15
Vanadium	TS04	0.019	0.35	0.04
Vanadium	TS03	0.054	0.99	0.10
Vanadium	TS02	0.024	0.44	0.04
Vanadium	TS01	0.050	0.91	0.09
Vanadium	S-3 Ponds	0.058	1.06	0.11
Vanadium	Oil Landfarm	0.083	1.51	0.15
Vanadium	Boneyard/Burnyard	0.036	0.65	0.07
Vanadium	Burial Ground	0.069	1.25	0.13
Vinylchloride	Burial Ground	0.000	0.00	0.00
Zinc	TS13	0.388	0.01	0.00
Zinc	TS10	0.674	0.02	0.01
Zinc	TS09	0.625	0.01	0.01
Zinc	TS08	0.898	0.02	0.01
Zinc	TS07	0.576	0.01	0.01
Zinc	TS06	0.388	0.01	0.00
Zinc	TS05	0.396	0.01	0.00
Zinc	TS04	0.620	0.01	0.01
Zinc	TS03	0.578	0.01	0.01
Zinc	TS02	0.665	0.01	0.01
Zinc	TS01	0.600	0.01	0.01
Zinc	S-3 Ponds	0.895	0.02	0.01
Zinc	Oil Landfarm	1.730	0.04	0.02
Zinc	Boneyard/Burnyard	6.235	0.14	0.07

Table G.58 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Zinc	Burial Ground	0.840	0.02	0.01
Zirconium	Oil Landfarm	0.066	0.25	
Zirconium	Boneyard/Burnyard	0.065	0.25	
Zirconium	Burial Ground	0.061	0.23	

**Table G.59. Point estimates of contaminant exposure
for red fox in Bear Creek watershed**

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
1,1-Dichloroethene	Burial Ground	0.000	0.00	
1,1,1-Trichloroethane	Burial Ground	0.000	0.00	
1,2-Dichloroethane	Burial Ground	0.000	0.00	
1,2-Dichloroethene	Burial Ground	0.000	0.00	
2378-TCDD	Boneyard/Burnyard	0.000	0.05	0.01
Acetone	S-3 Ponds	0.002	0.00	0.00
Acetone	Boneyard/Burnyard	0.000	0.00	0.00
Acetone	Oil Land Farm	0.001	0.00	0.00
Acetone	Burial Ground	0.000	0.00	0.00
Aldrin	TS04	0.000	0.00	0.00
Aluminum	S-3 Ponds	200.992	364.78	36.44
Aluminum	TS01	244.024	442.87	44.25
Aluminum	Creekside	186.524	338.52	33.82
Aluminum	Bear Creek Roadside	70.034	127.10	12.70
Aluminum	Boneyard/Burnyard	123.713	224.52	22.43
Aluminum	Oil Land Farm	528.506	959.18	95.83
Aluminum	TS02	27.394	49.72	4.97
Aluminum	TS03	76.201	138.30	13.82
Aluminum	Burial Ground	438.822	796.41	79.57
Aluminum	TS04	70.393	127.75	12.76
Aluminum	TS05	134.149	243.46	24.32
Aluminum	TS06	83.691	151.89	15.18
Aluminum	TS07	73.980	134.26	13.41
Aluminum	TS08	136.404	247.56	24.73
Aluminum	TS09	106.412	193.13	19.30
Aluminum	TS10	251.567	456.56	45.62
Aluminum	TS13	156.152	283.40	28.31
Aluminum	R	117.363	213.00	21.28
Antimony	S-3 Ponds	0.000	0.00	0.00
Antimony	TS01	0.004	0.10	0.01
Antimony	Creekside	0.001	0.04	0.00
Antimony	Bear Creek Roadside	0.003	0.08	0.01
Antimony	Boneyard/Burnyard	1.093	30.36	3.06
Antimony	Oil Land Farm	0.000	0.00	0.00
Antimony	TS02	0.005	0.13	0.01
Antimony	TS03	0.002	0.07	0.01
Antimony	Burial Ground	0.001	0.03	0.00
Antimony	TS04	0.004	0.12	0.01
Antimony	TS07	0.002	0.07	0.01
Antimony	TS09	0.001	0.02	0.00

Table G.59 (continued)

Analyte	Location	Estimated exposure	NOAEL	LOAEL
		(mg/kg/d)	HQ	HQ
Antimony	R	0.003	0.08	0.01
Arsenic	S-3 Ponds	0.031	0.86	0.09
Arsenic	TS01	0.092	2.56	0.26
Arsenic	Creekside	0.036	1.00	0.10
Arsenic	Bear Creek Roadside	0.049	1.35	0.13
Arsenic	Boneyard/Burnyard	0.076	2.10	0.21
Arsenic	Oil Land Farm	0.057	1.58	0.16
Arsenic	TS02	0.030	0.84	0.08
Arsenic	TS03	0.070	1.93	0.19
Arsenic	Burial Ground	0.050	1.39	0.14
Arsenic	TS04	0.147	4.09	0.41
Arsenic	TS05	0.024	0.67	0.07
Arsenic	TS06	0.011	0.30	0.03
Arsenic	TS07	0.024	0.68	0.07
Arsenic	TS08	0.024	0.67	0.07
Arsenic	TS09	0.017	0.47	0.05
Arsenic	TS10	0.014	0.38	0.04
Arsenic	TS13	0.019	0.54	0.05
Arsenic	R	0.038	1.05	0.10
Barium	S-3 Ponds	1.299	0.46	0.12
Barium	TS01	1.709	0.61	0.16
Barium	Creekside	0.925	0.33	0.09
Barium	Bear Creek Roadside	5.875	2.10	0.56
Barium	Boneyard/Burnyard	1.541	0.55	0.15
Barium	Oil Land Farm	1.945	0.69	0.19
Barium	TS02	1.152	0.41	0.11
Barium	TS03	2.271	0.81	0.22
Barium	Burial Ground	1.604	0.57	0.15
Barium	TS04	1.559	0.56	0.15
Barium	TS05	0.798	0.28	0.08
Barium	TS06	0.677	0.24	0.06
Barium	TS07	1.059	0.38	0.10
Barium	TS08	0.693	0.25	0.07
Barium	TS09	1.186	0.42	0.11
Barium	TS10	1.027	0.37	0.10
Barium	TS13	1.217	0.43	0.12
Barium	R	1.604	0.57	0.15
Benzo(a)pyrene	TS01	0.001	0.00	0.00
Benzo(a)pyrene	Creekside	0.022	0.08	0.01
Benzo(a)pyrene	Bear Creek Roadside	0.000	0.00	0.00
Benzo(a)pyrene	Boneyard/Burnyard	0.054	0.19	0.02

Table G.59 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Benzo(a)pyrene	Oil Land Farm	0.008	0.03	0.00
Benzo(a)pyrene	TS03	0.004	0.01	0.00
Beryllium	S-3 Ponds	0.003	0.01	
Beryllium	TS01	0.016	0.05	
Beryllium	Creekside	0.005	0.01	
Beryllium	Bear Creek Roadside	0.003	0.01	
Beryllium	Boneyard/Burnyard	0.004	0.01	
Beryllium	Oil Land Farm	0.005	0.01	
Beryllium	TS02	0.002	0.01	
Beryllium	TS03	0.004	0.01	
Beryllium	Burial Ground	0.004	0.01	
Beryllium	TS04	0.011	0.03	
Beryllium	TS05	0.003	0.01	
Beryllium	TS06	0.002	0.01	
Beryllium	TS07	0.004	0.01	
Beryllium	TS08	0.002	0.01	
Beryllium	TS09	0.003	0.01	
Beryllium	TS10	0.002	0.01	
Beryllium	TS13	0.002	0.01	
Beryllium	R	0.001	0.00	
Bis(2-ethylhexyl)phthalate	TS01	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	Creekside	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	Bear Creek Roadside	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	Boneyard/Burnyard	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	Oil Land Farm	0.006	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS02	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS03	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	Burial Ground	0.001	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS04	0.005	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS06	0.004	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS07	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS08	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS09	0.000	0.00	0.00
Cadmium	S-3 Ponds	0.078	0.15	0.02
Cadmium	TS01	0.373	0.73	0.07
Cadmium	Creekside	0.325	0.64	0.06
Cadmium	Bear Creek Roadside	2.979	5.85	0.58
Cadmium	Boneyard/Burnyard	0.743	1.46	0.15
Cadmium	Oil Land Farm	0.309	0.61	0.06
Cadmium	TS02	0.026	0.05	0.01
Cadmium	TS03	0.185	0.36	0.04

Table G.59 (continued)

Analyte	Location	Estimated exposure	NOAEL	LOAEL
		(mg/kg/d)	HQ	HQ
Cadmium	TS04	0.017	0.03	0.00
Cadmium	TS05	0.315	0.62	0.06
Cadmium	TS06	0.237	0.47	0.05
Cadmium	TS07	0.347	0.68	0.07
Cadmium	TS08	0.045	0.09	0.01
Cadmium	TS09	0.055	0.11	0.01
Cadmium	TS10	0.118	0.23	0.02
Cadmium	R	0.030	0.06	0.01
Chlordane	TS01	0.000	0.00	0.00
Chlordane	TS03	0.000	0.00	0.00
Chlordane	TS04	0.000	0.00	0.00
Chlordane	TS05	0.000	0.00	0.00
Chlordane	TS06	0.000	0.00	0.00
Chlordane	TS07	0.000	0.00	0.00
Chlordane	TS08	0.000	0.00	0.00
Chlordane	TS09	0.000	0.00	0.00
Chlordane	TS10	0.000	0.00	0.00
Chlordane	TS13	0.000	0.00	0.00
Chloroform	Oil Land Farm	0.000	0.00	0.00
Chloroform	TS13	0.000	0.00	0.00
Chromium	S-3 Ponds	1.761	1.02	0.25
Chromium	TS01	0.735	0.43	0.11
Chromium	Creekside	5.856	3.39	0.84
Chromium	Bear Creek Roadside	4.274	2.47	0.62
Chromium	Boneyard/Burnyard	1.181	0.68	0.17
Chromium	Oil Land Farm	2.674	1.55	0.39
Chromium	TS02	0.661	0.38	0.10
Chromium	TS03	4.163	2.41	0.60
Chromium	Burial Ground	2.225	1.29	0.32
Chromium	TS04	2.877	1.66	0.41
Chromium	TS05	3.128	1.81	0.45
Chromium	TS06	0.616	0.36	0.09
Chromium	TS07	3.621	2.09	0.52
Chromium	TS08	0.846	0.49	0.12
Chromium	TS09	0.202	0.12	0.03
Chromium	TS10	1.745	1.01	0.25
Chromium	TS13	0.837	0.48	0.12
Chromium	R	1.957	1.13	0.28
Copper	S-3 Ponds	16.446	2.06	1.55
Copper	TS01	0.761	0.10	0.07
Copper	Creekside	29.602	3.70	2.79

Table G.59 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Copper	Bear Creek Roadside	939.279	117.41	88.61
Copper	Boneyard/Burnyard	4.996	0.62	0.47
Copper	Oil Land Farm	35.112	4.39	3.31
Copper	TS02	0.611	0.08	0.06
Copper	TS03	1.784	0.22	0.17
Copper	Burial Ground	10.053	1.26	0.95
Copper	TS04	37.586	4.70	3.55
Copper	TS05	2.794	0.35	0.26
Copper	TS06	4.006	0.50	0.38
Copper	TS07	1.484	0.19	0.14
Copper	TS08	8.796	1.10	0.83
Copper	TS09	7.404	0.93	0.70
Copper	TS10	3.302	0.41	0.31
Copper	TS13	11.892	1.49	1.12
Copper	R	2.056	0.26	0.19
Cyanide	S-3 Ponds	0.001	0.00	
Cyanide	Boneyard/Burnyard	0.001	0.00	
Cyanide	Burial Ground	0.032	0.00	
Cyanide	TS10	0.003	0.00	
Dieldrin	TS01	0.000	0.00	0.00
Dieldrin	TS03	0.000	0.00	0.00
Dieldrin	TS04	0.000	0.00	0.00
Dieldrin	TS06	0.000	0.00	0.00
Dieldrin	TS07	0.000	0.01	0.00
Dieldrin	TS08	0.000	0.00	0.00
Dieldrin	TS09	0.000	0.00	0.00
Dieldrin	TS10	0.000	0.00	0.00
Diethylphthalate	Boneyard/Burnyard	0.001	0.00	
Diethylphthalate	TS04	0.005	0.00	
Di-n-butylphthalate	TS01	0.002	0.00	0.00
Di-n-butylphthalate	Boneyard/Burnyard	0.002	0.00	0.00
Di-n-butylphthalate	Oil Land Farm	0.001	0.00	0.00
Di-n-butylphthalate	TS03	0.001	0.00	0.00
Di-n-butylphthalate	Burial Ground	0.000	0.00	0.00
Di-n-butylphthalate	TS05	0.000	0.00	0.00
Di-n-butylphthalate	TS06	0.004	0.00	0.00
Di-n-butylphthalate	TS07	0.004	0.00	0.00
Di-n-butylphthalate	TS10	0.000	0.00	0.00
Endosulfan	TS01	0.000	0.00	
Endosulfan	TS03	0.000	0.00	
Endosulfan	TS09	0.000	0.00	

Table G.59 (continued)

Analyte	Location	Estimated	NOAEL	LOAEL
		exposure (mg/kg/d)	HQ	HQ
Endrin	TS01	0.000	0.00	0.00
Endrin	TS02	0.000	0.00	0.00
Endrin	TS03	0.000	0.00	0.00
Endrin	TS04	0.000	0.00	0.00
Endrin	TS06	0.000	0.01	0.00
Endrin	TS07	0.000	0.02	0.00
Endrin	TS08	0.000	0.00	0.00
Endrin	TS09	0.000	0.00	0.00
Endrin	TS10	0.000	0.00	0.00
Endrin	TS13	0.000	0.00	0.00
Heptachlor	TS06	0.000	0.00	0.00
Heptachlor	TS10	0.000	0.00	0.00
Lead	S-3 Ponds	0.561	0.13	0.01
Lead	TS01	0.267	0.06	0.01
Lead	Creekside	0.998	0.24	0.02
Lead	Bear Creek Roadside	10.884	2.58	0.26
Lead	Boneyard/Burnyard	1.914	0.45	0.05
Lead	Oil Land Farm	1.008	0.24	0.02
Lead	TS02	0.087	0.02	0.00
Lead	TS03	0.220	0.05	0.01
Lead	Burial Ground	0.327	0.08	0.01
Lead	TS04	2.145	0.51	0.05
Lead	TS05	0.475	0.11	0.01
Lead	TS06	0.343	0.08	0.01
Lead	TS07	0.159	0.04	0.00
Lead	TS08	0.676	0.16	0.02
Lead	TS09	0.345	0.08	0.01
Lead	TS10	0.414	0.10	0.01
Lead	TS13	1.171	0.28	0.03
Lead	R	0.107	0.03	0.00
Lindane	TS04	0.000	0.00	
Lithium	TS01	0.443	0.09	0.04
Lithium	Creekside	0.174	0.03	0.02
Lithium	Bear Creek Roadside	0.058	0.01	0.01
Lithium	Boneyard/Burnyard	0.131	0.03	0.01
Lithium	Oil Land Farm	0.265	0.05	0.03
Lithium	TS02	0.153	0.03	0.02
Lithium	TS03	0.206	0.04	0.02
Lithium	Burial Ground	0.163	0.03	0.02
Lithium	TS04	0.445	0.09	0.04
Lithium	TS05	0.025	0.00	0.00

Table G.59 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Lithium	TS06	0.046	0.01	0.00
Lithium	TS07	0.201	0.04	0.02
Lithium	TS08	0.103	0.02	0.01
Lithium	TS09	0.005	0.00	0.00
Lithium	TS10	0.066	0.01	0.01
Lithium	TS13	0.062	0.01	0.01
Lithium	R	0.020	0.00	0.00
Manganese	TS01	5.006	0.11	0.03
Manganese	Creekside	4.777	0.10	0.03
Manganese	Bear Creek Roadside	2.002	0.04	0.01
Manganese	Boneyard/Burnyard	0.999	0.02	0.01
Manganese	TS02	4.080	0.09	0.03
Manganese	TS03	8.698	0.19	0.06
Manganese	TS04	10.769	0.23	0.07
Manganese	TS05	2.976	0.06	0.02
Manganese	TS06	6.870	0.15	0.05
Manganese	TS07	9.994	0.22	0.07
Manganese	TS08	7.006	0.15	0.05
Manganese	TS09	7.935	0.17	0.05
Manganese	TS10	4.021	0.09	0.03
Manganese	TS13	7.123	0.15	0.05
Manganese	R	2.308	0.05	0.02
Mercury	S-3 Ponds	0.949	94.85	55.80
Mercury	TS01	0.086	8.59	5.05
Mercury	Creekside	1.294	129.40	76.12
Mercury	Bear Creek Roadside	0.212	21.17	12.46
Mercury	Boneyard/Burnyard	0.144	14.35	8.44
Mercury	Oil Land Farm	0.377	37.68	22.17
Mercury	TS02	0.014	1.35	0.80
Mercury	TS03	0.012	1.24	0.73
Mercury	Burial Ground	0.005	0.55	0.32
Mercury	TS04	0.030	3.03	1.78
Mercury	TS05	0.027	2.67	1.57
Mercury	TS06	0.035	3.51	2.07
Mercury	TS07	0.018	1.76	1.04
Mercury	TS08	0.016	1.65	0.97
Mercury	TS09	0.001	0.15	0.09
Mercury	TS10	0.011	1.10	0.65
Mercury	TS13	0.044	4.36	2.57
Mercury	R	0.007	0.70	0.41
Methoxychlor	S-3 Ponds	0.000	0.00	0.00

Table G.59 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Methoxychlor	TS01	0.000	0.00	0.00
Methoxychlor	TS03	0.000	0.00	0.00
Methoxychlor	TS06	0.000	0.00	0.00
Methoxychlor	TS07	0.000	0.00	0.00
Methoxychlor	TS10	0.000	0.00	0.00
Methoxychlor	TS13	0.000	0.00	0.00
Methylenechloride	S-3 Ponds	0.000	0.00	0.00
Methylenechloride	Oil Land Farm	0.000	0.00	0.00
Mixed-BHC	TS01	0.000	0.01	0.00
Mixed-BHC	TS04	0.000	0.00	0.00
Mixed-BHC	TS06	0.000	0.00	0.00
Mixed-BHC	TS07	0.000	0.00	0.00
Molybdenum	S-3 Ponds	0.005	0.07	0.01
Molybdenum	TS01	0.114	1.63	0.15
Molybdenum	Boneyard/Burnyard	0.249	3.55	0.34
Molybdenum	Oil Land Farm	0.014	0.19	0.02
Molybdenum	TS02	0.056	0.80	0.08
Molybdenum	TS03	0.577	8.24	0.78
Molybdenum	Burial Ground	0.010	0.15	0.01
Molybdenum	TS04	0.292	4.17	0.39
Molybdenum	TS07	0.274	3.91	0.37
Molybdenum	TS09	0.060	0.86	0.08
Molybdenum	R	0.370	5.28	0.50
Nickel	S-3 Ponds	2.697	0.13	0.06
Nickel	TS01	0.911	0.04	0.02
Nickel	Creekside	3.288	0.16	0.08
Nickel	Bear Creek Roadside	6.614	0.31	0.16
Nickel	Boneyard/Burnyard	3.521	0.17	0.08
Nickel	Oil Land Farm	2.886	0.14	0.07
Nickel	TS02	0.395	0.02	0.01
Nickel	TS03	4.512	0.21	0.11
Nickel	Burial Ground	2.048	0.10	0.05
Nickel	TS04	5.070	0.24	0.12
Nickel	TS05	1.568	0.07	0.04
Nickel	TS06	0.941	0.04	0.02
Nickel	TS07	2.190	0.10	0.05
Nickel	TS08	1.339	0.06	0.03
Nickel	TS09	0.870	0.04	0.02
Nickel	TS10	1.058	0.05	0.03
Nickel	TS13	3.327	0.16	0.08
Nickel	R	1.780	0.08	0.04

Table G.59 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Niobium	Boneyard/Burnyard	0.024	0.54	0.05
Niobium	Oil Land Farm	0.017	0.38	0.04
Niobium	Burial Ground	0.016	0.35	0.04
PCB-1248	S-3 Ponds	0.000	0.01	0.00
PCB-1248	Burial Ground	0.147	14.69	1.43
PCB-1254	S-3 Ponds	0.001	0.01	0.00
PCB-1254	TS01	0.013	0.14	0.03
PCB-1254	Creekside	0.012	0.12	0.02
PCB-1254	Bear Creek Roadside	0.035	0.36	0.07
PCB-1254	Boneyard/Burnyard	0.010	0.10	0.02
PCB-1254	Oil Land Farm	0.004	0.04	0.01
PCB-1254	TS03	0.001	0.01	0.00
PCB-1254	Burial Ground	0.008	0.09	0.02
PCB-1254	TS07	0.004	0.04	0.01
PCB-1254	TS09	0.000	0.00	0.00
PCB-1254	TS10	0.011	0.12	0.02
PCB-1260	S-3 Ponds	0.000	0.00	0.00
PCB-1260	TS01	0.006	0.06	0.01
PCB-1260	Boneyard/Burnyard	0.014	0.15	0.03
PCB-1260	Oil Land Farm	0.000	0.00	0.00
PCB-1260	TS02	0.003	0.03	0.01
PCB-1260	TS03	0.003	0.04	0.01
PCB-1260	Burial Ground	0.008	0.09	0.02
PCB-1260	TS04	1.208	12.59	2.55
PCB-1260	TS06	0.003	0.03	0.01
PCB-1260	TS07	0.077	0.80	0.16
PCB-1260	TS08	0.000	0.00	0.00
PCB-1260	TS09	0.001	0.01	0.00
PCB-1260	TS10	0.126	1.31	0.26
PCB-1260	TS13	0.011	0.11	0.02
Selenium	TS01	0.098	0.93	0.56
Selenium	Creekside	0.071	0.67	0.41
Selenium	Bear Creek Roadside	0.063	0.59	0.36
Selenium	Boneyard/Burnyard	0.124	1.17	0.71
Selenium	TS02	0.038	0.36	0.22
Selenium	TS03	0.102	0.97	0.59
Selenium	Burial Ground	0.020	0.19	0.12
Selenium	TS04	0.058	0.55	0.33
Selenium	TS05	0.084	0.80	0.49
Selenium	TS06	0.042	0.39	0.24
Selenium	TS07	0.066	0.62	0.38

Table G.59 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Selenium	TS08	0.129	1.22	0.74
Selenium	TS09	0.012	0.11	0.07
Selenium	TS10	0.040	0.38	0.23
Selenium	TS13	0.059	0.55	0.34
Selenium	R	0.051	0.48	0.29
Strontium	TS01	0.558	0.00	
Strontium	Boneyard/Burnyard	0.846	0.01	
Strontium	Oil Land Farm	0.114	0.00	
Strontium	TS02	0.516	0.00	
Strontium	TS03	0.716	0.01	
Strontium	Burial Ground	0.156	0.00	
Strontium	TS04	0.398	0.00	
Strontium	TS07	0.430	0.00	
Strontium	TS09	0.077	0.00	
Strontium	R	0.657	0.00	
Tetrachloroethene	S-3 Ponds	0.000	0.00	0.00
Tetrachloroethene	Boneyard/Burnyard	0.000	0.00	0.00
Tetrachloroethene	Burial Ground	0.000	0.00	0.00
Thallium	S-3 Ponds	0.001	0.19	0.02
Thallium	TS01	0.000	0.03	0.00
Thallium	Boneyard/Burnyard	0.001	0.23	0.02
Thallium	Oil Land Farm	0.001	0.18	0.02
Thallium	TS02	0.007	1.76	0.18
Thallium	TS03	0.000	0.00	0.00
Thallium	TS04	0.000	0.08	0.01
Thallium	TS07	0.000	0.00	0.00
Thallium	R	0.001	0.32	0.03
Tin	S-3 Ponds	0.008	0.00	0.00
Tin	Boneyard/Burnyard	0.138	0.02	0.01
Tin	Oil Land Farm	0.009	0.00	0.00
Tin	Burial Ground	0.008	0.00	0.00
Toluene	S-3 Ponds	0.000	0.00	0.00
Toluene	Boneyard/Burnyard	0.001	0.00	0.00
Toluene	Oil Land Farm	0.000	0.00	0.00
Toluene	Burial Ground	0.000	0.00	0.00
Total DDT	Burial Ground	0.000	0.00	0.00
Total-DDT	TS01	0.000	0.00	0.00
Total-DDT	TS03	0.000	0.00	0.00
Total-DDT	TS04	0.000	0.00	0.00
Total-DDT	TS05	0.000	0.00	0.00
Total-DDT	TS06	0.000	0.00	0.00

Table G.59 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Total-DDT	TS07	0.000	0.00	0.00
Total-DDT	TS08	0.000	0.00	0.00
Total-DDT	TS09	0.000	0.00	0.00
Total-DDT	TS13	0.000	0.00	0.00
Trichloroethene	Burial Ground	0.000	0.00	0.00
Vanadium	S-3 Ponds	0.137	1.33	0.13
Vanadium	TS01	0.129	1.26	0.13
Vanadium	Creekside	0.104	1.01	0.10
Vanadium	Bear Creek Roadside	0.072	0.69	0.07
Vanadium	Boneyard/Burnyard	0.177	1.72	0.17
Vanadium	Oil Land Farm	0.195	1.89	0.19
Vanadium	TS02	0.083	0.81	0.08
Vanadium	TS03	0.207	2.01	0.20
Vanadium	Burial Ground	0.161	1.57	0.16
Vanadium	TS04	0.120	1.16	0.12
Vanadium	TS05	0.103	1.00	0.10
Vanadium	TS06	0.055	0.54	0.05
Vanadium	TS07	0.125	1.22	0.12
Vanadium	TS08	0.057	0.56	0.06
Vanadium	TS09	0.073	0.71	0.07
Vanadium	TS10	0.058	0.56	0.06
Vanadium	TS13	0.060	0.59	0.06
Vanadium	R	0.181	1.75	0.18
Vinylchloride	Burial Ground	0.000	0.00	0.00
Zinc	S-3 Ponds	12.592	0.15	0.07
Zinc	TS01	7.299	0.09	0.04
Zinc	Creekside	28.451	0.34	0.17
Zinc	Bear Creek Roadside	164.864	1.95	0.98
Zinc	Boneyard/Burnyard	9.676	0.11	0.06
Zinc	Oil Land Farm	24.325	0.29	0.14
Zinc	TS02	6.661	0.08	0.04
Zinc	TS03	8.677	0.10	0.05
Zinc	Burial Ground	11.819	0.14	0.07
Zinc	TS04	27.663	0.33	0.16
Zinc	TS05	5.609	0.07	0.03
Zinc	TS06	5.459	0.06	0.03
Zinc	TS07	7.569	0.09	0.04
Zinc	TS08	12.828	0.15	0.08
Zinc	TS09	5.244	0.06	0.03
Zinc	TS10	9.647	0.11	0.06
Zinc	TS13	5.455	0.06	0.03

Table G.59 (continued)

Analyte	Location	Estimated exposure	NOAEL	LOAEL
		(mg/kg/d)	HQ	HQ
Zinc	R	5.235	0.06	0.03
Zirconium	Boneyard/Burnyard	0.297	0.60	
Zirconium	Oil Land Farm	0.300	0.60	
Zirconium	Burial Ground	0.277	0.56	

Table G.60. Point estimates for contaminant exposure for red-tailed hawk in the Bear Creek watershed

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
111Trichloroethane	Burial Ground	0.000		
1,1-Dichloroethene	Burial Ground	0.000		
1,2-Dichloroethane	Burial Ground	0.000	0.00	0.00
1,2-Dichloroethene	Burial Ground	0.000		
2378-TCDD	Boneyard/Burnyard	0.000	0.00	0.00
2-Butanone	Burial Ground	0.000		
2-Butanone	S-3 Ponds	0.000		
4-Methyl2pentanone	S-3 Ponds	0.000		
4-Methyl2pentanone	Burial Ground	0.000		
Acetone	Boneyard/Burnyard	0.000		
Acetone	S-3 Ponds	0.000		
Acetone	Oil Landfarm	0.000		
Acetone	Burial Ground	0.000		
Aldrin	TS04	0.000		
Aluminum	TS05	9.187	0.08	0.21
Aluminum	Oil Landfarm	16.064	0.15	0.36
Aluminum	Boneyard/Burnyard	6.394	0.06	0.14
Aluminum	TS02	7.647	0.07	0.17
Aluminum	TS03	3.675	0.03	0.08
Aluminum	TS13	4.308	0.04	0.10
Aluminum	TS04	8.259	0.08	0.19
Aluminum	TS08	5.208	0.05	0.12
Aluminum	TS09	5.288	0.05	0.12
Aluminum	TS01	8.182	0.07	0.18
Aluminum	TS06	5.109	0.05	0.11
Aluminum	Burial Ground	10.300	0.09	0.23
Aluminum	TS10	27.083	0.25	0.61
Aluminum	TS07	8.835	0.08	0.20
Aluminum	S-3 Ponds	22.487	0.21	0.51
Antimony	Boneyard/Burnyard	0.000		

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Antimony	Burial Ground	0.002		
Antimony	S-3 Ponds	0.004		
Antimony	TS09	0.002		
Antimony	TS02	0.003		
Antimony	TS07	0.003		
Antimony	TS03	0.001		
Antimony	TS01	0.001		
Antimony	Oil Landfarm	0.002		
Antimony	TS04	0.001		
Arsenic	TS03	0.004	0.00	0.00
Arsenic	TS09	0.002	0.00	0.00
Arsenic	TS10	0.004	0.00	0.00
Arsenic	Burial Ground	0.005	0.00	0.00
Arsenic	TS02	0.002	0.00	0.00
Arsenic	TS05	0.001	0.00	0.00
Arsenic	TS07	0.007	0.00	0.00
Arsenic	Boneyard/Burnyard	0.006	0.00	0.00
Arsenic	TS06	0.003	0.00	0.00
Arsenic	TS08	0.004	0.00	0.00
Arsenic	TS04	0.004	0.00	0.00
Arsenic	TS01	0.004	0.00	0.00
Arsenic	Oil Landfarm	0.007	0.00	0.00
Arsenic	TS13	0.005	0.00	0.00
Arsenic	S-3 Ponds	0.006	0.00	0.00
Barium	S-3 Ponds	0.652	0.03	0.02
Barium	TS01	0.584	0.03	0.01
Barium	TS02	1.001	0.05	0.02
Barium	TS09	0.325	0.02	0.01
Barium	Oil Landfarm	0.412	0.02	0.01
Barium	TS08	0.295	0.01	0.01
Barium	TS10	0.410	0.02	0.01

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Barium	TS13	0.341	0.02	0.01
Barium	TS07	1.599	0.08	0.04
Barium	Boneyard/Burnyard	0.486	0.02	0.01
Barium	TS04	0.702	0.03	0.02
Barium	Burial Ground	0.608	0.03	0.01
Barium	TS06	0.910	0.04	0.02
Barium	TS05	0.283	0.01	0.01
Barium	TS03	0.751	0.04	0.02
Benzo(a)pyrene	Oil Landfarm	0.000		
Benzo(a)pyrene	TS01	0.000		
Benzo(a)pyrene	Boneyard/Burnyard	0.000		
Benzo(a)pyrene	TS03	0.000		
Beryllium	TS07	0.001		
Beryllium	Burial Ground	0.000		
Beryllium	TS05	0.001		
Beryllium	TS10	0.000		
Beryllium	S-3 Ponds	0.000		
Beryllium	TS04	0.000		
Beryllium	TS06	0.001		
Beryllium	TS02	0.000		
Beryllium	TS01	0.000		
Beryllium	TS08	0.000		
Beryllium	TS03	0.000		
Beryllium	Oil Landfarm	0.001		
Beryllium	TS13	0.001		
Beryllium	Boneyard/Burnyard	0.000		
Beryllium	TS09	0.001		
Bis(2-ethylhexyl)phthalate	TS03	0.000	0.00	
Bis(2-ethylhexyl)phthalate	TS08	0.000	0.00	
Bis(2-ethylhexyl)phthalate	TS09	0.000	0.00	
Bis(2-ethylhexyl)phthalate	TS06	0.000	0.00	

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Bis(2-ethylhexyl)phthalate	TS04	0.000	0.00	
Bis(2-ethylhexyl)phthalate	TS02	0.000	0.00	
Bis(2-ethylhexyl)phthalate	TS01	0.000	0.00	
Bis(2-ethylhexyl)phthalate	TS07	0.000	0.00	
Bis(2-ethylhexyl)phthalate	Burial Ground	0.000	0.00	
Bis(2-ethylhexyl)phthalate	Oil Landfarm	0.000	0.00	
Bis(2-ethylhexyl)phthalate	Boneyard/Burnyard	0.000	0.00	
Cadmium	TS10	0.006	0.00	0.00
Cadmium	TS09	0.000	0.00	0.00
Cadmium	TS07	0.002	0.00	0.00
Cadmium	S-3 Ponds	0.008	0.01	0.00
Cadmium	TS06	0.012	0.01	0.00
Cadmium	TS08	0.017	0.01	0.00
Cadmium	Boneyard/Burnyard	0.006	0.00	0.00
Cadmium	TS01	0.015	0.01	0.00
Cadmium	Oil Landfarm	0.007	0.00	0.00
Cadmium	TS02	0.015	0.01	0.00
Cadmium	TS05	0.004	0.00	0.00
Cadmium	TS03	0.016	0.01	0.00
Cadmium	TS04	0.031	0.02	0.00
Chlordane	TS09	0.000	0.00	0.00
Chlordane	TS04	0.000	0.00	0.00
Chlordane	TS13	0.000	0.00	0.00
Chlordane	TS08	0.000	0.00	0.00
Chlordane	TS03	0.000	0.00	0.00
Chlordane	TS05	0.000	0.00	0.00
Chlordane	TS01	0.000	0.00	0.00
Chlordane	TS06	0.000	0.00	0.00
Chlordane	TS10	0.000	0.00	0.00
Chlordane	TS07	0.000	0.00	0.00
Chloroform	Oil Landfarm	0.000		

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Chloroform	TS13	0.000		
Chromium	S-3 Ponds	0.132	0.13	0.03
Chromium	TS02	0.280	0.28	0.06
Chromium	Burial Ground	0.121	0.12	0.02
Chromium	Boneyard/Burnyard	0.132	0.13	0.03
Chromium	TS05	0.184	0.18	0.04
Chromium	TS07	0.094	0.09	0.02
Chromium	TS09	0.505	0.50	0.10
Chromium	TS13	0.445	0.45	0.09
Chromium	TS04	0.144	0.14	0.03
Chromium	TS08	0.402	0.40	0.08
Chromium	TS01	0.056	0.06	0.01
Chromium	Oil Landfarm	0.272	0.27	0.05
Chromium	TS10	0.413	0.41	0.08
Chromium	TS03	0.144	0.14	0.03
Chromium	TS06	0.343	0.34	0.07
Copper	TS01	13.784	0.29	0.22
Copper	Oil Landfarm	3.816	0.08	0.06
Copper	TS02	8.790	0.19	0.14
Copper	Boneyard/Burnyard	10.192	0.22	0.17
Copper	Burial Ground	0.631	0.01	0.01
Copper	TS05	4.625	0.10	0.08
Copper	TS09	3.231	0.07	0.05
Copper	TS06	44.770	0.95	0.73
Copper	S-3 Ponds	1.845	0.04	0.03
Copper	TS10	0.631	0.01	0.01
Copper	TS04	0.456	0.01	0.01
Copper	TS03	19.008	0.40	0.31
Copper	TS07	40.583	0.86	0.66
Copper	TS08	0.678	0.01	0.01
Copper	TS13	11.619	0.25	0.19

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Cyanide	TS10	0.000		
Cyanide	Boneyard/Burnyard	0.000		
Cyanide	Burial Ground	0.000		
Cyanide	S-3 Ponds	0.000		
Dieldrin	TS03	0.000	0.00	
Dieldrin	TS08	0.000	0.00	
Dieldrin	TS09	0.000	0.00	
Dieldrin	TS10	0.000	0.00	
Dieldrin	TS06	0.000	0.00	
Dieldrin	TS07	0.000	0.00	
Dieldrin	TS04	0.000	0.00	
Dieldrin	TS01	0.000	0.00	
Diethylphthalate	TS04	0.000		
Diethylphthalate	Boneyard/Burnyard	0.000		
Di-n-butylphthalate	TS06	0.000	0.00	0.00
Di-n-butylphthalate	TS07	0.000	0.00	0.00
Di-n-butylphthalate	TS05	0.000	0.00	0.00
Di-n-butylphthalate	Boneyard/Burnyard	0.000	0.00	0.00
Di-n-butylphthalate	TS03	0.000	0.00	0.00
Di-n-butylphthalate	TS10	0.000	0.00	0.00
Di-n-butylphthalate	Oil Landfarm	0.000	0.00	0.00
Di-n-butylphthalate	TS01	0.000	0.00	0.00
Di-n-octylphthalate	Burial Ground	0.000		
Endosulfan	TS01	0.000	0.00	
Endosulfan	TS09	0.000	0.00	
Endosulfan	TS03	0.000	0.00	
Endrin	TS03	0.000	0.00	0.00
Endrin	TS09	0.000	0.00	0.00
Endrin	TS13	0.000	0.00	0.00
Endrin	TS04	0.000	0.00	0.00
Endrin	TS01	0.000	0.00	0.00

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Endrin	TS10	0.000	0.00	0.00
Endrin	TS07	0.000	0.00	0.00
Endrin	TS02	0.000	0.00	0.00
Endrin	TS08	0.000	0.00	0.00
Endrin	TS06	0.000	0.00	0.00
Heptachlor	TS10	0.000		
Heptachlor	TS06	0.000		
Lead	TS09	0.967	0.86	0.09
Lead	Oil Landfarm	0.329	0.29	0.03
Lead	TS05	0.353	0.31	0.03
Lead	TS04	0.549	0.49	0.05
Lead	TS06	0.019	0.02	0.00
Lead	TS10	0.258	0.23	0.02
Lead	TS01	0.389	0.34	0.03
Lead	TS13	1.314	1.16	0.12
Lead	TS07	0.083	0.07	0.01
Lead	TS03	0.015	0.01	0.00
Lead	Burial Ground	0.034	0.03	0.00
Lead	Boneyard/Burnyard	0.425	0.38	0.04
Lead	TS02	0.764	0.68	0.07
Lead	S-3 Ponds	0.030	0.03	0.00
Lead	TS08	0.248	0.22	0.02
Lindane	TS04	0.000	0.00	0.00
Lithium	Boneyard/Burnyard	0.077		
Lithium	TS08	0.082		
Lithium	Burial Ground	0.000		
Lithium	TS04	0.087		
Lithium	TS06	0.003		
Lithium	TS13	0.026		
Lithium	TS01	0.016		
Lithium	TS09	0.048		

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Lithium	Oil Landfarm	0.014		
Lithium	TS10	0.073		
Lithium	TS07	0.055		
Lithium	TS05	0.158		
Lithium	TS02	0.025		
Lithium	TS03	0.097		
Manganese	TS04	0.536	0.00	
Manganese	TS13	0.240	0.00	
Manganese	TS07	0.622	0.00	
Manganese	TS06	0.493	0.00	
Manganese	TS01	0.342	0.00	
Manganese	TS10	0.298	0.00	
Manganese	TS05	0.206	0.00	
Manganese	TS08	0.486	0.00	
Manganese	TS03	0.695	0.00	
Manganese	TS09	0.296	0.00	
Manganese	TS02	0.399	0.00	
Mercury	TS13	0.038	6.35	0.60
Mercury	TS07	0.000	0.00	0.00
Mercury	TS09	0.000	0.00	0.00
Mercury	TS05	0.000	0.00	0.00
Mercury	Burial Ground	0.005	0.81	0.08
Mercury	TS10	0.028	4.73	0.44
Mercury	TS02	0.023	3.86	0.36
Mercury	TS06	0.024	4.03	0.38
Mercury	TS03	0.003	0.48	0.05
Mercury	TS01	0.009	1.45	0.14
Mercury	Oil Landfarm	0.007	1.13	0.11
Mercury	Boneyard/Burnyard	0.788	131.38	12.32
Mercury	TS04	0.313	52.19	4.89
Mercury	TS08	0.011	1.77	0.17

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Mercury	S-3 Ponds	0.005	0.76	0.07
Methoxychlor	S-3 Ponds	0.000		
Methoxychlor	TS03	0.000		
Methoxychlor	TS01	0.000		
Methoxychlor	TS13	0.000		
Methoxychlor	TS07	0.000		
Methoxychlor	TS06	0.000		
Methoxychlor	TS10	0.000		
Mixed-BHC	TS06	0.000	0.00	0.00
Mixed-BHC	TS04	0.000	0.00	0.00
Mixed-BHC	TS07	0.000	0.00	0.00
Mixed-BHC	TS01	0.000	0.00	0.00
Molybdenum	S-3 Ponds	0.000	0.00	0.00
Molybdenum	Oil Landfarm	0.037	0.01	0.00
Molybdenum	TS09	0.050	0.01	0.00
Molybdenum	TS04	0.030	0.01	0.00
Molybdenum	Burial Ground	0.020	0.01	0.00
Molybdenum	TS07	0.032	0.01	0.00
Molybdenum	TS03	0.000	0.00	0.00
Molybdenum	TS02	0.000	0.00	0.00
Molybdenum	TS01	0.074	0.02	0.00
Molybdenum	Boneyard/Burnyard	0.000	0.00	0.00
Nickel	TS10	1.976	0.03	0.02
Nickel	Boneyard/Burnyard	0.623	0.01	0.01
Nickel	Oil Landfarm	0.593	0.01	0.01
Nickel	TS09	0.789	0.01	0.01
Nickel	TS03	0.252	0.00	0.00
Nickel	TS06	0.529	0.01	0.00
Nickel	TS02	0.926	0.01	0.01
Nickel	TS01	3.833	0.05	0.04
Nickel	Burial Ground	1.924	0.02	0.02

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Nickel	TS08	0.197	0.00	0.00
Nickel	TS05	0.153	0.00	0.00
Nickel	S-3 Ponds	1.566	0.02	0.01
Nickel	TS13	1.675	0.02	0.02
Nickel	TS07	0.188	0.00	0.00
Nickel	TS04	1.189	0.02	0.01
PCB-1232	Oil Landfarm	0.000		
PCB-1248	S-3 Ponds	0.000		
PCB-1248	Burial Ground	0.000		
PCB-1254	TS09	0.008	0.05	0.00
PCB-1254	TS07	0.000	0.00	0.00
PCB-1254	TS10	0.000	0.00	0.00
PCB-1254	TS03	0.000	0.00	0.00
PCB-1254	S-3 Ponds	0.000	0.00	0.00
PCB-1254	Boneyard/Burnyard	0.001	0.00	0.00
PCB-1254	Oil Landfarm	0.003	0.01	0.00
PCB-1254	Burial Ground	0.000	0.00	0.00
PCB-1254	TS01	0.005	0.03	0.00
PCB-1260	TS01	0.067	0.37	0.04
PCB-1260	TS03	0.778	4.32	0.43
PCB-1260	Burial Ground	0.030	0.17	0.02
PCB-1260	Oil Landfarm	0.200	1.11	0.11
PCB-1260	TS07	0.061	0.34	0.03
PCB-1260	TS09	0.157	0.87	0.09
PCB-1260	TS02	0.741	4.11	0.41
PCB-1260	S-3 Ponds	0.006	0.03	0.00
PCB-1260	TS04	0.042	0.23	0.02
PCB-1260	TS10	0.020	0.11	0.01
PCB-1260	TS08	0.000	0.00	0.00
PCB-1260	TS06	0.000	0.00	0.00
PCB-1260	Boneyard/Burnyard	0.013	0.07	0.01

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
PCB-1260	TS13	0.000	0.00	0.00
Selenium	TS01	0.035	0.07	0.04
Selenium	TS02	0.023	0.05	0.02
Selenium	Burial Ground	0.026	0.05	0.03
Selenium	TS08	0.081	0.16	0.08
Selenium	TS03	0.043	0.09	0.04
Selenium	TS04	0.025	0.05	0.02
Selenium	TS06	0.052	0.10	0.05
Selenium	TS13	0.036	0.07	0.04
Selenium	TS05	0.034	0.07	0.03
Selenium	TS07	0.026	0.05	0.03
Selenium	TS10	0.034	0.07	0.03
Selenium	TS09	0.024	0.05	0.02
Selenium	Boneyard/Burnyard	0.012	0.02	0.01
Strontium	TS09	0.000		
Strontium	TS02	0.371		
Strontium	Burial Ground	0.327		
Strontium	Oil Landfarm	0.717		
Strontium	Boneyard/Burnyard	0.452		
Strontium	TS01	0.486		
Strontium	TS03	0.000		
Strontium	TS04	0.445		
Strontium	TS07	0.000		
Tetrachloroethene	S-3 Ponds	0.000		
Tetrachloroethene	Burial Ground	0.000		
Tetrachloroethene	Boneyard/Burnyard	0.000		
Thallium	TS01	0.000		
Thallium	TS04	0.000		
Thallium	TS02	0.000		
Thallium	Boneyard/Burnyard	0.002		
Thallium	Oil Landfarm	0.000		

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Thallium	TS07	0.000		
Thallium	S-3 Ponds	0.000		
Thallium	TS03	0.000		
Tin	S-3 Ponds	0.000	0.00	0.00
Tin	Oil Landfarm	0.000	0.00	0.00
Tin	Burial Ground	0.000	0.00	0.00
Tin	Boneyard/Burnyard	0.000	0.00	0.00
Toluene	Oil Landfarm	0.000		
Toluene	S-3 Ponds	0.000		
Toluene	Boneyard/Burnyard	0.000		
Toluene	Burial Ground	0.000		
Total DDE	Burial Ground	0.000	0.00	0.00
Total DDT	Burial Ground	0.000	0.00	0.00
Total-DDT	TS09	0.000	0.00	0.00
Total-DDT	TS01	0.000	0.00	0.00
Total-DDT	TS08	0.000	0.00	0.00
Total-DDT	TS06	0.000	0.00	0.00
Total-DDT	TS07	0.000	0.00	0.00
Total-DDT	TS13	0.000	0.00	0.00
Total-DDT	TS05	0.000	0.00	0.00
Total-DDT	TS03	0.000	0.00	0.00
Total-DDT	TS04	0.000	0.00	0.00
Trichloroethene	Burial Ground	0.000		
Uranium	TS03	0.000	0.00	
Uranium	TS09	0.001	0.00	
Uranium	Oil Landfarm	0.010	0.00	
Uranium	TS02	0.010	0.00	
Uranium	TS07	0.002	0.00	
Uranium	Boneyard/Burnyard	0.002	0.00	
Uranium	TS04	0.000	0.00	
Uranium	Burial Ground	0.039	0.00	

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Uranium	TS01	0.000	0.00	
Vanadium	TS10	0.037	0.00	
Vanadium	TS04	0.058	0.01	
Vanadium	TS05	0.064	0.01	
Vanadium	TS13	0.037	0.00	
Vanadium	TS06	0.000	0.00	
Vanadium	TS07	0.031	0.00	
Vanadium	Boneyard/Burnyard	0.170	0.01	
Vanadium	Oil Landfarm	0.000	0.00	
Vanadium	TS09	0.000	0.00	
Vanadium	TS01	0.000	0.00	
Vanadium	TS08	0.000	0.00	
Vanadium	S-3 Ponds	0.083	0.01	
Vanadium	TS02	0.118	0.01	
Vanadium	TS03	0.000	0.00	
Vanadium	Burial Ground	0.098	0.01	
Vinylchloride	Burial Ground	0.000		
Zinc	TS06	5.800	0.40	0.04
Zinc	Burial Ground	10.342	0.71	0.08
Zinc	TS01	5.191	0.36	0.04
Zinc	TS05	13.738	0.95	0.10
Zinc	TS04	8.018	0.55	0.06
Zinc	TS07	5.804	0.40	0.04
Zinc	TS03	5.984	0.41	0.05
Zinc	TS02	31.156	2.15	0.24
Zinc	TS08	8.795	0.61	0.07
Zinc	S-3 Ponds	7.122	0.49	0.05
Zinc	Oil Landfarm	7.124	0.49	0.05
Zinc	TS09	13.384	0.92	0.10
Zinc	Boneyard/Burnyard	25.854	1.78	0.20
Zinc	TS10	6.686	0.46	0.05

Table G.60 (continued)

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Zinc	TS13	12.563	0.87	0.10
Zirconium	Burial Ground	0.000		
Zirconium	Oil Landfarm	0.000		
Zirconium	Boneyard/Burnyard	0.000		

**Table G.61. Point estimates of contaminant exposure
for mink in the Bear Creek watershed**

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
111Trichloroethane	Burial Ground	Small mammals	0.000	0.00	
1,1-Dichloroethene	Burial Ground	Small mammals	0.000	0.00	
1,2-Dichloroethane	Burial Ground	Small mammals	0.000	0.00	
1,2-Dichloroethene	Burial Ground	Small mammals	0.000	0.00	
2378-TCDD	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
2-Butanone	S-3 Ponds	Small mammals	0.000	0.00	0.00
2-Butanone	Burial Ground	Small mammals	0.000	0.00	0.00
4-Methyl2pentanone	S-3 Ponds	Small mammals	0.000	0.00	
4-Methyl2pentanone	Burial Ground	Small mammals	0.000	0.00	
Acetone	S-3 Ponds	Small mammals	0.000	0.00	0.00
Acetone	Oil Landfarm	Small mammals	0.000	0.00	0.00
Acetone	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
Acetone	Burial Ground	Small mammals	0.000	0.00	0.00
Aldrin	TS04	Small mammals	0.000	0.00	0.00
Aluminum	TS13	Small mammals	5.903	7.35	0.74
Aluminum	TS10	Small mammals	10.322	12.85	1.29
Aluminum	TS09	Small mammals	4.108	5.12	0.51
Aluminum	TS08	Small mammals	4.914	6.12	0.61
Aluminum	TS07	Small mammals	2.361	2.94	0.29
Aluminum	TS06	Small mammals	2.768	3.45	0.34
Aluminum	TS05	Small mammals	5.306	6.61	0.66
Aluminum	TS04	Small mammals	3.346	4.17	0.42
Aluminum	TS03	Small mammals	3.398	4.23	0.42
Aluminum	TS02	Small mammals	5.257	6.55	0.65
Aluminum	TS01	Small mammals	3.283	4.09	0.41
Aluminum	S-3 Ponds	Small mammals	6.618	8.24	0.82
Aluminum	Oil Landfarm	Small mammals	17.401	21.67	2.17
Aluminum	Boneyard/Burnyard	Small mammals	5.677	7.07	0.71
Aluminum	Burial Ground	Small mammals	14.448	17.99	1.80
Antimony	TS09	Small mammals	0.000	0.00	0.00
Antimony	TS07	Small mammals	0.001	0.02	0.00
Antimony	TS04	Small mammals	0.002	0.05	0.00

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Antimony	TS03	Small mammals	0.001	0.02	0.00
Antimony	TS02	Small mammals	0.002	0.04	0.00
Antimony	TS01	Small mammals	0.002	0.04	0.00
Antimony	BCK 9.4	Fish	0.000	0.01	0.00
Antimony	BCK 3.3	Fish	0.000	0.01	0.00
Antimony	BCK 12.4	Fish	0.001	0.01	0.00
Antimony	S-3 Ponds	Small mammals	0.001	0.01	0.00
Antimony	Oil Landfarm	Small mammals	0.001	0.02	0.00
Antimony	Boneyard/Burnyard	Small mammals	0.001	0.02	0.00
Antimony	Burial Ground	Small mammals	0.001	0.02	0.00
Arsenic	TS13	Small mammals	0.003	0.05	0.01
Arsenic	TS10	Small mammals	0.002	0.03	0.00
Arsenic	TS09	Small mammals	0.003	0.05	0.01
Arsenic	TS08	Small mammals	0.003	0.06	0.01
Arsenic	TS07	Small mammals	0.001	0.02	0.00
Arsenic	TS06	Small mammals	0.001	0.02	0.00
Arsenic	TS05	Small mammals	0.004	0.09	0.01
Arsenic	TS04	Small mammals	0.004	0.07	0.01
Arsenic	TS03	Small mammals	0.002	0.04	0.00
Arsenic	TS02	Small mammals	0.002	0.05	0.00
Arsenic	TS01	Small mammals	0.002	0.05	0.00
Arsenic	BCK 9.4	Fish	0.040	0.77	0.08
Arsenic	BCK 3.3	Fish	0.028	0.53	0.05
Arsenic	BCK 12.4	Fish	0.025	0.48	0.05
Arsenic	S-3 Ponds	Small mammals	0.003	0.05	0.00
Arsenic	Oil Landfarm	Small mammals	0.005	0.09	0.01
Arsenic	Boneyard/Burnyard	Small mammals	0.003	0.06	0.01
Arsenic	Burial Ground	Small mammals	0.004	0.08	0.01
Barium	TS13	Small mammals	0.419	0.10	0.03
Barium	TS10	Small mammals	0.375	0.09	0.02
Barium	TS09	Small mammals	0.643	0.16	0.04
Barium	TS08	Small mammals	0.209	0.05	0.01
Barium	TS07	Small mammals	0.265	0.06	0.02

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Barium	TS06	Small mammals	0.189	0.05	0.01
Barium	TS05	Small mammals	0.264	0.06	0.02
Barium	TS04	Small mammals	0.219	0.05	0.01
Barium	TS03	Small mammals	1.028	0.25	0.07
Barium	TS02	Small mammals	0.312	0.08	0.02
Barium	TS01	Small mammals	0.451	0.11	0.03
Barium	S-3 Ponds	Small mammals	0.391	0.09	0.03
Barium	Oil Landfarm	Small mammals	0.585	0.14	0.04
Barium	Boneyard/Burnyard	Small mammals	0.182	0.04	0.01
Barium	Burial Ground	Small mammals	0.482	0.12	0.03
Benzo(a)pyrene	TS03	Small mammals	0.000	0.00	0.00
Benzo(a)pyrene	TS01	Small mammals	0.000	0.00	0.00
Benzo(a)pyrene	Oil Landfarm	Small mammals	0.000	0.00	0.00
Benzo(a)pyrene	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
Beryllium	TS13	Small mammals	0.000	0.00	
Beryllium	TS10	Small mammals	0.000	0.00	
Beryllium	TS09	Small mammals	0.001	0.00	
Beryllium	TS08	Small mammals	0.000	0.00	
Beryllium	TS07	Small mammals	0.000	0.00	
Beryllium	TS06	Small mammals	0.000	0.00	
Beryllium	TS05	Small mammals	0.001	0.00	
Beryllium	TS04	Small mammals	0.000	0.00	
Beryllium	TS03	Small mammals	0.000	0.00	
Beryllium	TS02	Small mammals	0.000	0.00	
Beryllium	TS01	Small mammals	0.000	0.00	
Beryllium	BCK 9.4	Fish	0.002	0.00	
Beryllium	BCK 3.3	Fish	0.001	0.00	
Beryllium	BCK 12.4	Fish	0.002	0.00	
Beryllium	S-3 Ponds	Small mammals	0.000	0.00	
Beryllium	Oil Landfarm	Small mammals	0.001	0.00	
Beryllium	Boneyard/Burnyard	Small mammals	0.000	0.00	
Beryllium	Burial Ground	Small mammals	0.001	0.00	
Bis(2-ethylhexyl)phthalate	TS09	Small mammals	0.000	0.00	0.00

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Bis(2-ethylhexyl)phthalate	TS08	Small mammals	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS07	Small mammals	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS06	Small mammals	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS04	Small mammals	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS03	Small mammals	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS02	Small mammals	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	TS01	Small mammals	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	Oil Landfarm	Small mammals	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
Bis(2-ethylhexyl)phthalate	Burial Ground	Small mammals	0.000	0.00	0.00
Cadmium	TS10	Small mammals	0.004	0.67	0.50
Cadmium	TS09	Small mammals	0.000	0.00	0.00
Cadmium	TS08	Small mammals	0.002	0.26	0.19
Cadmium	TS07	Small mammals	0.005	0.83	0.62
Cadmium	TS06	Small mammals	0.008	1.31	0.98
Cadmium	TS05	Small mammals	0.011	1.80	1.35
Cadmium	TS04	Small mammals	0.004	0.62	0.47
Cadmium	TS03	Small mammals	0.009	1.55	1.17
Cadmium	TS02	Small mammals	0.004	0.73	0.54
Cadmium	TS01	Small mammals	0.010	1.66	1.24
Cadmium	BCK 9.4	Fish	0.044	7.23	5.78
Cadmium	BCK 3.3	Fish	0.018	2.96	2.37
Cadmium	BCK 12.4	Fish	0.156	25.35	20.28
Cadmium	S-3 Ponds	Small mammals	0.003	0.44	0.33
Cadmium	Oil Landfarm	Small mammals	0.011	1.75	1.31
Cadmium	Boneyard/Burnyard	Small mammals	0.020	3.32	2.49
Chlordane	TS13	Small mammals	0.000	0.00	0.00
Chlordane	TS10	Small mammals	0.000	0.00	0.00
Chlordane	TS09	Small mammals	0.000	0.00	0.00
Chlordane	TS08	Small mammals	0.000	0.00	0.00
Chlordane	TS07	Small mammals	0.000	0.00	0.00
Chlordane	TS06	Small mammals	0.000	0.00	0.00
Chlordane	TS05	Small mammals	0.000	0.00	0.00

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Chlordane	TS04	Small mammals	0.000	0.00	0.00
Chlordane	TS03	Small mammals	0.000	0.00	0.00
Chlordane	TS01	Small mammals	0.000	0.00	0.00
Chloroform	TS13	Small mammals	0.000	0.00	0.00
Chloroform	Oil Landfarm	Small mammals	0.000	0.00	0.00
Chromium	TS13	Small mammals	0.085	0.03	0.01
Chromium	TS10	Small mammals	0.180	0.07	0.02
Chromium	TS09	Small mammals	0.078	0.03	0.01
Chromium	TS08	Small mammals	0.085	0.03	0.01
Chromium	TS07	Small mammals	0.118	0.05	0.01
Chromium	TS06	Small mammals	0.060	0.02	0.01
Chromium	TS05	Small mammals	0.324	0.13	0.03
Chromium	TS04	Small mammals	0.286	0.11	0.03
Chromium	TS03	Small mammals	0.093	0.04	0.01
Chromium	TS02	Small mammals	0.258	0.10	0.03
Chromium	TS01	Small mammals	0.036	0.01	0.00
Chromium	S-3 Ponds	Small mammals	0.175	0.07	0.02
Chromium	Oil Landfarm	Small mammals	0.265	0.11	0.03
Chromium	Boneyard/Burnyard	Small mammals	0.093	0.04	0.01
Chromium	Burial Ground	Small mammals	0.221	0.09	0.02
Chromium (+6)	BCK 9.4	Fish	0.085	0.03	0.01
Chromium (+6)	BCK 3.3	Fish	0.070	0.03	0.01
Chromium (+6)	BCK 12.4	Fish	0.065	0.03	0.01
Copper	TS13	Small mammals	8.857	0.76	0.59
Copper	TS10	Small mammals	2.452	0.21	0.16
Copper	TS09	Small mammals	5.648	0.48	0.37
Copper	TS08	Small mammals	6.548	0.56	0.43
Copper	TS07	Small mammals	0.406	0.03	0.03
Copper	TS06	Small mammals	2.972	0.25	0.20
Copper	TS05	Small mammals	2.076	0.18	0.14
Copper	TS04	Small mammals	28.766	2.46	1.90
Copper	TS03	Small mammals	1.185	0.10	0.08
Copper	TS02	Small mammals	0.406	0.03	0.03

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Copper	TS01	Small mammals	0.293	0.03	0.02
Copper	BCK 9.4	Fish	0.091	0.01	0.01
Copper	BCK 3.3	Fish	0.081	0.01	0.01
Copper	BCK 12.4	Fish	0.070	0.01	0.00
Copper	S-3 Ponds	Small mammals	12.213	1.04	0.81
Copper	Oil Landfarm	Small mammals	26.075	2.23	1.72
Copper	Boneyard/Burnyard	Small mammals	0.435	0.04	0.03
Copper	Burial Ground	Small mammals	7.466	0.64	0.49
Cyanide	TS10	Small mammals	0.000	0.00	
Cyanide	S-3 Ponds	Small mammals	0.000	0.00	
Cyanide	Boneyard/Burnyard	Small mammals	0.000	0.00	
Cyanide	Burial Ground	Small mammals	0.000	0.00	
Dieldrin	TS10	Small mammals	0.000	0.00	0.00
Dieldrin	TS09	Small mammals	0.000	0.00	0.00
Dieldrin	TS08	Small mammals	0.000	0.00	0.00
Dieldrin	TS07	Small mammals	0.000	0.00	0.00
Dieldrin	TS06	Small mammals	0.000	0.00	0.00
Dieldrin	TS04	Small mammals	0.000	0.00	0.00
Dieldrin	TS03	Small mammals	0.000	0.00	0.00
Dieldrin	TS01	Small mammals	0.000	0.00	0.00
Diethylphthalate	TS04	Small mammals	0.000	0.00	
Diethylphthalate	Boneyard/Burnyard	Small mammals	0.000	0.00	
Di-n-butylphthalate	TS10	Small mammals	0.000	0.00	0.00
Di-n-butylphthalate	TS07	Small mammals	0.000	0.00	0.00
Di-n-butylphthalate	TS06	Small mammals	0.000	0.00	0.00
Di-n-butylphthalate	TS05	Small mammals	0.000	0.00	0.00
Di-n-butylphthalate	TS03	Small mammals	0.000	0.00	0.00
Di-n-butylphthalate	TS01	Small mammals	0.000	0.00	0.00
Di-n-butylphthalate	Oil Landfarm	Small mammals	0.000	0.00	0.00
Di-n-butylphthalate	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
Di-n-octylphthalate	Burial Ground	Small mammals			
Endosulfan	TS09	Small mammals	0.000	0.00	
Endosulfan	TS03	Small mammals	0.000	0.00	

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Endosulfan	TS01	Small mammals	0.000	0.00	
Endrin	TS13	Small mammals	0.000	0.00	0.00
Endrin	TS10	Small mammals	0.000	0.00	0.00
Endrin	TS09	Small mammals	0.000	0.00	0.00
Endrin	TS08	Small mammals	0.000	0.00	0.00
Endrin	TS07	Small mammals	0.000	0.00	0.00
Endrin	TS06	Small mammals	0.000	0.00	0.00
Endrin	TS04	Small mammals	0.000	0.00	0.00
Endrin	TS03	Small mammals	0.000	0.00	0.00
Endrin	TS02	Small mammals	0.000	0.00	0.00
Endrin	TS01	Small mammals	0.000	0.00	0.00
Heptachlor	TS10	Small mammals	0.000	0.00	0.00
Heptachlor	TS06	Small mammals	0.000	0.00	0.00
Lead	TS13	Small mammals	0.621	0.10	0.01
Lead	TS10	Small mammals	0.211	0.03	0.00
Lead	TS09	Small mammals	0.227	0.04	0.00
Lead	TS08	Small mammals	0.353	0.06	0.01
Lead	TS07	Small mammals	0.012	0.00	0.00
Lead	TS06	Small mammals	0.166	0.03	0.00
Lead	TS05	Small mammals	0.250	0.04	0.00
Lead	TS04	Small mammals	0.844	0.14	0.01
Lead	TS03	Small mammals	0.053	0.01	0.00
Lead	TS02	Small mammals	0.010	0.00	0.00
Lead	TS01	Small mammals	0.022	0.00	0.00
Lead	BCK 9.4	Fish	0.053	0.01	0.00
Lead	BCK 3.3	Fish	0.025	0.00	0.00
Lead	BCK 12.4	Fish	0.050	0.01	0.00
Lead	S-3 Ponds	Small mammals	0.273	0.04	0.00
Lead	Oil Landfarm	Small mammals	0.491	0.08	0.01
Lead	Boneyard/Burnyard	Small mammals	0.019	0.00	0.00
Lead	Burial Ground	Small mammals	0.159	0.03	0.00
Lindane	TS04	Small mammals	0.000	0.00	
Lithium	TS13	Small mammals	0.050	0.01	0.00

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Lithium	TS10	Small mammals	0.053	0.01	0.00
Lithium	TS09	Small mammals	0.000	0.00	0.00
Lithium	TS08	Small mammals	0.056	0.01	0.00
Lithium	TS07	Small mammals	0.002	0.00	0.00
Lithium	TS06	Small mammals	0.017	0.00	0.00
Lithium	TS05	Small mammals	0.010	0.00	0.00
Lithium	TS04	Small mammals	0.031	0.00	0.00
Lithium	TS03	Small mammals	0.009	0.00	0.00
Lithium	TS02	Small mammals	0.047	0.01	0.00
Lithium	TS01	Small mammals	0.035	0.00	0.00
Lithium	BCK 9.4	Fish	0.077	0.01	0.01
Lithium	BCK 3.3	Fish	0.036	0.01	0.00
Lithium	BCK 12.4	Fish	0.029	0.00	0.00
Lithium	Oil Landfarm	Small mammals	0.102	0.01	0.01
Lithium	Boneyard/Burnyard	Small mammals	0.016	0.00	0.00
Lithium	Burial Ground	Small mammals	0.063	0.01	0.00
Manganese	TS13	Small mammals	0.344	0.01	0.00
Manganese	TS10	Small mammals	0.154	0.00	0.00
Manganese	TS09	Small mammals	0.400	0.01	0.00
Manganese	TS08	Small mammals	0.317	0.00	0.00
Manganese	TS07	Small mammals	0.220	0.00	0.00
Manganese	TS06	Small mammals	0.192	0.00	0.00
Manganese	TS05	Small mammals	0.132	0.00	0.00
Manganese	TS04	Small mammals	0.312	0.00	0.00
Manganese	TS03	Small mammals	0.447	0.01	0.00
Manganese	TS02	Small mammals	0.190	0.00	0.00
Manganese	TS01	Small mammals	0.256	0.00	0.00
Mercury	TS13	Small mammals	0.025	1.63	0.98
Mercury	TS10	Small mammals	0.000	0.00	0.00
Mercury	TS09	Small mammals	0.000	0.00	0.00
Mercury	TS08	Small mammals	0.000	0.00	0.00
Mercury	TS07	Small mammals	0.003	0.21	0.12
Mercury	TS06	Small mammals	0.018	1.21	0.73

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Mercury	TS05	Small mammals	0.015	0.99	0.59
Mercury	TS04	Small mammals	0.016	1.04	0.62
Mercury	TS03	Small mammals	0.002	0.12	0.07
Mercury	TS02	Small mammals	0.006	0.37	0.22
Mercury	TS01	Small mammals	0.004	0.29	0.17
Mercury	BCK 9.4	Fish	0.007	0.45	0.27
Mercury	BCK 4.5	Fish	0.022	1.46	0.87
Mercury	BCK 3.3	Fish	0.005	0.35	0.21
Mercury	BCK 12.4	Fish	0.010	0.69	0.41
Mercury	BCK 0.6	Fish	0.031	2.08	1.25
Mercury	S-3 Ponds	Small mammals	0.507	33.77	20.26
Mercury	Oil Landfarm	Small mammals	0.201	13.41	8.05
Mercury	Boneyard/Burnyard	Small mammals	0.007	0.46	0.27
Mercury	Burial Ground	Small mammals	0.003	0.20	0.12
Methoxychlor	TS13	Small mammals	0.000	0.00	0.00
Methoxychlor	TS10	Small mammals	0.000	0.00	0.00
Methoxychlor	TS07	Small mammals	0.000	0.00	0.00
Methoxychlor	TS06	Small mammals	0.000	0.00	0.00
Methoxychlor	TS03	Small mammals	0.000	0.00	0.00
Methoxychlor	TS01	Small mammals	0.000	0.00	0.00
Methoxychlor	S-3 Ponds	Small mammals	0.000	0.00	0.00
Mixed-BHC	TS07	Small mammals	0.000	0.00	0.00
Mixed-BHC	TS06	Small mammals	0.000	0.00	0.00
Mixed-BHC	TS04	Small mammals	0.000	0.00	0.00
Mixed-BHC	TS01	Small mammals	0.000	0.00	0.00
Molybdenum	TS09	Small mammals	0.000	0.00	0.00
Molybdenum	TS07	Small mammals	0.024	0.22	0.02
Molybdenum	TS04	Small mammals	0.032	0.30	0.03
Molybdenum	TS03	Small mammals	0.019	0.18	0.02
Molybdenum	TS02	Small mammals	0.013	0.12	0.01
Molybdenum	TS01	Small mammals	0.021	0.19	0.02
Molybdenum	S-3 Ponds	Small mammals	0.000	0.00	0.00
Molybdenum	Oil Landfarm	Small mammals	0.000	0.00	0.00

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Molybdenum	Boneyard/Burnyard	Small mammals	0.047	0.44	0.04
Molybdenum	Burial Ground	Small mammals	0.000	0.00	0.00
Nickel	TS13	Small mammals	1.270	0.04	0.02
Nickel	TS10	Small mammals	0.400	0.01	0.01
Nickel	TS09	Small mammals	0.381	0.01	0.01
Nickel	TS08	Small mammals	0.507	0.02	0.01
Nickel	TS07	Small mammals	0.162	0.01	0.00
Nickel	TS06	Small mammals	0.340	0.01	0.01
Nickel	TS05	Small mammals	0.595	0.02	0.01
Nickel	TS04	Small mammals	2.463	0.08	0.04
Nickel	TS03	Small mammals	1.237	0.04	0.02
Nickel	TS02	Small mammals	0.127	0.00	0.00
Nickel	TS01	Small mammals	0.098	0.00	0.00
Nickel	BCK 9.4	Fish	0.079	0.00	0.00
Nickel	BCK 3.3	Fish	0.054	0.00	0.00
Nickel	BCK 12.4	Fish	0.264	0.01	0.00
Nickel	S-3 Ponds	Small mammals	1.006	0.03	0.02
Nickel	Oil Landfarm	Small mammals	1.076	0.04	0.02
Nickel	Boneyard/Burnyard	Small mammals	0.121	0.00	0.00
Nickel	Burial Ground	Small mammals	0.764	0.02	0.01
PCB total	BCK 4.5	Fish	0.406	2.90	0.59
PCB total	BCK 0.6	Fish	0.127	0.90	0.18
PCB-1232	Oil Landfarm	Small mammals	0.000		
PCB-1248	S-3 Ponds	Small mammals	0.000	0.00	0.00
PCB-1248	Burial Ground	Small mammals	0.000	0.00	0.00
PCB-1254	TS10	Small mammals	0.005	0.04	0.01
PCB-1254	TS09	Small mammals	0.000	0.00	0.00
PCB-1254	TS07	Small mammals	0.000	0.00	0.00
PCB-1254	TS03	Small mammals	0.000	0.00	0.00
PCB-1254	TS01	Small mammals	0.000	0.00	0.00
PCB-1254	S-3 Ponds	Small mammals	0.000	0.00	0.00
PCB-1254	Oil Landfarm	Small mammals	0.002	0.01	0.00
PCB-1254	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
PCB-1254	Burial Ground	Small mammals	0.003	0.02	0.00
PCB-1260	TS13	Small mammals	0.043	0.31	0.06
PCB-1260	TS10	Small mammals	0.500	3.57	0.72
PCB-1260	TS09	Small mammals	0.019	0.14	0.03
PCB-1260	TS08	Small mammals	0.129	0.92	0.19
PCB-1260	TS07	Small mammals	0.039	0.28	0.06
PCB-1260	TS06	Small mammals	0.101	0.72	0.15
PCB-1260	TS04	Small mammals	0.476	3.40	0.69
PCB-1260	TS03	Small mammals	0.004	0.03	0.01
PCB-1260	TS02	Small mammals	0.027	0.19	0.04
PCB-1260	TS01	Small mammals	0.013	0.09	0.02
PCB-1260	S-3 Ponds	Small mammals	0.000	0.00	0.00
PCB-1260	Oil Landfarm	Small mammals	0.000	0.00	0.00
PCB-1260	Boneyard/Burnyard	Small mammals	0.008	0.06	0.01
PCB-1260	Burial Ground	Small mammals	0.000	0.00	0.00
PCB, total	BCK 9.4	Fish	0.284	2.03	0.41
PCB, total	BCK 3.3	Fish	0.094	0.67	0.14
PCB, total	BCK 12.4	Fish	0.030	0.21	0.04
Selenium	TS13	Small mammals	0.023	0.70	0.07
Selenium	TS10	Small mammals	0.015	0.47	0.05
Selenium	TS09	Small mammals	0.017	0.52	0.05
Selenium	TS08	Small mammals	0.052	1.62	0.16
Selenium	TS07	Small mammals	0.027	0.86	0.09
Selenium	TS06	Small mammals	0.016	0.49	0.05
Selenium	TS05	Small mammals	0.033	1.05	0.11
Selenium	TS04	Small mammals	0.023	0.72	0.07
Selenium	TS03	Small mammals	0.022	0.68	0.07
Selenium	TS02	Small mammals	0.017	0.52	0.05
Selenium	TS01	Small mammals	0.022	0.68	0.07
Selenium	BCK 9.4	Fish	0.057	1.80	0.18
Selenium	BCK 3.3	Fish	0.048	1.53	0.15
Selenium	BCK 12.4	Fish	0.037	1.17	0.12
Selenium	Boneyard/Burnyard	Small mammals	0.016	0.49	0.05

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Selenium	Burial Ground	Small mammals	0.008	0.24	0.02
Strontium	TS09	Small mammals	0.000	0.00	
Strontium	TS07	Small mammals	0.238	0.00	
Strontium	TS04	Small mammals	0.210	0.00	
Strontium	TS03	Small mammals	0.461	0.00	
Strontium	TS02	Small mammals	0.290	0.00	
Strontium	TS01	Small mammals	0.312	0.00	
Strontium	Oil Landfarm	Small mammals	0.000	0.00	
Strontium	Boneyard/Burnyard	Small mammals	0.286	0.00	
Strontium	Burial Ground	Small mammals	0.000	0.00	
Tetrachloroethene	S-3 Ponds	Small mammals	0.000	0.00	0.00
Tetrachloroethene	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
Tetrachloroethene	Burial Ground	Small mammals	0.000	0.00	0.00
Thallium	TS07	Small mammals	0.000	0.00	0.00
Thallium	TS04	Small mammals	0.000	0.00	0.00
Thallium	TS03	Small mammals	0.000	0.00	0.00
Thallium	TS02	Small mammals	0.001	0.21	0.02
Thallium	TS01	Small mammals	0.000	0.00	0.00
Thallium	BCK 9.4	Fish	0.001	0.22	0.02
Thallium	BCK 3.3	Fish	0.001	0.10	0.01
Thallium	BCK 12.4	Fish	0.001	0.12	0.01
Thallium	S-3 Ponds	Small mammals	0.000	0.05	0.01
Thallium	Oil Landfarm	Small mammals	0.000	0.05	0.00
Thallium	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
Tin	S-3 Ponds	Small mammals	0.000	0.00	0.00
Tin	Oil Landfarm	Small mammals	0.000	0.00	0.00
Tin	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
Tin	Burial Ground	Small mammals	0.000	0.00	0.00
Toluene	S-3 Ponds	Small mammals	0.000	0.00	0.00
Toluene	Oil Landfarm	Small mammals	0.000	0.00	0.00
Toluene	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
Toluene	Burial Ground	Small mammals	0.000	0.00	0.00
Total DDE	Burial Ground	Small mammals	0.000	0.00	0.00

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Total DDT	Burial Ground	Small mammals	0.000	0.00	0.00
Total-DDT	TS13	Small mammals	0.000	0.00	0.00
Total-DDT	TS09	Small mammals	0.000	0.00	0.00
Total-DDT	TS08	Small mammals	0.000	0.00	0.00
Total-DDT	TS07	Small mammals	0.000	0.00	0.00
Total-DDT	TS06	Small mammals	0.000	0.00	0.00
Total-DDT	TS05	Small mammals	0.000	0.00	0.00
Total-DDT	TS04	Small mammals	0.000	0.00	0.00
Total-DDT	TS03	Small mammals	0.000	0.00	0.00
Total-DDT	TS01	Small mammals	0.000	0.00	0.00
Trichloroethene	Burial Ground	Small mammals	0.000	0.00	0.00
Uranium	TS09	Small mammals	0.000	0.00	0.00
Uranium	TS07	Small mammals	0.001	0.00	0.00
Uranium	TS04	Small mammals	0.006	0.00	0.00
Uranium	TS03	Small mammals	0.006	0.00	0.00
Uranium	TS02	Small mammals	0.001	0.00	0.00
Uranium	TS01	Small mammals	0.001	0.00	0.00
Uranium	BCK 9.4	Fish	0.087	0.07	0.21
Uranium	BCK 3.3	Fish	0.037	0.03	0.09
Uranium	BCK 12.4	Fish	0.070	0.06	0.17
Uranium	Oil Landfarm	Small mammals	0.000	0.00	0.00
Uranium	Boneyard/Burnyard	Small mammals	0.025	0.02	0.01
Uranium	Burial Ground	Small mammals	0.000	0.00	0.00
Vanadium	TS13	Small mammals	0.024	0.16	0.02
Vanadium	TS10	Small mammals	0.037	0.25	0.02
Vanadium	TS09	Small mammals	0.041	0.27	0.03
Vanadium	TS08	Small mammals	0.024	0.16	0.02
Vanadium	TS07	Small mammals	0.000	0.00	0.00
Vanadium	TS06	Small mammals	0.020	0.13	0.01
Vanadium	TS05	Small mammals	0.109	0.73	0.07
Vanadium	TS04	Small mammals	0.000	0.00	0.00
Vanadium	TS03	Small mammals	0.000	0.00	0.00
Vanadium	TS02	Small mammals	0.000	0.00	0.00

Table G.61 (continued)

Analyte	Location	Exposure medium	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Vanadium	TS01	Small mammals	0.000	0.00	0.00
Vanadium	S-3 Ponds	Small mammals	0.053	0.36	0.04
Vanadium	Oil Landfarm	Small mammals	0.076	0.51	0.05
Vanadium	Boneyard/Burnyard	Small mammals	0.000	0.00	0.00
Vanadium	Burial Ground	Small mammals	0.063	0.42	0.04
Vinylchloride	Burial Ground	Small mammals	0.000	0.00	0.00
Zinc	TS13	Small mammals	3.726	0.03	0.02
Zinc	TS10	Small mammals	6.645	0.05	0.03
Zinc	TS09	Small mammals	3.335	0.03	0.01
Zinc	TS08	Small mammals	8.827	0.07	0.04
Zinc	TS07	Small mammals	5.152	0.04	0.02
Zinc	TS06	Small mammals	3.729	0.03	0.02
Zinc	TS05	Small mammals	3.845	0.03	0.02
Zinc	TS04	Small mammals	20.018	0.16	0.08
Zinc	TS03	Small mammals	5.651	0.05	0.02
Zinc	TS02	Small mammals	4.576	0.04	0.02
Zinc	TS01	Small mammals	4.577	0.04	0.02
Zinc	BCK 9.4	Fish	4.017	0.03	0.02
Zinc	BCK 3.3	Fish	4.922	0.04	0.02
Zinc	BCK 12.4	Fish	3.205	0.03	0.01
Zinc	S-3 Ponds	Small mammals	8.599	0.07	0.03
Zinc	Oil Landfarm	Small mammals	16.612	0.14	0.07
Zinc	Boneyard/Burnyard	Small mammals	4.296	0.03	0.02
Zinc	Burial Ground	Small mammals	8.072	0.07	0.03
Zirconium	Oil Landfarm	Small mammals	0.000	0.00	
Zirconium	Boneyard/Burnyard	Small mammals	0.000	0.00	
Zirconium	Burial Ground	Small mammals	0.000	0.00	

**Table G.62. Point estimates of contaminant exposure for belted kingfisher
in the Bear Creek watershed**

Analyte	Location	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Antimony	BCK3.3	0.002		
Antimony	BCK9.4	0.003		
Antimony	BCK12.4	0.005		
Arsenic	BCK3.3	0.190	0.037	0.015
Arsenic	BCK9.4	0.272	0.053	0.021
Arsenic	BCK12.4	0.172	0.034	0.013
Beryllium	BCK3.3	0.008		
Beryllium	BCK9.4	0.014		
Beryllium	BCK12.4	0.015		
Cadmium	BCK3.3	0.123	0.085	0.006
Cadmium	BCK9.4	0.301	0.208	0.015
Cadmium	BCK12.4	1.056	0.729	0.053
Chromium (+6)	BCK3.3	0.471	0.471	0.094
Chromium (+6)	BCK9.4	0.573	0.573	0.115
Chromium (+6)	BCK12.4	0.442	0.442	0.088
Copper	BCK3.3	0.546	0.012	0.009
Copper	BCK9.4	0.614	0.013	0.010
Copper	BCK12.4	0.476	0.010	0.008
Lead	BCK3.3	0.169	0.150	0.015
Lead	BCK9.4	0.357	0.316	0.032
Lead	BCK12.4	0.337	0.298	0.030
Lithium	BCK3.3	0.246		
Lithium	BCK9.4	0.522		
Lithium	BCK12.4	0.198		
Mercury	BCK0.6	0.211	35.236	3.303
Mercury	BCK3.3	0.036	6.005	0.563
Mercury	BCK4.5	0.148	24.679	2.314
Mercury	BCK9.4	0.045	7.576	0.710
Mercury	BCK12.4	0.070	11.706	1.097
Nickel	BCK3.3	0.363	0.005	0.003
Nickel	BCK9.4	0.533	0.007	0.005
Nickel	BCK12.4	1.791	0.023	0.017
PCB total	BCK0.6	0.858	4.767	0.477
PCB total	BCK4.5	2.748	15.268	1.527
PCB, total	BCK3.3	0.639	3.552	0.355
PCB, total	BCK9.4	1.921	10.673	1.067
PCB, total	BCK12.4	0.202	1.124	0.112
Selenium	BCK3.3	0.328	0.657	0.328
Selenium	BCK9.4	0.386	0.771	0.386
Selenium	BCK12.4	0.250	0.500	0.250
Thallium	BCK3.3	0.004		
Thallium	BCK9.4	0.008		
Thallium	BCK12.4	0.005		
Uranium	BCK3.3	0.249	0.016	
Uranium	BCK9.4	0.586	0.037	
Uranium	BCK12.4	0.475	0.030	
Zinc	BCK3.3	33.346	2.300	0.255
Zinc	BCK9.4	27.211	1.877	0.208
Zinc	BCK12.4	21.712	1.497	0.166

Table G.63. Total biomass of fish observed at BMAP fish sampling locations in 1993

Sample location		Fish biomass (g/m ²)			Proportion of total biomass at sampled locations	
Fish community	Bioaccumulation	Spring	Fall	Mean annual biomass	Data from all 5 locations	Data from only 3 locations
BCK 0.7	BCK 0.6	5.84	4.73	5.29	0.18	
BCK 3.25	BCK 3.3	2.57	3.29	2.93	0.1	0.137
BCK 3.25	BCK 4.5	2.57	3.29	2.93	0.1	
BCK 9.4	BCK 9.4	5.37	12.59	8.98	0.30	0.42
BCK 12.36	BCK 12.4	14.43	4.43	9.43	0.32	0.442

Source: Hinzman et al. 1995.

Table G.64. Results of Monte Carlo simulation of exposure for wildlife in the Bear Creek watershed

Analyte	Species	Area	Mean	Standard deviation	80th percentile	% > NOAEL	% > LOAEL
Aluminum	Short tailed shrew	BCOU1	2503.922	168.914	2648.736	>95%	>95%
Aluminum	Short tailed shrew	BCV	1268.847	73.645	1332.284	>95%	>95%
Aluminum	Short-tailed shrew	Background	3062.981	159.955	3195.581	>95%	>95%
Antimony	Short tailed shrew	BCOU1	20.732	20.821	37.794	80-85%	80-85%
Antimony	Short tailed shrew	BCV	6.987	6.940	12.674	80-85%	75-80%
Antimony	Short tailed shrew	Background	0.003	0.001	0.004	<5%	<5%
Arsenic	Short tailed shrew	BCOU1	0.994	0.115	1.086	>95%	<5%
Arsenic	Short tailed shrew	BCV	0.714	0.046	0.751	>95%	<5%
Arsenic	Short tailed shrew	Background	0.833	0.111	0.930	>95%	<5%
Barium	Short tailed shrew	BCOU1	21.499	1.309	22.527	>95%	<5%
Barium	Short tailed shrew	BCV	19.241	0.741	19.834	>95%	<5%
Barium	Short tailed shrew	Background	16.318	4.300	20.040	80-85%	<5%
Cadmium	Short tailed shrew	BCOU1	5.248	2.527	7.416	80-85%	<5%
Cadmium	Short tailed shrew	BCV	7.899	3.490	10.933	90-95%	<5%
Cadmium	Short tailed shrew	Background	0.906	0.238	1.098	<5%	<5%
Chromium	Short tailed shrew	BCOU1	3.478	0.148	3.588	<5%	<5%
Chromium	Short tailed shrew	BCV	2.484	0.050	2.526	<5%	<5%
Chromium	Short tailed shrew	Background	3.248	0.242	3.442	<5%	<5%
Copper	Short tailed shrew	BCOU1	30.167	7.088	36.118	25-30%	<5%
Copper	Short tailed shrew	BCV	54.498	26.505	76.700	75-80%	65-70%

Table G.64 (continued)

Analyte	Species	Area	Mean	Standard deviation	80th percentile	% > NOAEL	% > LOAEL
Copper	Short tailed shrew	Background	3.665	0.407	3.975	<5%	<5%
Lead	Short tailed shrew	BCOU1	22.455	12.220	14.452	<5%	<5%
Lead	Short tailed shrew	BCV	5.732	0.948	6.509	<5%	<5%
Lead	Short tailed shrew	Background	2.131	0.306	2.383	<5%	<5%
Mercury	Short tailed shrew	BCOU1	2.865	0.766	3.441	>95%	>95%
Mercury	Short tailed shrew	BCV	0.907	0.205	1.063	>95%	>95%
Mercury	Short tailed shrew	Background	0.155	0.042	0.191	>95%	<5%
Molybdenum	Short tailed shrew	BCOU1	0.813	0.203	0.986	>95%	<5%
Molybdenum	Short tailed shrew	BCV	2.970	0.551	3.432	>95%	40-45%
Molybdenum	Short tailed shrew	Background	12.023	4.143	15.489	>95%	>95%
Nickel	Short tailed shrew	BCOU1	43.592	8.782	51.333	<5%	<5%
Nickel	Short tailed shrew	BCV	36.549	3.944	39.747	<5%	<5%
Nickel	Short tailed shrew	Background	47.380	12.615	57.395	<5%	<5%
PCB	Short tailed shrew	BCOU1	1.328	0.675	1.806	>95%	85-90%
PCB	Short tailed shrew	BCV	0.646	0.896	1.317	75-80%	45-50%
Selenium	Short tailed shrew	BCOU1	0.865	0.401	1.196	85-90%	60-65%
Selenium	Short tailed shrew	BCV	0.973	0.079	1.041	>95%	>95%
Selenium	Short tailed shrew	Background	1.312	0.092	1.390	>95%	>95%
Vanadium	Short tailed shrew	BCOU1	4.303	0.190	4.470	>95%	50-55%

Table G.64 (continued)

Analyte	Species	Area	Mean	Standard deviation	80th percentile	% > NOAEL	% > LOAEL
Vanadium	Short tailed shrew	BCV	2.498	0.067	2.555	>95%	<5%
Vanadium	Short tailed shrew	Background	3.987	0.193	4.154	>95%	90-95%
Zinc	Short tailed shrew	BCOU1	62.678	5.922	67.665	<5%	<5%
Zinc	Short tailed shrew	BCV	77.911	6.023	82.890	<5%	<5%
Zinc	Short tailed shrew	Background	44.033	7.618	50.581	<5%	<5%
Aluminum	White-footed mouse	BCOU1	435.645	166.475	575.943	>95%	>95%
Aluminum	White-footed mouse	BCV	391.134	47.939	430.410	>95%	>95%
Aluminum	White-footed mouse	Background	974.048	86.703	1049.190	>95%	>95%
Cadmium	White-footed mouse	BCOU1	0.736	0.329	1.004	<5%	<5%
Cadmium	White-footed mouse	BCV	1.108	0.435	1.447	<5%	<5%
Cadmium	White-footed mouse	Background	0.118	0.033	0.146	<5%	<5%
Chromium	White-footed mouse	BCOU1	7.197	1.338	8.262	65-70%	<5%
Chromium	White-footed mouse	BCV	3.864	0.512	4.270	<5%	<5%
Chromium	White-footed mouse	Background	8.552	2.331	10.307	80-85%	<5%
Copper	White-footed mouse	BCOU1	1.433	0.261	1.656	<5%	<5%
Copper	White-footed mouse	BCV	2.976	0.237	3.172	<5%	<5%
Copper	White-footed mouse	Background	0.306	0.009	0.313	<5%	<5%
Mercury	White-footed mouse	BCOU1	0.293	0.097	0.372	>95%	35-40%
Mercury	White-footed mouse	BCV	0.108	0.024	0.127	>95%	<5%

Table G.64 (continued)

Analyte	Species	Area	Mean	Standard deviation	80th percentile	% > NOAEL	% > LOAEL
Mercury	White-footed mouse	Background	0.020	0.005	0.024	<5%	<5%
Molybdenum	White-footed mouse	BCOU1	0.092	0.028	0.116	<5%	<5%
Molybdenum	White-footed mouse	BCV	0.386	0.073	0.444	90-95%	<5%
Molybdenum	White-footed mouse	Background	1.547	0.506	1.962	>95%	<5%
PCB	White-footed mouse	BCOU1	0.029	0.009	0.036	<5%	<5%
PCB	White-footed mouse	BCV	0.010	0.003	0.012	<5%	<5%
Aluminum	White-tailed deer	BCV	9.869	0.560	10.350	>95%	>95%
Aluminum	White-tailed deer	Background	22.840	1.283	23.919	>95%	>95%
Antimony	White-tailed deer	BCV	0.00806	0.00702	0.01411	5-10%	<5%
Antimony	White-tailed deer	Background	0.00030	0.00002	0.00033	<5%	<5%
Copper	White-tailed deer	BCV	0.794	0.046	0.834	<5%	<5%
Copper	White-tailed deer	Background	0.066	0.006	0.071	<5%	<5%
Mercury	White-tailed deer	BCV	0.005	0.000	0.005	<5%	<5%
Mercury	White-tailed deer	Background	0.001	0.000	0.001	<5%	<5%
Aluminum	Red fox	BCV	385.513	22.785	405.176	>95%	>95%
Aluminum	Red fox	Background	904.583	52.321	950.396	>95%	>95%
Antimony	Red fox	BCV	0.03435	0.03169	0.06101	45-50%	<5%
Antimony	Red fox	Background	0.00404	0.00011	0.00414	<5%	<5%
Copper	Red fox	BCV	23.979	17.200	38.304	80-85%	75-80%

Table G.64 (continued)

Analyte	Species	Area	Mean	Standard deviation	80th percentile	% > NOAEL	% > LOAEL
Copper	Red fox	Background	1.146	0.476	1.552	<5%	<5%
Mercury	Red fox	BCV	0.049	0.009	0.057	>95%	>95%
Mercury	Red fox	Background	0.004	0.001	0.005	<5%	<5%
PCB	Red fox	BCV	0.056	0.013	0.066	<5%	<5%
Copper	Red-tailed hawk	BCV	27.313	20.750	44.635	15-20%	<5%
Copper	Red-tailed hawk	Background	3.537	3.208	6.078	<5%	<5%
Mercury	Red-tailed hawk	BCV	0.03489	0.01076	0.04320	>95%	<5%
Mercury	Red-tailed hawk	Background	0.00194	0.00031	0.00217	<5%	<5%
Zinc	Red-tailed hawk	BCV	13.066	1.837	14.626	20-25%	<5%
Zinc	Red-tailed hawk	Background	4.417	0.435	4.775	<5%	<5%
Aluminum	Mink	BCV	1.195	0.197	1.363	>95%	<5%
Copper	Mink	BCV	17.043	12.599	27.317	65-70%	50-55%
Copper	Mink	Background	0.850	0.347	1.148	<5%	<5%
Mercury	Mink	BCV	0.02082	0.00613	0.02586	80-85%	20-25%
Mercury	Mink	Background	0.00125	0.00018	0.00141	<5%	<5%
PCB	Mink	BCV	0.037	0.017	0.052	<5%	<5%
Mercury	Belted kingfisher	BCV	0.076	0.004	0.079	>95%	>95%
PCB	Belted kingfisher	BCV	0.855	0.091	0.933	>95%	<5%

Table G.65. Experimental information for derivation of mammalian NOAELs and LOAELs

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation
Acetone	NA	rat	10 ^a 90 d	50 ^a 90 d	liver, kidney damage	EPA 1986c
Aldrin	NA	rat	0.2 3 gen.	1 3 gen.	reproduction	Treon and Cleveland 1955
Aluminum	AlCl ₃	mouse	1.93 ^b 3 gen.	19.3 3 gen.	reproduction	Ondreicka et al. 1966
Antimony	potassium tartrate	mouse	0.125 lifetime	1.25 lifetime	reproduction	Schroeder et al. 1968
Aroclor-1248	NA	rhesus monkey	0.01 ^b 14 months	0.1 14 months	reproduction	Barsotti et al. 1976
Aroclor-1254	NA	mink	0.14 4.5 months	0.69 4.5 months	reproduction	Aulerich and Ringer 1977
Arsenic	As+3	mouse	0.126 ^b 3 gen.	1.26 3 gen.	reproduction	Schroeder and Mitchner 1971
Barium	chloride	rat	5.1 16 months		growth, hypertension	Perry et al. 1983
Barium	chloride	rat		19.8 ^a 10 d	mortality	Borzelleca et al. 1988
Benzene	NA	mouse	26.36 ^b 6-12 d, gest.	263.6 6-12 d, gest.	reproduction	Nawrot and Staples 1979
Benzo(a)pyrene	NA	mouse	1 ^b 7-16 d, gest.	10 7-16 d, gest.	reproduction	Mackenzie and Angevine 1981
Beryllium	sulfate	rat	0.66 1126 d		longevity/ weight loss	Schroeder and Mitchner 1975

Table G.65 (continued)

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation
BHC (mixed isomers)	NA	rat	1.6 4 gen.	3.2 4 gen.	reproduction	Grant et al. 1977
Bis(2-ethylhexyl) phthalate	NA	mouse	18.3 105 d	183 105 d	reproduction	Lamb et al. 1987
Boron	boric acid, borax	rat	28 3 gen.	93.6 3 gen.	reproduction	Weir and Fisher 1972
Cadmium	CdCl ₂	rat	1 6 wks	10 6 wks	reproduction	Sutou et al. 1980
Carbon tetrachloride	NA	rat	16 2 years		reproduction	Alumot et al. 1976a
Chlordane	NA	mouse	4.6 6 gen.	9.2 6 gen.	reproduction	WHO 1984 (Keplinger et al. 1968)
Chloroform	NA	rat	15 ^a 13 weeks	41 ^a 13 weeks	liver, kidney, gonad cond	Palmer et al. 1979
Chromium	Cr ⁺⁶	rat	3.28 1 year		weight loss, food consumption	Mackenzie et al. 1958
Chromium	Cr ⁺⁶	rat		13.14 ^a 3 months	Mortality	Steven et al. 1976
Copper	sulfate	mink	11.71 1 year	15.14 1 year	reproduction	Aulerich et al. 1982
Cyanide	potassium cyanide	rat	68.7 gest. lact.		reproduction	Tewe and Maner 1981

Table G.65 (continued)

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation
DDT and metabolites	NA	rat	0.8 2 years	4.0 2 years	reproduction	Fitzhugh 1948
1,2 Dichloroethane	NA	mouse	50 2 gen.		reproduction	Lane et al. 1982
1,1 Dichloroethene	NA	rat	30 2 years		mortality, body weight, blood chem., liver histology	Quast et al. 1983
1,1 Dichloroethene	NA	dog	2.5 ^a 97 d		mortality, body weight, blood chem., liver histology	Quast et al. 1983
1,2 Dichloroethene	NA	mouse	45.2 ^a 90 d		body, organ weight, blood chem. hepatic function	Palmer et al. 1979
Dieldrin	NA	rat	0.02 ^b 3 gen.	0.2 3 gen.	reproduction	Treon and Cleveland 1955
Diethylphthalate	NA	mouse	4583 105 d		reproduction	Lamb et al. 1987
Di-n-butylphthalate	NA	mouse	550 105 d	1833 105 d	reproduction	Lamb et al. 1987
Endosulfan	NA	rat	0.15 ^a 30 d		reproduction, blood chem.	Dikshith et al 1984

Table G.65 (continued)

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation
Endrin	NA	mouse	0.092 ^b 120 d	0.92 120 d	reproduction	Good and Ware 1969
Fluoride	NaF	mink	31.37 382 d	52.75 382 d	reproduction	Aulerich et al. 1987
Heptachlor	NA	mink	0.1 ^b 181 d	1 181 d	reproduction	Crum et al. 1993
Lead	acetate	rat	8 3 gen.	80 3 gen.	reproduction	Azar et al. 1973
Lindane	NA	rat	8 3 gen.		reproduction	Palmer et al. 197
Lithium	carbonate	rat	9.4 gest.	18.8 gest.	reproduction	Marathe and Thomas 1986
Manganese	oxide	rat	88 224 d, gest.	284 224 d, gest.	reproduction	Laskey et al. 1982
Mercury	methyl	mink	0.015 ^a 93 d	93 d	mortality	Wobeser et al. 1976
Mercury	methyl	rat	3 gen.	0.16 3 gen.	reproduction	Verschuuren et al. 1976
Methyl Ethyl Ketone	NA	rat	1771 2 gen.	4571 2 gen.	reproduction	Cox et al. 1975
4-Methyl, 2-Pentanone	NA	rat	25 ^a 13 weeks	13 weeks	liver, kidney function	Microbiological Associates 1986 (from HEAST; EPA 1993f)

Table G.65 (continued)

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation
Methoxychlor	NA	rat	4 11 months	8 11 months	reproduction	Gray et al. 1988
Molybdenum	molybdate	mouse	0.26 ^b 3 gen.	2.6 3 gen.	reproduction	Schroeder and Mitchner 1971
Nickel	sulfate	rat	40 3 gen.	80 3 gen.	reproduction	Ambrose et al. 1976
Niobium	sodium niobate	mouse	0.155 ^b lifetime	1.55 lifetime	lifespan, longevity	Schroeder et al. 1968
Nitrate	potassium nitrate	guinea pig	507 143-204 d	1130 143-204 d	reproduction	Sleight and Atallah 1968
Selenium	potassium selenate	rat	0.2 2 gen.	0.33 2 gen.	reproduction	Rosenfeld and Beath 1954
Strontium	chloride	rat	263 3 years	3 years	body weight, bone changes	Skoryna 1981
2378 - TCDD	NA	rat	0.000001 3 gen.	0.00001 3 gen.	reproduction	Murray et al. 1979
1,1,2,2-Tetrachloroethene	NA	mouse	1.4 ^a 6 weeks	7 ^a 6 weeks	Hepatotoxicity	Buben and O'Flaherty 1985
Thallium	sulfate	rat	0.0074 ^{a,b} 60 d	0.074 ^{a,b} 60 d	reproduction	Formigli et al. 1986
Tin	(TBTO)	mouse	23.4 6-15 d, gest.	35 6-15 d, gest.	reproduction	Davis et al. 1987

Table G.65 (continued)

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation
Toluene	NA	mouse	26 ^b 6-12 d, gest.	260 6-12 d, gest.	reproduction	Nawrot and Staples 1979
Trichloroethene	NA	mouse	0.7 ^{a,b} 6 weeks	7 ^a 6 weeks	hepatotoxicity	Buben and O'Flaherty 1985
1,1,1 Trichloroethane	NA	mouse	1000 3 gen.	3 gen.	reproduction	Lane et al. 1982
Uranium	acetate	mouse	3.07 gest.	6.13 gest.	reproduction	Paternain et al. 1989
Vanadium	NaVO3	rat	0.21 ^b 60 d + gest.	2.1 60 d + gest.	reproduction	Domingo et al. 1986
Vinyl chloride	NA	rat	0.17 ^b lifetime	1.7 lifetime	longevity, mortality	Feron et al. 1981
Zinc	oxide	rat	160 gest.	320 gest.	reproduction	Schlicker and Cox 1968
Zirconium	sulfate	mouse	1.74 lifetime	lifetime	lifespan, longevity	Schroeder et al. 1968b

^aEstimated NOAEL: subchronic to chronic factor of 10 applied.^bEstimated NOAEL: LOAEL to NOAEL factor of 10 applied.

Table G.66. Estimated NOAELs and LOAELs for mammalian endpoints

Contaminant	Estimated NOAELs					Estimated LOAELs				
	Shrew	Mouse	Mink	Fox	Deer	Shrew	Mouse	Mink	Fox	Deer
Acetone	21.978	19.972	7.692	5.281	2.806	109.892	99.858	38.458	26.405	14.028
Aldrin	0.440	0.399	0.154	0.106	0.056	2.198	1.997	0.769	0.528	0.281
Aluminum	2.295	2.086	0.803	0.551	0.293	22.952	20.856	8.032	5.515	2.930
Antimony	0.149	0.135	0.052	0.036	0.019	1.487	1.351	0.520	0.357	0.190
Aroclor 1248	0.043	0.039	0.015	0.010	0.005	0.427	0.388	0.150	0.103	0.055
Aroclor 1254	0.067	0.061	0.140	0.096	0.009	0.668	0.607	0.690	0.474	0.085
Arsenic	0.150	0.136	0.052	0.036	0.019	1.498	1.362	0.524	0.360	0.191
Barium	11.835	10.754	4.142	2.844	1.511	43.517	39.544	15.229	10.456	5.555
Benzene	31.348	28.485	10.971	7.532	4.001	313.476	284.851	109.705	75.321	40.014
BHC-mixed	3.517	3.195	0.014	0.010	0.449	7.033	6.391	0.140	0.096	0.898
Benzo(a)pyrene	1.189	1.081	0.416	0.286	0.152	11.892	10.806	4.162	2.857	1.518
Beryllium	1.451	1.318	0.508	0.349	0.185					
Bis(2-ethylhexyl)phthalate	21.763	19.775	7.616	5.229	2.778	217.625	197.753	76.161	52.290	27.779
Boron	61.539	55.920	21.536	14.787	7.855	205.717	186.933	71.993	49.430	26.259
Cadmium	2.12	1.926	0.742	0.509	0.271	21.2	19.3	7.4	5.1	2.7
Carbon Tetrachloride	35.165	31.954	12.307	8.450	4.489					
Chlordane	5.470	4.971	1.914	1.314	0.698	10.941	9.942	3.829	2.629	1.397
Chloroform	32.967	29.957	11.537	7.922	4.208	90.111	81.883	31.536	21.652	11.503
Chromium (Cr+3)	6015.461	5466.200	2105.191	1445.410	767.865					

Table G.66 (continued)

Contaminant	Estimated NOAELs					Estimated LOAELs				
	Shrew	Mouse	Mink	Fox	Deer	Shrew	Mouse	Mink	Fox	Deer
Chromium (Cr+6)	7.209	6.551	2.523	1.732	0.920	28.879	26.243	10.107	6.939	3.686
Copper	33.432	30.380	11.700	8.033	4.267	43.262	39.312	15.140	10.395	5.522
Cyanide	141.890	128.941	49.659	34.095	18.113					
DDT	1.758	1.598	0.615	0.422	0.224	8.791	7.989	3.077	2.112	1.122
1,2-Dichloroethane	61.797	56.154	21.627	14.849	7.888					
1,1-Dichloroethene	65.935	59.915	4.446	3.052	8.417					
1,2-Dichloroethene	53.752	48.844	18.811	12.915	6.861					
Dieldrin	0.044	0.040	0.015	0.011	0.006	0.440	0.399	0.154	0.106	0.056
Diethylphthalate	5450.149	4952.481	1907.353	1309.546	695.699					
Di-n-butyl phthalate	654.066	594.341	228.899	157.157	83.490	2179.822	1980.776	762.858	523.761	278.249
Endosulfan	0.330	0.300	0.115	0.079	0.042					
Endrin	0.109	0.099	0.038	0.026	0.014	1.094	0.994	0.383	0.263	0.140
Fluoride	89.638	81.453	31.370	21.538	11.442	150.730	136.967	52.750	36.218	19.240
Heptachlor	0.286	0.260	0.100	0.069	0.036	2.857	2.597	1.000	0.687	0.365
Lead	17.583	15.977	6.153	4.225	2.244	175.826	159.772	61.533	42.248	22.444
Lindane (Gamma-BHC)	17.583	15.977	6.153	4.225	2.244					
Lithium	20.660	18.773	7.230	4.964	2.637	41.319	37.546	14.460	9.928	5.274
Manganese	193.409	175.749	67.686	46.473	24.688	624.140	567.191	218.441	149.980	79.676
Methylmercury	0.070	0.064	0.015	0.010	0.009	0.352	0.320	0.123	0.085	0.045

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Table G.66 (continued)

Contaminant	Estimated NOAELs					Estimated LOAELs				
	Shrew	Mouse	Mink	Fox	Deer	Shrew	Mouse	Mink	Fox	Deer
Methoxychlor	8.791	7.989	3.077	2.112	1.122	17.583	15.977	6.153	4.225	2.244
Methyl Ethyl Ketone (2-Butanone)	3892.357	4628.827	1362.182	935.265	496.854	10046.28	11947.13	3515.83	2413.94	1282.394
						1	1	0	5	
4-Methyl 2-Pentanone	54.946	49.929	19.229	13.203	7.014					
Molybdenum	0.309	0.281	0.108	0.074	0.039	3.092	2.810	1.082	0.743	0.395
Nickel	87.913	79.886	30.766	21.124	11.222	175.826	159.772	61.533	42.248	22.444
Niobium	0.184	0.168	0.065	0.044	0.024	1.843	1.675	0.645	0.443	0.235
Nitrate	1395.112	1267.728	488.241	335.218	178.084	3109.421	2825.509	1088.19	747.133	396.913
						0				
Selenium (Sodium selenite)	0.44	0.399	0.154	0.106	0.056	0.725	0.659	0.254	0.174	0.093
Strontium	578.029	525.250	202.289	138.890	73.785					
2,3,7,8-Tetrachloro Dibenzodioxin	2.20e -06	2.00e -06	7.70e -07	5.30e -07	2.80e -07	2.20e -05	2.00e -05	7.70e -06	5.30e -06	2.80e -06
1,1,2,2-Tetrachloroethene	1.665	1.513	0.583	0.400	0.213	8.324	7.564	2.913	2.000	1.063
Thallium	0.016	0.015	0.006	0.004	0.002	0.164	0.149	0.058	0.039	0.021
Tin	27.828	25.287	9.739	6.686	3.552	41.622	37.822	14.566	10.001	5.313
Toluene	30.919	28.096	10.821	7.429	3.947	309.195	280.961	108.207	74.292	39.468
1,1,1-Trichloroethane	1235.930	1123.080	432.530	296.970	157.760					
Trichloroethene	0.832	0.756	0.291	0.200	0.106	8.324	7.564	2.913	2.000	1.063

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Table G.66 (continued)

Contaminant	Estimated NOAELs					Estimated LOAELs				
	Shrew	Mouse	Mink	Fox	Deer	Shrew	Mouse	Mink	Fox	Deer
Uranium	3.588	3.261	1.256	0.862	0.458	7.165	6.511	2.508	1.722	0.915
Vanadium	0.428	0.389	0.150	0.103	0.055	4.285	3.894	1.500	1.030	0.547
Vinyl Chloride	0.374	0.340	0.131	0.090	0.048	3.736	3.395	1.308	0.898	0.477
Xylene(mixed)	2.497	2.269	0.874	0.600	0.319	3.092	2.810	1.082	0.743	0.395
Zinc	351.653	319.544	123.066	84.496	44.888	703.306	639.088	246.131	168.992	89.776
Zirconium	2.069	1.880	0.724	0.497	0.264					

Table G.67. Estimated NOAELs and LOAELs for avian endpoints

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation	Estimated NOAEL (mg/kg/d)	Estimated LOAEL (mg/kg/d)
Aluminum	Al ₂ (SO ₄) ₃	ringed dove	109.7 4 months		reproduction	Carriere et al. 1986	109.7	
Aluminum	chloride	day-old white leghorn chicks	2 weeks	44.5 ^a 2 weeks	mortality	Storer and Nelson 1968		44.5
Aroclor 1242	NA	screech owl	0.41 2 generation	2 generation	reproduction	McLane and Hughes 1980	0.41	
Aroclor 1254	NA	Ring-necked pheasant	0.18 ^a 17 weeks	1.8 17 weeks	reproduction	Dahlgren et al. 1972	0.18	1.8
Arsenic	arsenite	mallard duck	5.14 128 d	12.84 128 d	mortality	USFWS 1964	5.14	12.84
Arsenic	Paris Green	brown-headed cowbird	2.46 7 months	7.38 7 months	mortality	USFWS 1969	2.46	7.38
Barium	hydroxide	day-old chicks	20.8 ^a 4 weeks	41.7 ^a 4 weeks	mortality	Johnson et al. 1960	20.8	41.7
BHC (mixed isomers)	NA	Japanese Quail	0.56 90 d	2.25 90 d	reproduction	Vos et al. 1971	0.56	2.25
bis(2-ethylhexyl) Phthalate	NA	ringed dove	1.1 4 weeks	4 weeks	reproduction	Peakall 1974	1.1	
Boron	boric acid	mallard duck	28.8 3 weeks before, during, 3 weeks post reproduction	100 3 weeks before, during, 3 weeks post reproduction	reproduction	Smith and Anders 1989	28.8	100
Cadmium	CdCl ₂	mallard duck	1.45 90 d	20 90 d	reproduction	White and Finley 1978	1.45	20
Chlordane	NA	red-winged blackbird	2.14 84 d	10.7 84 d	mortality	Stickel et al. 1983	2.14	10.7

Table G.67 (continued)

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation	Estimated NOAEL (mg/kg/d)	Estimated LOAEL (mg/kg/d)
Chromium	Cr ⁺³	black duck	1 10 months	5 10 months	reproduction	Haseltine et al., unpubl. data	1	5
Copper	oxide	chicken	33.2 10 weeks	46.97 10 weeks	growth/ mortality	Mehring et al. 1960	33.2	46.97
1,2-Dichloroethane	NA	chicken	17.2 2 years	34.4 2 years	reproduction	Alumot et al. 1976b	17.2	
DDT and metabolites	NA	Brown Pelican	0.0028 ^b >1 year	0.028 ^b >1 year	reproduction	Anderson et al. 1975	0.0028	0.028
Dieldrin	NA	barn owl	0.077 2 year		reproduction	Mendenhall et al. 1983	0.077	
Di-n-butylphthalate	NA	ringed dove	0.11 ^c 4 weeks	1.1 4 weeks	reproduction	Peakall 1974	0.11	
Endosulfan	NA	gray partridge	10 4 weeks		reproduction	Abiola 1992	10	
Endrin	NA	screech owl	0.01 ^c 83 d	0.1 83 d	reproduction	Fleming et al. 1982	0.01	0.1
Fluoride	NaF	screech owl	7.8 5-6 months	32 5-6 months	reproduction	Pattee et al. 1988	7.8	32
Lead	metal	American Kestrel	3.85 7 months		reproduction	Pattee 1984	3.85	
Lead	acetate	Japanese quail		11.3 12 weeks	reproduction	Edens et al. 1976		11.3
Lindane	NA	mallard duck	2 ^c 8 weeks	20 8 weeks	reproduction	Chakravarty and Lahiri 1986	2	20

Table G.67 (continued)

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation	Estimated NOAEL (mg/kg/d)	Estimated LOAEL (mg/kg/d)
Manganese	oxide	Japanese quail	977 75 d	75 d	growth, aggressiveness	Laskey and Edens 1985	977	
Mercury	methyl	mallard duck	0.0064 ^a 3 generations	0.064 3 generations	reproduction	Heinz 1979	0.0064	0.064
Molybdenum	sodium Mo	chicken	3.5 ^c 21 d	35.3 21 d	reproduction	Lepore and Miller	3.5	35.3
Nickel	sulfate	mallard duck	77.4 90 d	107 90 d	mortality, growth, behavior	Cain and Pafford 1981	77.4	107
Pentachloro nitrobenzene	NA	chicken	7.07 35 weeks	70.7 35 weeks	reproduction	Dunn et al. 1979	7.07	70.7
Selenium	selenite	mallard duck	0.5 10 weeks	1.0 10 weeks	reproduction	Heinz et al. 1987	0.5	1.0
Selenium	seleno- methionine	mallard duck	0.4 100 d	0.8 100 d	reproduction	Heinz et al. 1989	0.4	0.8
2,3,7,8-Tetrachloro dibenzodioxin	NA	ring-necked pheasant	0.000014 10 weeks	0.00014 10 weeks	reproduction	Nosek et al. 1992	0.000014	0.00014
2,3,7,8-Tetrachloro dibenzofuran	NA	day-old chicks	0.000001 ^{a,c} 21 d	0.00001 ^a 21 d	mortality, weight gain	McKinney 1976	0.000001	0.00001
Tin	(TBTO)	Japanese quail	6.8 6 weeks	16.9 6 weeks	reproduction	Schlatter et al. 1993	6.8	16.9
Uranium	depleted metal	black duck	16 ^c 6 weeks		mortality, growth, behavior	Haseltine and Sileo 1983	16	

Table G.67 (continued)

Contaminant	Form	Test species	NOAEL (mg/kg/d) and duration	LOAEL (mg/kg/d) and duration	Endpoint	Citation	Estimated NOAEL (mg/kg/d)	Estimated LOAEL (mg/kg/d)
Vanadium	vanadyl sulfate	mallard duck	11.4 12 weeks	12 weeks	mortality, body weight, blood chem.	White and Dieter 1978	11.4	
Zinc	zinc sulfate	chicken	14.5 44 week(s)	130.9 44 week(s)	reproduction	Stahl et al. 1990	14.5	1309

^aEstimated NOAEL: subchronic to chronic factor of 10 applied.^bFrom EPA 1993.^cEstimated NOAEL: LOAEL to NOAEL factor of 10 applied.

Table G.68. Water benchmark values for wildlife endpoints

Contaminant	Estimated NOAEL's							Estimated LOAEL's						
	Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk	Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
Acetone	99.90	66.57	77.69	62.54	42.84			499.51	332.86	388.47	312.69	214.20		
Aldrin	2.00	1.33	1.55	1.25	0.86			9.99	6.66	7.77	6.25	4.28		
Aluminum	10.43	6.95	8.11	6.53	4.47	1,014.70	1,930.03	104.33	69.52	81.13	65.31	44.74	411.63	782.92
Antimony	0.68	0.45	0.53	0.42	0.29			6.76	4.50	5.26	4.23	2.90		
Aroclor 1248	0.19	0.13	0.15	0.12	0.08			1.94	1.29	1.51	1.22	0.83		
Aroclor 1254	0.30	0.20	1.41	1.14	0.13	1.67	3.17	3.08	2.02	6.97	5.61	1.30	16.65	31.67
Arsenic (Sodium Arsenite)	0.68	0.45	0.53	0.43	0.29	47.50	90.34	6.81	4.54	5.30	4.26	2.92	118.77	225.90
Arsenic (Paris Green)						22.76	43.28						68.27	129.84
Barium	53.80	35.85	41.84	33.68	23.07	192.40	365.95	197.81	131.81	153.83	123.83	84.83	385.73	733.66
Benzene	142.49	94.95	110.81	89.20	61.10			1,424.89	949.51	1,108.13	891.96	611.03		
BHC-mixed	15.98	10.65	0.14	0.11	6.86	5.18	9.85	31.97	21.30	1.41	1.14	13.71	20.81	39.59
Benzo(a)pyrene	5.41	3.60	4.20	3.38	2.32			54.06	36.02	42.04	33.84	23.18		
Beryllium	6.59	4.39	5.13	4.13	2.83									
Bis(2-ethylhexyl) phthalate	98.92	65.92	76.93	61.92	42.42	10.18	19.35	989.21	659.18	769.30	619.23	424.20		
Boron	279.72	186.40	217.54	175.11	119.95	266.40	506.70	935.08	623.11	727.21	585.36	400.99	925.00	1,759.38
Cadmium	0.08	0.05	0.06	0.05	0.03	13.41	25.51	0.10	0.07	0.08	0.06	0.04	185.00	351.88
Carbon Tetrachloride	159.84	106.52	124.31	100.06	68.55									
Chlordane	24.87	16.57	19.34	15.57	10.66	19.80	37.65	49.73	33.14	38.68	31.13	21.33	98.98	188.25
Chloroform	149.85	99.86	116.54	93.81	64.26			409.60	272.94	318.54	256.41	175.65		
Chromium (Cr+3)	27,343.00	18,220.70	21,264.60	17,116.70	11,725.50	9.25	17.59						46.25	87.97
Chromium (Cr+6)	32.77	21.84	25.48	20.51	14.05			131.27	87.48	102.09	82.18	56.29		
Copper	151.96	101.27	118.18	95.13	65.17	434.75	826.91	196.64	131.04	152.93	123.10	84.33	570.73	1,085.53
Cyanide	644.99	429.80	501.61	403.76	276.59									
DDT	7.99	5.33	6.25	5.00	3.43	0.03	0.05	39.96	26.63	31.08	25.02	17.14	0.26	0.49

Table G.68 (continued)

Contaminant	Estimated NOAEL's							Estimated LOAEL's						
	Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk	Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
1,2-Dichloroethane	280.89	187.18	218.45	175.84	120.45	159.10	302.61						318.20	605.23
1,1-Dichloroethene	299.70	199.72	44.91	36.15	128.52									
1,2-Dichloroethene	244.33	162.81	190.01	152.95	104.78									
Dieldrin	0.20	0.13	0.16	0.13	0.09	0.71	1.36	2.00	1.33	1.55	1.25	0.86		
Diethylphthalate	24,773.40	16,508.30	19,266.20	15,507.80	10,623.50									
Di-n-butyl phthalate	2,973.03	1,981.14	2,312.11	1,861.07	1,274.92	1.02	1.94	9,908.28	6,602.58	7,705.64	6,202.44	4,248.94	10.18	19.35
Endosulfan	1.50	1.00	1.17	0.94	0.64	92.50	175.94							
Endrin	0.50	0.33	0.39	0.31	0.21	0.09	0.18	4.97	3.31	3.87	3.11	2.13	0.93	1.76
Fluoride	407.45	271.51	316.87	255.06	174.72	72.15	137.23	685.14	456.56	532.82	428.89	293.80	296.00	563.00
Heptachlor	1.30	0.87	1.01	0.81	0.56			12.99	8.66	10.10	8.13	5.57		
Lead (Metal)	79.92	53.26	62.15	50.03	34.27	35.61	67.74							
Lead (Acetate)														
Lindane (Gamma-BHC)	79.92	53.26	62.15	50.03	34.27	10.45	19.88	799.21	532.57	621.54	500.31	342.73	104.53	198.81
Lithium	93.91	62.58	73.03	58.79	40.27	18.50	35.19						185.00	351.88
Manganese	879.13	585.83	683.70	550.34	377.00	9,037.30	17,189.10	187.82	125.16	146.06	117.57	80.54		
Methylmercury	0.32	0.21	0.15	0.12	0.14	0.06	0.11	2,837.20	1,890.64	2,206.48	1,776.08	1,216.68		
Methoxychlor	39.96	26.63	31.08	25.02	17.14			1.60	1.07	1.24	1.00	0.69	0.59	1.13
Methyl Ethyl Ketone (2-Butanone)	17,692.50	28,930.20	13,759.40	11,075.50	7,587.10			79.92	53.26	62.15	50.03	34.27		
								45,664.90	74,669.60	35,513.40	28,586.20	19,582.50		
4-Methyl 2-Pentanone	249.75	166.43	194.23	156.35	107.10									
Molybdenum	1.41	0.94	1.09	0.88	0.60	32.38	61.58	14.05	9.37	10.93	8.80	6.03	326.53	621.06
Nickel	399.61	266.29	310.77	250.15	171.36	715.95	1,361.76	799.21	532.57	621.54	500.31	342.73	989.75	1,882.53
Niobium	0.84	0.59	0.65	0.52	0.54			8.38	5.58	6.52	5.25	3.59		
Nitrate	6,341.42	4,225.76	4,931.73	3,969.69	2,719.39			14,133.70	9,418.36	10,991.80	8,847.63	6,060.96		

Table G.69 (continued)

Location	Analyte	UCL95	NOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
BCK 9.40	4-Methyl-2-pentanon	0.009	0.00	0.00	0.00	0.00	0.00		
NT2	4-Methyl-2-pentanon	0.003	0.00	0.00	0.00	0.00	0.00		
NT3	4-Methyl-2-pentanon	0.003	0.00	0.00	0.00	0.00	0.00		
SS1	4-Methyl-2-pentanon	0.004	0.00	0.00	0.00	0.00	0.00		
SS5	4-Methyl-2-pentanon	0.004	0.00	0.00	0.00	0.00	0.00		
Upper BC	4-Methyl-2-pentanon	0.004	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Acetone	0.015	0.00	0.00	0.00	0.00	0.00		
BCK 12.36	Acetone	0.009	0.00	0.00	0.00	0.00	0.00		
BCK 4.55	Acetone	0.005	0.00	0.00	0.00	0.00	0.00		
BCK 9.40	Acetone	0.008	0.00	0.00	0.00	0.00	0.00		
BCK S3	Acetone	0.014	0.00	0.00	0.00	0.00	0.00		
NT1	Acetone	0.005	0.00	0.00	0.00	0.00	0.00		
NT2	Acetone	0.010	0.00	0.00	0.00	0.00	0.00		
NT3	Acetone	0.012	0.00	0.00	0.00	0.00	0.00		
NT6	Acetone	0.012	0.00	0.00	0.00	0.00	0.00		
NT7	Acetone	0.012	0.00	0.00	0.00	0.00	0.00		
NT8	Acetone	0.004	0.00	0.00	0.00	0.00	0.00		
SS1	Acetone	0.005	0.00	0.00	0.00	0.00	0.00		

Table G.69 (continued)

Location	Analyte	UCL95	NOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
SS5	Acetone	0.004	0.00	0.00	0.00	0.00	0.00		
SS8	Acetone	0.004	0.00	0.00	0.00	0.00	0.00		
Upper BC	Acetone	0.007	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Aluminum	8.816	0.85	1.27	1.09	1.35	1.97	0.01	0.00
BCK 0.63	Aluminum	0.428	0.04	0.06	0.05	0.07	0.10	0.00	0.00
BCK 11.97	Aluminum	0.495	0.05	0.07	0.06	0.08	0.11	0.00	0.00
BCK 12.36	Aluminum	3.091	0.30	0.44	0.38	0.47	0.69	0.00	0.00
BCK 4.55	Aluminum	0.815	0.08	0.12	0.10	0.12	0.18	0.00	0.00
BCK 9.40	Aluminum	3.176	0.30	0.46	0.39	0.49	0.71	0.00	0.00
NT1	Aluminum	0.785	0.08	0.11	0.10	0.12	0.18	0.00	0.00
NT2	Aluminum	1.836	0.18	0.26	0.23	0.28	0.41	0.00	0.00
NT3	Aluminum	1.610	0.15	0.23	0.20	0.25	0.36	0.00	0.00
NT4	Aluminum	2.450	0.23	0.35	0.30	0.38	0.55	0.00	0.00
NT5	Aluminum	2.482	0.24	0.36	0.31	0.38	0.55	0.00	0.00
NT6	Aluminum	2.405	0.23	0.35	0.30	0.37	0.54	0.00	0.00
NT7	Aluminum	6.263	0.60	0.90	0.77	0.96	1.40	0.01	0.00
NT8	Aluminum	2.420	0.23	0.35	0.30	0.37	0.54	0.00	0.00
SS1	Aluminum	0.562	0.05	0.08	0.07	0.09	0.13	0.00	0.00

Table G.69 (continued)

Location	Analyte	UCL95	NOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
SS4	Aluminum	0.540	0.05	0.08	0.07	0.08	0.12	0.00	0.00
SS5	Aluminum	0.151	0.01	0.02	0.02	0.02	0.03	0.00	0.00
SS6	Aluminum	0.501	0.05	0.07	0.06	0.08	0.11	0.00	0.00
SS8	Aluminum	0.450	0.04	0.06	0.06	0.07	0.10	0.00	0.00
Upper BC	Aluminum	1.873	0.18	0.27	0.23	0.29	0.42	0.00	0.00
BC9.4-SS5	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
BCK 0.63	Antimony	0.057	0.08	0.13	0.11	0.13	0.20		
BCK 12.36	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
BCK 9.40	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
BCK S3	Antimony	0.002	0.00	0.00	0.00	0.00	0.01		
NT2	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
NT3	Antimony	0.001	0.00	0.00	0.00	0.00	0.01		
NT4	Antimony	0.001	0.00	0.00	0.00	0.00	0.01		
NT6	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
NT7	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
NT8	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
SS1	Antimony	0.002	0.00	0.00	0.00	0.00	0.01		
SS4	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		

Table G.69 (continued)

Location	Analyte	NOAEL-based hazard quotient							
		UCL95	Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
SS5	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
SS6	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
SS8	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
Upper BC	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Arsenic	0.008	0.01	0.02	0.01	0.02	0.03	0.00	0.00
BCK 0.63	Arsenic	0.060	0.09	0.13	0.11	0.14	0.21	0.00	0.00
BCK 11.97	Arsenic	0.056	0.08	0.12	0.11	0.13	0.19	0.00	0.00
BCK 12.36	Arsenic	0.002	0.00	0.01	0.00	0.01	0.01	0.00	0.00
BCK 4.55	Arsenic	0.050	0.07	0.11	0.09	0.12	0.17	0.00	0.00
BCK 9.40	Arsenic	0.005	0.01	0.01	0.01	0.01	0.02	0.00	0.00
BCK S3	Arsenic	0.002	0.00	0.00	0.00	0.00	0.01	0.00	0.00
NT3	Arsenic	0.002	0.00	0.00	0.00	0.00	0.01	0.00	0.00
NT4	Arsenic	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT5	Arsenic	0.002	0.00	0.00	0.00	0.00	0.01	0.00	0.00
NT6	Arsenic	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT7	Arsenic	0.009	0.01	0.02	0.02	0.02	0.03	0.00	0.00
NT8	Arsenic	0.004	0.01	0.01	0.01	0.01	0.01	0.00	0.00
SS1	Arsenic	0.002	0.00	0.00	0.00	0.01	0.01	0.00	0.00

Table G.69 (continued)

Location	Analyte	UCL95	NOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
SS8	Arsenic	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper BC	Arsenic	0.008	0.01	0.02	0.02	0.02	0.03	0.00	0.00
BC9.4-SS5	Barium	0.111	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 0.63	Barium	0.066	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 11.97	Barium	0.439	0.01	0.01	0.01	0.01	0.02	0.00	0.00
BCK 12.36	Barium	0.409	0.01	0.01	0.01	0.01	0.02	0.00	0.00
BCK 4.55	Barium	0.064	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 9.40	Barium	0.109	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK S3	Barium	0.135	0.00	0.00	0.00	0.00	0.01	0.00	0.00
NT1	Barium	0.838	0.02	0.02	0.02	0.02	0.04	0.00	0.00
NT2	Barium	0.390	0.01	0.01	0.01	0.01	0.02	0.00	0.00
NT3	Barium	0.076	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT4	Barium	0.071	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT5	Barium	0.084	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT6	Barium	0.060	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT7	Barium	0.082	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT8	Barium	0.088	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS1	Barium	0.149	0.00	0.00	0.00	0.00	0.01	0.00	0.00

Table G.69 (continued)

Location	Analyte	UCL95	NOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
SS4	Barium	0.163	0.00	0.00	0.00	0.00	0.01	0.00	0.00
SS5	Barium	0.091	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS6	Barium	0.058	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS8	Barium	0.046	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper BC	Barium	0.431	0.01	0.01	0.01	0.01	0.02	0.00	0.00
NT7	Benzene	0.003	0.00	0.00	0.00	0.00	0.00		
NT8	Benzene	0.003	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		
BCK 0.63	Beryllium	0.001	0.00	0.00	0.00	0.00	0.00		
BCK 12.36	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		
BCK 4.55	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		
BCK 9.40	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		
NT1	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		
NT2	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		
NT3	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		
NT7	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		
NT8	Beryllium	0.002	0.00	0.00	0.00	0.00	0.00		
SS5	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		

Table G.69 (continued)

Location	Analyte	NOAEL-based hazard quotient							
		UCL95	Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
Upper BC	Beryllium	0.000	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Boron	0.537	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 0.63	Boron	0.149	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 11.97	Boron	0.083	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 4.55	Boron	0.073	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 9.40	Boron	1.386	0.00	0.01	0.01	0.01	0.01	0.01	0.00
NT1	Boron	0.101	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS1	Boron	0.060	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS4	Boron	0.142	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS5	Boron	0.103	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS6	Boron	0.015	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS8	Boron	0.022	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper BC	Boron	0.082	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 11.97	Cadmium	0.005	0.07	0.10	0.09	0.11	0.16	0.00	0.00
NT1	Cadmium	0.026	0.33	0.49	0.42	0.52	0.77	0.00	0.00
SS1	Cadmium	0.006	0.08	0.12	0.10	0.13	0.19	0.00	0.00
Upper BC	Cadmium	0.011	0.14	0.21	0.18	0.23	0.33	0.00	0.00
NT7	Chloroform	0.005	0.00	0.00	0.00	0.00	0.00		

Table G.69 (continued)

Location	Analyte	NOAEL-based hazard quotient						
		UCL95	Shrew	Mouse	Mink	Fox	Deer	Hawk
BCK 12.36	Manganese	2.066	0.00	0.00	0.00	0.00	0.01	0.00
BCK 4.55	Manganese	0.085	0.00	0.00	0.00	0.00	0.00	0.00
BCK 9.40	Manganese	0.173	0.00	0.00	0.00	0.00	0.00	0.00
BCK S3	Manganese	0.110	0.00	0.00	0.00	0.00	0.00	0.00
NT1	Manganese	4.599	0.01	0.01	0.01	0.01	0.01	0.00
NT2	Manganese	0.151	0.00	0.00	0.00	0.00	0.00	0.00
NT3	Manganese	0.374	0.00	0.00	0.00	0.00	0.00	0.00
NT4	Manganese	0.155	0.00	0.00	0.00	0.00	0.00	0.00
NT5	Manganese	0.254	0.00	0.00	0.00	0.00	0.00	0.00
NT6	Manganese	0.620	0.00	0.00	0.00	0.00	0.00	0.00
NT7	Manganese	0.372	0.00	0.00	0.00	0.00	0.00	0.00
NT8	Manganese	0.191	0.00	0.00	0.00	0.00	0.00	0.00
SS1	Manganese	0.444	0.00	0.00	0.00	0.00	0.00	0.00
SS4	Manganese	0.200	0.00	0.00	0.00	0.00	0.00	0.00
SS5	Manganese	0.010	0.00	0.00	0.00	0.00	0.00	0.00
SS6	Manganese	0.067	0.00	0.00	0.00	0.00	0.00	0.00
SS8	Manganese	0.034	0.00	0.00	0.00	0.00	0.00	0.00
Upper BC	Manganese	2.023	0.00	0.00	0.00	0.00	0.01	0.00

Table G.69 (continued)

Location	Analyte	NOAEL-based hazard quotient							
		UCL95	Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
BC9.4-SS5	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 12.36	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 4.55	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 9.40	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK S3	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT3	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT4	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT6	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT7	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT8	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS1	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS4	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper BC	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BC9.4-SS5	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		
BCK 12.36	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		
BCK 9.40	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		
NT2	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		
NT5	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		

Table G.69 (continued)

Location	Analyte	NOAEL-based hazard quotient							
		UCL95	Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
NT6	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		
NT7	Methylene chloride	0.004	0.00	0.00	0.00	0.00	0.00		
NT8	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		
SS5	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		
SS6	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		
Upper BC	Methylene chloride	0.003	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Nickel	0.010	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 0.63	Nickel	0.007	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 11.97	Nickel	0.031	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 12.36	Nickel	0.049	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 4.55	Nickel	0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 9.40	Nickel	0.006	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT1	Nickel	0.099	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT2	Nickel	0.004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT3	Nickel	0.004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT6	Nickel	0.004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT7	Nickel	0.006	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT8	Nickel	0.003	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Table G.69 (continued)

Location	Analyte	UCL95	NOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
NT6	Nitrate	3.481	0.00	0.00	0.00	0.00	0.00		
NT7	Nitrate	4.011	0.00	0.00	0.00	0.00	0.00		
NT8	Nitrate	0.468	0.00	0.00	0.00	0.00	0.00		
SS1	Nitrate	47.069	0.01	0.01	0.01	0.01	0.02		
SS4	Nitrate	37.582	0.01	0.01	0.01	0.01	0.01		
SS5	Nitrate	13.635	0.00	0.00	0.00	0.00	0.01		
SS6	Nitrate	1.191	0.00	0.00	0.00	0.00	0.00		
SS8	Nitrate	0.372	0.00	0.00	0.00	0.00	0.00		
Upper BC	Nitrate	116.811	0.02	0.03	0.02	0.03	0.04		
BC9.4-SS5	Selenium	0.001	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BCK 11.97	Selenium	0.071	0.17	0.26	0.22	0.28	0.40	0.02	0.01
BCK 9.40	Selenium	0.001	0.00	0.01	0.00	0.01	0.01	0.00	0.00
NT6	Selenium	0.001	0.00	0.01	0.00	0.01	0.01	0.00	0.00
Upper BC	Selenium	0.009	0.02	0.03	0.03	0.04	0.05	0.00	0.00
BC9.4-SS5	Strontium	0.261	0.00	0.00	0.00	0.00	0.00		
BCK 0.63	Strontium	0.089	0.00	0.00	0.00	0.00	0.00		
BCK 11.97	Strontium	0.667	0.00	0.00	0.00	0.00	0.00		
BCK 4.55	Strontium	0.083	0.00	0.00	0.00	0.00	0.00		

Table G.69 (continued)

Location	Analyte	UCL95	NOAEL-based hazard quotient					
			Shrew	Mouse	Mink	Fox	Deer	Hawk
BCK 9.40	Strontium	0.187	0.00	0.00	0.00	0.00	0.00	
NT1	Strontium	0.950	0.00	0.00	0.00	0.00	0.00	
SS1	Strontium	0.528	0.00	0.00	0.00	0.00	0.00	
SS4	Strontium	0.286	0.00	0.00	0.00	0.00	0.00	
SS5	Strontium	0.145	0.00	0.00	0.00	0.00	0.00	
SS6	Strontium	0.023	0.00	0.00	0.00	0.00	0.00	
SS8	Strontium	0.037	0.00	0.00	0.00	0.00	0.00	
Upper BC	Strontium	0.707	0.00	0.00	0.00	0.00	0.00	
BCK 12.36	Thallium	0.002	0.02	0.03	0.03	0.03	0.05	
BCK 4.55	Thallium	0.016	0.21	0.31	0.27	0.33	0.49	
Upper BC	Thallium	0.002	0.02	0.03	0.03	0.03	0.05	
BC9.4-SS5	Toluene	0.003	0.00	0.00	0.00	0.00	0.00	
BCK 12.36	Toluene	0.003	0.00	0.00	0.00	0.00	0.00	
BCK 9.40	Toluene	0.003	0.00	0.00	0.00	0.00	0.00	
NT2	Toluene	0.003	0.00	0.00	0.00	0.00	0.00	
NT3	Toluene	0.003	0.00	0.00	0.00	0.00	0.00	
NT5	Toluene	0.003	0.00	0.00	0.00	0.00	0.00	
NT6	Toluene	0.003	0.00	0.00	0.00	0.00	0.00	

Table G.69 (continued)

Location	Analyte	UCL95	NOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
NT7	Toluene	0.003	0.00	0.00	0.00	0.00	0.00		
Upper BC	Toluene	0.003	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Uranium	0.175	0.01	0.02	0.01	0.02	0.03	0.00	0.00
BCK 0.63	Uranium	0.035	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 11.97	Uranium	0.225	0.01	0.02	0.02	0.02	0.03	0.00	0.00
BCK 4.55	Uranium	0.039	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BCK 9.40	Uranium	0.117	0.01	0.01	0.01	0.01	0.02	0.00	0.00
NT1	Uranium	0.144	0.01	0.01	0.01	0.01	0.02	0.00	0.00
SS1	Uranium	0.041	0.00	0.00	0.00	0.00	0.01	0.00	0.00
SS4	Uranium	0.174	0.01	0.02	0.01	0.02	0.02	0.00	0.00
SS5	Uranium	0.077	0.00	0.01	0.01	0.01	0.01	0.00	0.00
SS8	Uranium	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper BC	Uranium	0.181	0.01	0.02	0.01	0.02	0.03	0.00	0.00
BC9.4-SS5	Vanadium	0.018	0.01	0.01	0.01	0.02	0.02	0.00	0.00
BCK 0.63	Vanadium	0.003	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 12.36	Vanadium	0.006	0.00	0.00	0.00	0.00	0.01	0.00	0.00
BCK 4.55	Vanadium	0.003	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 9.40	Vanadium	0.008	0.00	0.01	0.01	0.01	0.01	0.00	0.00

Table G.70. Comparison of unfiltered surface water contaminant concentrations in Bear Creek with LOAEL-based water benchmarks for wildlife

[illegible]

Table G.70 (continued)

Location	Analyte	UCL95	LOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
NT2	Acetone	0.010	0.00	0.00	0.00	0.00	0.00		
NT3	Acetone	0.012	0.00	0.00	0.00	0.00	0.00		
NT6	Acetone	0.012	0.00	0.00	0.00	0.00	0.00		
NT7	Acetone	0.012	0.00	0.00	0.00	0.00	0.00		
NT8	Acetone	0.004	0.00	0.00	0.00	0.00	0.00		
SS1	Acetone	0.005	0.00	0.00	0.00	0.00	0.00		
SS5	Acetone	0.004	0.00	0.00	0.00	0.00	0.00		
SS8	Acetone	0.004	0.00	0.00	0.00	0.00	0.00		
Upper BC	Acetone	0.007	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Aluminum	8.816	0.08	0.13	0.11	0.13	0.20	0.02	0.01
BCK 0.63	Aluminum	0.428	0.00	0.01	0.01	0.01	0.01	0.00	0.00
BCK 11.97	Aluminum	0.495	0.00	0.01	0.01	0.01	0.01	0.00	0.00
BCK 12.36	Aluminum	3.091	0.03	0.04	0.04	0.05	0.07	0.01	0.00
BCK 4.55	Aluminum	0.815	0.01	0.01	0.01	0.01	0.02	0.00	0.00
BCK 9.40	Aluminum	3.176	0.03	0.05	0.04	0.05	0.07	0.01	0.00
NT1	Aluminum	0.785	0.01	0.01	0.01	0.01	0.02	0.00	0.00
NT2	Aluminum	1.836	0.02	0.03	0.02	0.03	0.04	0.00	0.00
NT3	Aluminum	1.610	0.02	0.02	0.02	0.02	0.04	0.00	0.00

Table G.70 (continued)

Location	Analyte	UCL95	LOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
NT4	Aluminum	2.450	0.02	0.04	0.03	0.04	0.05	0.01	0.00
NT5	Aluminum	2.482	0.02	0.04	0.03	0.04	0.06	0.01	0.00
NT6	Aluminum	2.405	0.02	0.03	0.03	0.04	0.05	0.01	0.00
NT7	Aluminum	6.263	0.06	0.09	0.08	0.10	0.14	0.02	0.01
NT8	Aluminum	2.420	0.02	0.03	0.03	0.04	0.05	0.01	0.00
SS1	Aluminum	0.562	0.01	0.01	0.01	0.01	0.01	0.00	0.00
SS4	Aluminum	0.540	0.01	0.01	0.01	0.01	0.01	0.00	0.00
SS5	Aluminum	0.151	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS6	Aluminum	0.501	0.00	0.01	0.01	0.01	0.01	0.00	0.00
SS8	Aluminum	0.450	0.00	0.01	0.01	0.01	0.01	0.00	0.00
Upper BC	Aluminum	1.873	0.02	0.03	0.02	0.03	0.04	0.00	0.00
BC9.4-SS5	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
BCK 0.63	Antimony	0.057	0.01	0.01	0.01	0.01	0.02		
BCK 12.36	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
BCK 9.40	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
BCK S3	Antimony	0.002	0.00	0.00	0.00	0.00	0.00		
NT2	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		
NT3	Antimony	0.001	0.00	0.00	0.00	0.00	0.00		

Table G.70 (continued)

Location	Analyte	UCL95	LOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
SS1	Lead	0.008	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS4	Lead	0.003	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS5	Lead	0.004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper BC	Lead	0.003	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BC9.4-SS5	Lithium	0.045	0.00	0.00	0.00	0.00	0.00		
BCK 12.36	Lithium	0.009	0.00	0.00	0.00	0.00	0.00		
BCK 4.55	Lithium	0.013	0.00	0.00	0.00	0.00	0.00		
BCK 9.40	Lithium	0.076	0.00	0.00	0.00	0.00	0.00		
NT2	Lithium	0.008	0.00	0.00	0.00	0.00	0.00		
NT3	Lithium	0.171	0.00	0.00	0.00	0.00	0.00		
NT4	Lithium	0.004	0.00	0.00	0.00	0.00	0.00		
NT5	Lithium	0.005	0.00	0.00	0.00	0.00	0.00		
NT6	Lithium	0.016	0.00	0.00	0.00	0.00	0.00		
NT7	Lithium	0.057	0.00	0.00	0.00	0.00	0.00		
NT8	Lithium	0.172	0.00	0.00	0.00	0.00	0.00		
SS1	Lithium	0.005	0.00	0.00	0.00	0.00	0.00		
SS4	Lithium	0.033	0.00	0.00	0.00	0.00	0.00		
SS5	Lithium	0.012	0.00	0.00	0.00	0.00	0.00		

Table G.70 (continued)

Location	Analyte	LOAEL-based hazard quotient							
		UCL95	Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
SS6	Lithium	0.005	0.00	0.00	0.00	0.00	0.00		
SS8	Lithium	0.002	0.00	0.00	0.00	0.00	0.00		
Upper BC	Lithium	0.009	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Manganese	0.362	0.00	0.00	0.00	0.00	0.00		
BCK 0.63	Manganese	0.078	0.00	0.00	0.00	0.00	0.00		
BCK 11.97	Manganese	1.175	0.00	0.00	0.00	0.00	0.00		
BCK 12.36	Manganese	2.066	0.00	0.00	0.00	0.00	0.00		
BCK 4.55	Manganese	0.085	0.00	0.00	0.00	0.00	0.00		
BCK 9.40	Manganese	0.173	0.00	0.00	0.00	0.00	0.00		
BCK S3	Manganese	0.110	0.00	0.00	0.00	0.00	0.00		
NT1	Manganese	4.599	0.00	0.00	0.00	0.00	0.00		
NT2	Manganese	0.151	0.00	0.00	0.00	0.00	0.00		
NT3	Manganese	0.374	0.00	0.00	0.00	0.00	0.00		
NT4	Manganese	0.155	0.00	0.00	0.00	0.00	0.00		
NT5	Manganese	0.254	0.00	0.00	0.00	0.00	0.00		
NT6	Manganese	0.620	0.00	0.00	0.00	0.00	0.00		
NT7	Manganese	0.372	0.00	0.00	0.00	0.00	0.00		
NT8	Manganese	0.191	0.00	0.00	0.00	0.00	0.00		

Table G.70 (continued)

Location	Analyte	UCL95	LOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
SS1	Manganese	0.444	0.00	0.00	0.00	0.00	0.00		
SS4	Manganese	0.200	0.00	0.00	0.00	0.00	0.00		
SS5	Manganese	0.010	0.00	0.00	0.00	0.00	0.00		
SS6	Manganese	0.066	0.00	0.00	0.00	0.00	0.00		
SS8	Manganese	0.034	0.00	0.00	0.00	0.00	0.00		
Upper BC	Manganese	2.023	0.00	0.00	0.00	0.00	0.00		
BC9.4-SS5	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 12.36	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 4.55	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK 9.40	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BCK S3	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT3	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT4	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT6	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT7	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT8	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS1	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS4	Mercury	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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Table G.70 (continued)

Location	Analyte	UCL95	LOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
NT1	Nickel	0.099	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT2	Nickel	0.004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT3	Nickel	0.004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT6	Nickel	0.004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT7	Nickel	0.006	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NT8	Nickel	0.003	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS1	Nickel	0.011	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS4	Nickel	0.006	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS5	Nickel	0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS6	Nickel	0.004	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SS8	Nickel	0.005	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upper BC	Nickel	0.047	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BC9.4-SS5	Nitrate	8.368	0.00	0.00	0.00	0.00	0.00		
BCK 0.63	Nitrate	5.593	0.00	0.00	0.00	0.00	0.00		
BCK 11.97	Nitrate	129.191	0.01	0.01	0.01	0.01	0.02		
BCK 12.36	Nitrate	103.756	0.01	0.01	0.01	0.01	0.02		
BCK 4.55	Nitrate	16.055	0.00	0.00	0.00	0.00	0.00		
BCK 9.40	Nitrate	17.370	0.00	0.00	0.00	0.00	0.00		

Table G.70 (continued)

Location	Analyte	UCL95	LOAEL-based hazard quotient						
			Shrew	Mouse	Mink	Fox	Deer	Kingfisher	Hawk
BCK 9.40	Uranium	0.117	0.00	0.01	0.00	0.01	0.01		
NT1	Uranium	0.144	0.00	0.01	0.01	0.01	0.01		
SS1	Uranium	0.041	0.00	0.00	0.00	0.00	0.00		
SS4	Uranium	0.174	0.01	0.01	0.01	0.01	0.01		
SS5	Uranium	0.077	0.00	0.00	0.00	0.00	0.01		
SS8	Uranium	0.001	0.00	0.00	0.00	0.00	0.00		
Upper BC	Uranium	0.181	0.01	0.01	0.01	0.01	0.01		
BC9.4-SS5	Vanadium	0.018	0.00	0.00	0.00	0.00	0.00		
BCK 0.63	Vanadium	0.003	0.00	0.00	0.00	0.00	0.00		
BCK 12.36	Vanadium	0.006	0.00	0.00	0.00	0.00	0.00		
BCK 4.55	Vanadium	0.003	0.00	0.00	0.00	0.00	0.00		
BCK 9.40	Vanadium	0.008	0.00	0.00	0.00	0.00	0.00		
NT2	Vanadium	0.003	0.00	0.00	0.00	0.00	0.00		
NT3	Vanadium	0.003	0.00	0.00	0.00	0.00	0.00		
NT4	Vanadium	0.005	0.00	0.00	0.00	0.00	0.00		
NT5	Vanadium	0.004	0.00	0.00	0.00	0.00	0.00		
NT6	Vanadium	0.004	0.00	0.00	0.00	0.00	0.00		
NT7	Vanadium	0.018	0.00	0.00	0.00	0.00	0.00		

Table G.71. Estimated abundance of wildlife endpoints in the Bear Creek watershed and within BC OU 1

Endpoint	Density	Suitable habitat	Estimated population	Estimated population
		BC OU	BC OU	BC OU1
Short-tailed Shrew	23 ha	637.74 ha	14668	746
White-footed Mouse	57 ha	652.36 ha	37185	2373
White-tailed Deer	0.1704 ha	652.36 ha	111	
Red Fox	0.077 ha	652.36 ha	50	
Red-Tailed Hawk	0.03 ha	652.36 ha	20	
Mink	0.6 stream km	12.4 stream km	7	
Belted Kingfisher	0.4 stream km	12.4 stream km	5	

Table G.72. Summary of number of individuals of wildlife endpoint species estimated to be experiencing adverse effects

Analyte	Endpoint species	Area	%>LOAEL	Number in area	Number adversely affected	Percent adversely affected
Antimony	Short-tailed shrew	BCV	35-40%	14668	5134-5867	35-40%
Antimony	Short-tailed shrew	BCOU1	65-70%	746	485-522	65-70%
Arsenic	Short-tailed shrew	BCV	<5%	14668	0	0
Arsenic	Short-tailed shrew	BCOU1	<5%	746	0	0
Barium	Short-tailed shrew	BCV	<5%	14668	0	0
Barium	Short-tailed shrew	BCOU1	<5%	746	0	0
Cadmium	Short-tailed shrew	BCV	25%	14668	3667	25%
Cadmium	Short-tailed shrew	BCOU1	50-55%	746	373-410	50-55%
Cadmium	Short-tailed shrew	Background	<5%			
Chromium	Short-tailed shrew	BCV	<5%	14668	0	0
Chromium	Short-tailed shrew	BCOU1	<5%	746	0	0
Chromium	Short-tailed shrew	Background	>95%			
Copper	Short-tailed shrew	BCV	<5%	14668	0	0
Copper	Short-tailed shrew	BCOU1	<5%	746	0	0
Mercury	Short-tailed shrew	BCV	>95%	14668	14668	100%
Mercury	Short-tailed shrew	BCOU1	>95%	746	746	100%
Molybdenum	Short-tailed shrew	BCV	40-45%	14668	5867-6600	40-45%
Molybdenum	Short-tailed shrew	BCOU1	<5%	746	0	0
Molybdenum	Short-tailed shrew	Background	>95%			

Table G.72 (continued)

Analyte	Endpoint species	Area	%>LOAEL	Number in area	Number adversely affected	Percent adversely affected
Nickel	Short-tailed shrew	BCV	<5%	14668	0	0
Nickel	Short-tailed shrew	BCOU1	<5%	746	0	0
Selenium	Short-tailed shrew	BCV	55%	14668	8067	55%
Selenium	Short-tailed shrew	BCOU1	45%	746	336	45%
Selenium	Short-tailed shrew	Background	>95%			
Total PCBs	Short-tailed shrew	BCV	90-95%	14668	14668	100%
Total PCBs	Short-tailed shrew	BCOU1	90-95%	746	746	100%
Vanadium	Short-tailed shrew	BCV	<5%	14668	0	0
Vanadium	Short-tailed shrew	BCOU1	20-25%	746	149-187	20-25%
Vanadium	Short-tailed shrew	Background	<5%			
Cadmium	White-footed mouse	BCV	30%	37185	11156	30%
Cadmium	White-footed mouse	BCOU1	60-65%	2373	1424-1542	60-65%
Cadmium	White-footed mouse	Background	<5%			
Chromium	White-footed mouse	BCV	50-55%	37185	18593-20452	50-55%
Chromium	White-footed mouse	BCOU1	5-10%	2373	0	0
Mercury	White-footed mouse	BCV	15%	37185	5578	15%
Mercury	White-footed mouse	BCOU1	50-55%	2373	1187-1305	50-55%
Molybdenum	White-footed mouse	BCV	90-95%	37185	37185	100%
Molybdenum	White-footed mouse	BCOU1	<5%	2373	0	0

Table G.72 (continued)

Analyte	Endpoint species	Area	%>LOAEL	Number in area	Number adversely affected	Percent adversely affected
Molybdenum	White-footed mouse	Background	>95%			
Total PCBs	White-footed mouse	BCV	<5%	37185	0	0
Total PCBs	White-footed mouse	BCOU1	5-10%	2373	0	0
Antimony	White-tailed deer	BCV	<5%	111	0	0
Cadmium	White-tailed deer	BCV	<5%	111	0	0
Cadmium	White-tailed deer	Background	<5%			
Mercury	White-tailed deer	BCV	<5%	111	0	0
Antimony	Red fox	BCV	55-60%	50	28-30	55-60%
Cadmium	Red fox	BCV	<5%	50	0	0
Cadmium	Red fox	Background	<5%			
Mercury	Red fox	BCV	>95%	50	50	100%
Total PCBs	Red fox	BCV	60-65%	50	30-33	60-65%
Mercury	Red-tailed hawk	BCV	<5%	20	0	0
Cadmium	Mink	BCV	<5%	7	0	0
Copper	Mink	BCV	<5%	7	0	0
Mercury	Mink	BCV	<5%	7	0	0
Mercury	Belted kingfisher	BCV	>95%	5	5	100%
Total PCBs	Belted kingfisher	BCV	<5%	5	0	0

**Table G.73. Concentrations of site-related contaminants in S-3 Pond
and Burial Ground waste inventory locations**

Site-related contaminant	Background conc. (mg/kg)	Estimated media conc. (mg/kg)
<i>S-3 Ponds Sludges (from Table A.3)</i>		
Beryllium	2.12	2.74
Boron	34	37.64
Cadmium	0.31	4.9
Chromium (III)	80.1	133.2
Chromium(VI)	<i>a</i>	0.19
Copper	35.5	92.45
Lithium	33	75.68
Mercury	0.34	2.28
Molybdenum	12.8	15.2
Nickel	56.7	550.32
Strontium	16.8	35.49
Tin	<i>a</i>	1.57
Uranium	<i>a</i>	991.71
Zirconium	<i>a</i>	478.42
Acetone	NA ^b	0.02295
Aroclor 1248	NA	5.67
Diethylphthalate	NA	0.523
Methylene chloride	NA	0.00049
Tetrachloroethene	NA	0.793
Toluene	NA	0.00027
Trichloroethene	NA	0.00028
<i>Waste Inventory -Burial Ground A-South (from Table A.13)</i>		
Uranium	<i>a</i>	15000
Methyl ethyl ketone	NA	62
PCBs	NA	21
Tetrachloroethene	NA	890
1,1,1-Trichloroethane	NA	960
Trichloroethene	NA	85

Table G.73 (continued)

Site-related contaminant	Background conc. (mg/kg)	Estimated media conc. (mg/kg)
<i>Waste Inventory - Burial Ground A-North (from Table A.14)</i>		
Uranium	<i>a</i>	15000
Methyl ethyl ketone	NA	62
PCBs	NA	21
Tetrachloroethene	NA	890
1,1,1-Trichloroethane	NA	960
Trichloroethene	NA	85
<i>Waste Inventory - Burial Ground A-16 (from Table A.15)</i>		
Uranium	<i>a</i>	610
<i>Waste Inventory - Burial Ground A-17 (from Table A.16)</i>		
Uranium	<i>a</i>	610
<i>Waste Inventory - Burial Ground A-18 (from Table A.17)</i>		
Uranium	<i>a</i>	610
<i>Waste Inventory - Burial Ground B (from Table A.18)</i>		
Uranium	<i>a</i>	300000
<i>Waste Inventory - Burial Ground C-East (from Table A.19)</i>		
Beryllium	2.12	1100
Lithium	33	280
Uranium	<i>a</i>	610
<i>Waste Inventory - Burial Ground C-West (from Table A.20)</i>		
Beryllium	2.12	1100
Lithium	33	280
Uranium	<i>a</i>	22000
<i>Waste Inventory - Burial Ground D-East (from Table A.21)</i>		
Uranium	<i>a</i>	24000
<i>Waste Inventory - Burial Ground D-south (from Table A.22)</i>		
Uranium	<i>a</i>	240000
<i>Waste Inventory - Burial Ground D-West, E, and J (from Table A.23)</i>		
Uranium	<i>a</i>	260000

Table G.73 (continued)

Site-related contaminant	Background conc. (mg/kg)	Estimated media conc. (mg/kg)
<i>Waste Inventory - Walk-In Pit 1 (North) (from Table A.24)</i>		
Beryllium	2.12	26
Lead	49.6	516
Mercury	0.34	17
Chloroform	NA	0.01
Cyanide	NA	0.02
DDT	NA	4.9
Ethanol	NA	0.1
Formaldehyde	NA	0.4
PCBs	NA	1.7
Trichloroethane	NA	7.7
<i>Waste Inventory - Walk-In Pits 2 and 3 (South) (from Table A.25)</i>		
Mercury	0.34	2
Uranium	<i>a</i>	75000

^aNo background reported.^bBackground does not apply for organic chemicals.

Table G.74. Point estimates of site-related contaminant exposure for short-tailed shrew in the S-3 Ponds and Burial Ground waste inventory locations

Site-related contaminant	Estimated exposure (mg/kg/d) ^a	NOAEL		LOAEL	
		Toxicity benchmark (mg/kg/d) ^b	HQ	Toxicity benchmark (mg/kg/d)	HQ
S-3 Ponds Sludges (source: Table A.3)					
Beryllium	0.214	1.451	0.15	c	c
Boron	2.936	61.539	0.048	205.72	0.014
Cadmium	0.382	2.12	0.18	21.2	0.018
Chromium (III)	10.39	6015.46	0.002	c	c
Chromium(VI)	0.015	7.209	0.002	28.879	0.001
Copper	7.211	33.432	0.22	43.262	0.17
Lithium	5.903	20.660	0.29	41.319	0.14
Mercury	0.178	0.070	2.54	0.352	0.50
Molybdenum	1.186	0.309	3.84	3.092	0.38
Nickel	42.925	87.913	0.49	175.826	0.24
Strontium	2.768	578.030	0.005	c	c
Tin	0.122	27.830	0.004	41.622	0.003
Uranium	77.353	3.588	21.6	7.165	10.8
Zirconium	37.317	2.069	18.0	c	c
Acetone	0.002	21.980	0.00	109.892	0.00
Aroclor 1248	0.442	0.067	6.6	0.427	1.04
Diethylphthalate	0.041	5450	0.00	c	c
Methylene chloride	0.000	12.860	0.00	109.892	0.00
Tetrachloroethene	0.062	1.665	0.037	8.324	0.007
Toluene	0.000	30.920	0.00	309.195	0.00
Trichloroethene	0.000	0.832	0.00	8.324	0.00
Waste Inventory - Burial Ground A-South (source: Table A.13)					
Uranium	1170.0	5.981	195.6	7.165	163.3
Aroclor	1.638	0.067	24.4	0.668	2.45
Methyl ethyl ketone	4.836	3892.360	0.001	10046	0.00
Tetrachloroethene	69.420	1.665	41.7	8.324	8.34
1,1,1-Trichloroethane	74.880	1235.930	0.061	c	c
Trichloroethene	6.630	0.832	8.0	8.324	0.80

Table G.74 (continued)

Site-related contaminant	Estimated exposure (mg/kg/d) ^a	NOAEL		LOAEL	
		Toxicity benchmark (mg/kg/d) ^b	HQ	Toxicity benchmark (mg/kg/d)	HQ
Waste Inventory - Burial Ground A-North (source: Table A.14)					
Uranium	1170	5.981	195.6	7.165	163.3
Aroclor	1.638	0.067	24.4	0.668	2.4
Methyl ethyl ketone	4.836	3892.360	0.001	10046	0.00
Tetrachloroethene	69.420	1.665	41.7	8.324	8.3
1,1,1-Trichloroethane	74.880	1235.930	0.061	c	c
Trichloroethene	6.630	0.832	8.0	8.324	0.8
Waste Inventory - Burial Ground A-16 (source: Table A.15)					
Uranium	47.580	5.981	7.96	7.165	6.6
Waste Inventory - Burial Ground A-17 (source: Table A.16)					
Uranium	47.580	5.981	7.96	7.165	6.6
Waste Inventory - Burial Ground A-18 (source: Table A.17)					
Uranium	47.580	5.981	7.96	7.165	6.6
Waste Inventory - Burial Ground B (source: Table A.18)					
Uranium	23400	5.981	3912	7.165	3266
Waste Inventory - Burial Ground C-East (source: Table A.19)					
Beryllium	85.800	1.451	59.1	c	c
Lithium	21.840	20.660	1.06	41.319	0.5
Uranium	47.580	5.981	7.96	7.165	6.6
Waste Inventory - Burial Ground C-West (source: Table A.20)					
Beryllium	85.800	1.451	59.1	c	c
Lithium	21.840	20.660	1.06	41.319	0.5
Uranium	1716	5.981	287	7.165	239.5
Waste Inventory - Burial Ground D-East (source: Table A.21)					
Uranium	18720.0	5.981	3130	7.165	2613
Waste Inventory - Burial Ground D-south (source: Table A.22)					
Uranium	18720.0	5.981	3130	7.165	2613
Waste Inventory - Burial Ground D-West, E, and J (source: Table A.23)					
Uranium	20280.0	5.981	3391	7.165	2830
Waste Inventory - Walk-In Pit 1 (North) (source: Table A.24)					
Beryllium	2.028	1.451	1.4	c	c
Lead	40.248	17.583	2.3	175.826	0.23
Mercury	1.326	0.070	18.9	0.352	3.8
Chloroform	0.001	32.967	0.00	90.111	0.00
Cyanide	0.002	141.898	0.00	c	c

Table G.74 (continued)

Site-related contaminant	Estimated exposure (mg/kg/d) ^a	NOAEL		LOAEL	
		Toxicity benchmark (mg/kg/d) ^b	HQ	Toxicity benchmark (mg/kg/d)	HQ
DDT	0.382	1.758	0.22	8.791	0.04
Ethanol	0.008	70.110	0.000	701.108	0.00
Formaldehyde	0.031	49.992	0.001	<i>c</i>	<i>c</i>
PCBs	0.133	0.067	1.98	0.668	0.20
Trichloroethane	0.601	1235.930	0.00	<i>c</i>	<i>c</i>
<i>Waste Inventory - Walk-In Pits 2 and 3 (South) (source: Table A.25)</i>					
Mercury	0.156	0.070	2.2	0.352	0.44
Uranium	5850	5.981	978	7.165	816

^aCalculated as described in Sect. G.6.5.1.1.^bBenchmarks from Tables G.6.28 and G.6.29.^cLOAEL-based toxicity benchmarks not available.

**Table G.75. COPECs for exposure of short-tailed shrew in the S-3 Ponds
and Burial Ground waste inventory locations**

COPEC	Inventory source	Estimated exposure (mg/kg/d)	NOAEL HQ	LOAEL HQ
Aroclor 1248	S3 Sludges	0.442	6.6	1.04
Beryllium	Burial Ground C-East	85.800	59.1	<i>a</i>
Beryllium	Burial Ground C-West	85.800	59.1	<i>a</i>
Beryllium	Walk-In Pit 1 (North)	2.028	1.4	<i>a</i>
Lead	Walk-In Pit 1 (North)	40.248	2.3	0.23
Lithium	Burial Ground C-East	21.840	1.06	0.5
Lithium	Burial Ground C-West	21.840	1.06	0.5
Mercury	S3 Sludges	0.178	2.54	0.50
Mercury	Walk-In Pit 1 (North)	1.326	18.9	3.8
Mercury	Walk-In Pits 2 and 3 (South)	0.156	2.2	0.44
Molybdenum	S3 Sludges	1.186	3.84	0.38
PCBs	Burial Ground A-North	1.638	24.4	2.4
PCBs	Burial Ground A-South	1.638	24.4	2.45
PCBs	Walk-In Pit 1 (North)	0.133	1.98	0.20
Tetrachloroethene	Burial Ground A-North	69.420	41.7	8.3
Tetrachloroethene	Burial Ground A-South	69.420	41.7	8.34
Trichloroethene	Burial Ground A-North	6.630	8.0	0.80
Trichloroethene	Burial Ground A-South	6.630	8.0	0.8
Uranium	Burial Ground A-16	47.580	7.96	6.6
Uranium	Burial Ground A-17	47.580	7.96	6.6
Uranium	Burial Ground A-18	47.580	7.96	6.6
Uranium	Burial Ground A-North	1170	195.6	163.3
Uranium	Burial Ground A-South	1170.0	195.6	163.3
Uranium	Burial Ground B	23400	3912	3266
Uranium	Burial Ground C-East	47.580	7.96	6.6
Uranium	Burial Ground C-West	1716	287	239.5
Uranium	Burial Ground D-East	18720.0	3130	2613
Uranium	Burial Ground D-South	18720.0	3130	2613
Uranium	Burial Ground D-West, E, and J	20280.0	3391	2830
Uranium	S3 Sludges	77.353	21.6	10.8
Uranium	Walk-In Pits 2 and 3 (South)	5850	978	816
Zirconium	S3 Sludges	37.317	18.0	<i>a</i>

^aIngestion exposure did not exceed a toxicity benchmark.

Table G.76 (continued)

Analyte	Contaminant Exposure Location	Contaminant Source Location	Maximum Water Concentration	LOAEL HQ						
				shrew	mouse	mink	fox	deer	kingfisher	hawk
Nickel	NT-7	NT-7 (BG_A)	0.09000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	NT-8T	NT-8 (ALL)	0.04000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	NT-3	NT-3 (BYBY)	0.15000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	NT-1	NT-1 (S3)	0.33000	0.000	0.001	0.001	0.001	0.001	0.000	0.000
	NT-1	NT-1 (S3)	541.00000	0.038	0.057	0.049	0.061	0.089		
	BCK 9.74	BCK 9.74	113.20000	0.008	0.012	0.010	0.013	0.019		
	NT-2	NT-2 (S3)	791.00000	0.056	0.084	0.072	0.089	0.131		
	NT-8C	NT-8 (CW)	0.02600	0.008	0.013	0.004	0.005	0.020	0.002	0.001
	NT-8T	NT-8 (ALL)	0.02616	0.008	0.013	0.004	0.005	0.020	0.002	0.001
	NT-8C	NT-8 (CW)	0.10000	0.030	0.046	0.039	0.048	0.071	0.011	0.006
Selenium	NT-8T	NT-8 (ALL)	0.10000	0.030	0.046	0.039	0.048	0.071	0.011	0.006
	NT-8T	NT-8 (ALL)	0.04000	0.053	0.080	0.069	0.085	0.125		
	BCK 9.74	BCK 9.74	0.00400	0.005	0.008	0.007	0.009	0.013		
	NT-8C	NT-8 (CW)	0.04000	0.053	0.080	0.069	0.085	0.125		
	NT-8C	NT-8 (CW)	0.03000	0.001	0.001	0.001	0.001	0.002		
	NT-7	NT-7 (BG_A)	0.42420	0.011	0.017	0.014	0.018	0.026		
	NT-8W	NT-8 (WIP)	0.02740	0.001	0.001	0.001	0.001	0.002		
	NT-3	NT-3 (BYBY)	0.05060	0.001	0.002	0.002	0.002	0.003		
	BCK 9.74	BCK 9.74	0.04230	0.001	0.002	0.001	0.002	0.003		
	NT-8T	NT-8 (ALL)	0.05743	0.002	0.002	0.002	0.002	0.004		
Uranium	NT-1	NT-1 (S3)	1.99000	0.061	0.092	0.079	0.098	0.142		
	NT-8W	NT-8 (WIP)	0.41000	0.013	0.019	0.016	0.020	0.029		
	NT-3	NT-3 (BYBY)	0.56000	0.017	0.026	0.022	0.027	0.040		
	NT-8T	NT-8 (ALL)	0.63000	0.019	0.029	0.025	0.031	0.045		
	NT-2	NT-2 (S3)	0.03400	0.001	0.002	0.001	0.002	0.002		
	BCK 9.74	BCK 9.74	0.31000	0.010	0.014	0.012	0.015	0.022		
	NT-8C	NT-8 (CW)	0.22000	0.007	0.010	0.009	0.011	0.016		
	NT-7	NT-7 (BG_A)	0.32000	0.010	0.015	0.013	0.016	0.023		
	NT-8C	NT-8 (CW)	0.46000	0.027	0.041	0.035	0.043	0.064		
	Vinyl chloride									

Table G.76 (continued)

Analyte	Contaminant Exposure Location	Contaminant Source Location	Maximum Water Concentration	LOAEL HQ					
				shrew	mouse	mink	fox	deer	kingfisher hawk
Vinyl chloride	NT-3	NT-3 (BYBY)	0.00310	0.000	0.000	0.000	0.000	0.000	
Vinyl chloride	NT-8W	NT-8 (WIP)	0.13340	0.008	0.012	0.010	0.013	0.018	
Vinyl chloride	NT-8T	NT-8 (ALL)	0.59338	0.035	0.052	0.045	0.056	0.082	
Vinyl chloride	BCK 9.74	BCK 9.74	0.06598	0.004	0.006	0.005	0.006	0.009	
Vinyl chloride	NT-7	NT-7 (BG A)	0.11180	0.007	0.010	0.008	0.011	0.015	

Table G.77. Radionuclide-specific ground and water dose coefficients, radiation energies, and absorption factors

Radionuclide ^a	Dose coefficients ^b		Energies (MeV/nt) ^b		Gamma absorption factors ^c					
	DF grd 0-15 (Sv m3/s Bq)	DF water (Sv m3/s Bq)	Alpha	Beta	Gamma	Worms, plants	Shrew, mouse	Mink, hawk, kingfisher	Fox, turkey	Deer
Americium-241	2.34e-19	1.88e-18	5.480	0.052	0.033	0.04	0.05	0.12	0.16	0.3
Beryllium-7	1.40e-18	5.15e-18			0.049	0.012	0.017	0.06	0.09	0.2
Cesium-137	3.94e-21	1.49e-20		0.187						
Barium-137m	1.71e-17	6.26e-17		0.065	0.597	0.011	0.015	0.04	0.06	0.15
Cobalt-57	2.66e-18	1.25e-17		0.019	0.125	0.0079	0.012	0.04	0.06	0.15
Cobalt-60	7.25e-17	2.74e-16		0.097	2.500	0.011	0.01	0.03	0.04	0.11
Curium-243	3.02e-18	1.30e-17	5.800	0.138	0.134	0.008	0.0105	0.04	0.06	0.15
Curium-244	6.74e-22	1.15e-20	5.800	0.009	0.002	0.63	0.79	0.94	0.94	0.94
Neptunium-237	4.16e-19	2.32e-18	4.770	0.070	0.035	0.027	0.04	0.11	0.15	0.29
Protactinium-233	5.16e-18	2.05e-17		0.196	0.204	0.009	0.01	0.04	0.06	0.14
Plutonium-238	8.07e-22	1.14e-20	5.490	0.011	0.002	0.63	0.79	0.94	0.94	0.94
Plutonium-239	1.52e-21	9.60e-21	5.148	0.007	0.002	0.63	0.79	0.94	0.94	0.94
Plutonium-240	7.84e-22	1.11e-20	5.156	0.011	0.002	0.63	0.79	0.94	0.94	0.94
Plutonium-239/240	1.15e-21	1.04e-20	5.150	0.009	0.001	0.63	0.79	0.94	0.94	0.94
Potassium-40	4.57e-18	1.74e-17		0.523	0.156	0.008	0.0115	0.04	0.06	0.14

Table G.77 (continued)

Radionuclide ^a	Dose coefficients ^b		Energies (MeV/nt) ^b		Gamma absorption factors ^c					
	DF grd 0-15 (Sv m3/s Bq)	DF water (Sv m3/s Bq)	Alpha	Beta	Gamma	Worms, plants	Shrew, mouse	Mink, hawk, kingfisher	Fox, turkey	Deer
Strontium-90	3.72e-21	1.46e-20		0.196						
Yttrium-90	1.20e-19	3.63e-19		0.935						
Technetium-99	6.70e-22	3.14e-21		0.101						
Thorium-228	4.17e-20	2.05e-19	5.400	0.021	0.003	0.63	0.79	0.94	0.94	0.94
Radium-224	2.62e-19	1.03e-18	5.670	0.002	0.010	0.63	0.79	0.29	0.35	0.52
Radon-220	1.10e-20	4.03e-20	6.290							
Polonium-216	4.87e-22	1.80e-21	6.780							
Lead-212	3.62e-18	1.52e-17		0.176	0.148	0.0082	0.011	0.04	0.06	0.15
Bismuth-212	5.36e-18	2.00e-17	2.170	0.472	0.186	0.0085	0.011	0.04	0.06	0.14
Thallium-208	9.68e-17	3.84e-16		0.598	3.380	0.008	0.01	0.03	0.04	0.11
Polonium-212	0.00000000 0000000	0.000000000 0000000	8.790							
Thorium-230	6.39e-21	3.94e-20	4.670	0.015	0.002	0.63	0.79	0.94	0.94	0.94
Thorium-232	2.78e-21	1.99e-20	4.000	0.012	0.001	0.63	0.79	0.94	0.94	0.94
Radium-228				0.017						
Actinium-228	2.76e-17	1.04e-16		0.475	0.971	0.01	0.0127	0.04	0.06	0.14

Table G.77 (continued)

Radionuclide ^a	Dose coefficients ^b		Energies (MeV/nt) ^b			Gamma absorption factors ^c				
	DF grd 0-15 (Sv m3/s Bq)	DF water (Sv m3/s Bq)	Alpha	Beta	Gamma	Worms, plants	Shrew, mouse	Mink, hawk, kingfisher	Fox, turkey	Deer
Uranium-233	7.24e-21	3.64e-20	4.820	0.006	0.001	0.63	0.79	0.29	0.35	0.52
Uranium-233/234	4.69e-21	2.70e-20	4.790	0.010	0.002	0.63	0.79	0.94	0.94	0.94
Uranium-234	2.14e-21	1.75e-20	4.760	0.013	0.002	0.63	0.79	0.94	0.94	0.94
Uranium-235	3.75e-18	1.59e-17	4.400	0.049	0.156	0.008	0.0115	0.04	0.06	0.14
Thorium-231	1.94e-19	1.18e-18		0.165	0.026	0.09	0.126	0.16	0.21	0.36
Uranium-238	5.52e-22	7.95e-21	4.190	0.010	0.001	0.63	0.79	0.94	0.94	0.94
Thorium-234	1.29e-19	7.64e-19		0.060	0.009	0.63	0.79	0.94	0.94	0.94
Protactinium-234m	4.20e-19	1.52e-18		0.822	0.012	0.55	0.63	0.93	0.93	0.93
Protactinium-234	5.38e-17	2.03e-16		0.494	1.920	0.085	0.0123	0.03	0.05	0.12

^aIndented radionuclides are short-lived daughter products of the parent radionuclides.^bSource: Eckerman and Ryman (1993).^cLarge insect absorption factors from Blaylock et al. (1993) were used for worms and plants.

Small fish absorption factors from Blaylock et al. (1993) were used for shrews and mice.

Absorption factors for other receptors were derived using the methodology described in Cristy and Eckerman (1987).

Table G-78. Measured and literature-derived radionuclide uptake factors for plant, earthworm, and wildlife receptors in the Bear Creek watershed

Radionuclide	Browse	Canopy	Herb	Earthworm	Small mammal	Other mammal	Bird	Fish BCF (L/g)
Americium-241	2.489 m	5.7 m	2.178 m	3.148 m	1.815 m	0.002	0.004	0.03
Curium-243	0.8 s	1.067 s	1.093 s	0.886 s	2.331 s	0.001	0.001	0.03
Cesium-137	0.014 l	0.014 l	0.014 l	2.5 p	2.5 l	2.5	7	2
Curium-244	0.8 m	1.067 m	1.093 m	0.886 m	2.331 m	0.001	0.001	0.03
Plutonium-238	0 m	5.2 s	5 s	0 m	4.28 s	0.001	0.002	0.03
Plutonium-239	1.8 s	5.2 s	5 s	2.5 s	4.28 s	0.001	0.002	0.03
Plutonium-240	1.8 s	5.2 s	5 s	2.5 s	4.28 s	0.001	0.002	0.03
Plutonium-239/240	1.8 m	5.2 m	5 m	2.5 m	4.28 m	0.001	0.002	0.03
Technetium-99	0 m	0 m	0 m	0 m	0 m	0.00005	0.021	0.02
Thorium-228	0.00014 l	0.00014 l	0.00014 l	0.005 p	0.005 l	0.005	0.005	0.1
Thorium-230	0.00014 l	0.00014 l	0.00014 l	0.005 p	0.005 l	0.005	0.005	0.1
Thorium-232	0.00014 l	0.00014 l	0.00014 l	0.005 p	0.005 l	0.005	0.005	0.1
Uranium-233/234	0.0001 e	0.001 e	0.0015 e	0.063 e	0.00022 e	0.015	0.7	0.01
Uranium-234	0.0001 e	0.001 e	0.0015 e	0.063 e	0.00022 e	0.015	0.7	0.01
Uranium-235	0.0001 e	0.001 e	0.0015 e	0.063 e	0.00022 e	0.015	0.7	0.01
Uranium-238	0.0001 e	0.001 e	0.0015 e	0.063 e	0.00022 e	0.015	0.7	0.01
Beryllium-7	0 m	0 m	0 m	0.082 e	0.01 l	0.01	1.01	0.1
Cobalt-57	0.004 e	0.003 e	0 m	0.167 e	0.008 e	0.005	1.4	0.3
Potassium-40	0 m	4.539 e	0 m	2.633 e	4.236 e	1	1	1
Strontium-90	0 e	0 e	0 e	0 e	0 e	0.4	0.056	0.06
Neptunium-237	0.003 l	0.003 l	0.003 l	0.05 p	0.05 l	0.05	0.05	0.03

p = Uptake factor for earthworms was unavailable. Used the larger of the herbaceous plant and small mammal values.

m = Soil-to-tissue uptake factor measured for Bear Creek biota

s = Assumed uptake is same as that for related isotope for which measured soil-to-tissue value was available

e = Soil-to-tissue uptake factor for elemental form used for radionuclide

l = Literature value from IAEA (1994), NCRP (1989), or Baes et al. (1984)

Literature biotransfer factors (d/kg) for beef were converted to unitless uptake factors

(mg/kg wet tissue over mg/kg wet food) assuming a cow ingestion rate of 50 kg wet food/d.

All other mammal and bird values were literature-derived.

Table G.79. Radiation dose rates (mrad/d) for earthworms exposed to radionuclides in soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil^a	External dose: soil^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	12	34.30	3.057	37.357	Uranium-238 (56.2%) Uranium-234 (36.5%)
Transect 2	10	3.66	0.537	4.197	ns
Transect 3	9	20.60	2.973	23.573	Uranium-238 (56.9%) Uranium-234 (27.5%)
Transect 4	11	23.66	5.055	28.715	Uranium-238 (76.8%)
Transect 5	8	1.33	0.349	1.679	ns
Transect 6	10	30.40	2.883	33.283	Uranium-238 (56.7%) Uranium-234 (28.2%)
Transect 7	11	26.14	2.351	28.491	Uranium-238 (57.9%) Uranium-234 (32.0%)
Transect 8	9	3.64	0.584	4.224	ns
Transect 9	10	2.61	0.361	2.971	ns
Transect 10	8	6.53	0.87	7.400	ns
Transect 13	6	1.66	0.413	2.073	ns
<i>Source Areas</i>					
Creekside DBA	12	21.06	1.72	22.780	Uranium-234 (37.8%) Uranium-238 (29.5%)
Road site DBA	10	147.5	3.848	151.348	Uranium-234 (84.0%) Uranium-238 (11.4%)
Burial Grounds	10	3.42	2.162	5.582	ns
Burnyard	8	2.00	13.066	15.066	Uranium-238 (92.4%)
OLF_SLF	10	9.66	2.507	12.167	ns
S3	9	2.12	0.45	2.570	ns

^aInternal soil exposures result from direct uptake from soil.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.80. Radiation dose rates (mrad/d) for browse plants exposed to radionuclides in soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil^a	External dose: soil^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	12	0.78	0.055	0.835	ns
Transect 2	10	0.56	0.028	0.588	ns
Transect 3	9	0.69	0.05	0.740	ns
Transect 4	11	0.81	0.061	0.871	ns
Transect 5	8	0.20	0.035	0.235	ns
Transect 6	10	2.95	0.064	3.014	ns
Transect 7	11	0.44	0.039	0.479	ns
Transect 8	9	0.20	0.035	0.235	ns
Transect 9	10	0.20	0.028	0.228	ns
Transect 10	8	0.30	0.029	0.329	ns
Transect 13	6	0.01	0.035	0.045	ns
<i>Source Areas</i>					
Creekside DBA	12	3.842	0.059	3.901	ns
Road site DBA	10	2.278	0.046	2.324	ns
Burial Grounds	10	0.01	0.209	0.219	ns
Burnyard	8	0.01	0.083	0.093	ns
OLF_SLF	10	0.13	0.265	0.395	ns
S3	9	0.27	0.02	0.290	ns

^aInternal soil exposures result from direct uptake from soil.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.81. Radiation dose rates (mrad/d) for canopy plants exposed to radionuclides in soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil^a	External dose: soil^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	12	2.34	0.055	2.395	ns
Transect 2	10	0.47	0.028	0.498	ns
Transect 3	9	15.94	0.05	15.990	Americium-241 (95.8%)
Transect 4	11	0.71	0.061	0.771	ns
Transect 5	8	0.56	0.035	0.595	ns
Transect 6	10	6.27	0.064	6.334	Americium-241 (80.8%)
Transect 7	11	0.83	0.039	0.869	ns
Transect 8	9	0.59	0.035	0.625	ns
Transect 9	10	0.57	0.028	0.598	ns
Transect 10	8	0.88	0.029	0.909	ns
Transect 13	6	0.02	0.035	0.055	ns
<i>Source Areas</i>					
Creekside DBA	12	23.62	0.059	23.679	Plutonium-238 (62.9%)
Road site DBA	10	4.843	0.046	4.889	ns
Burial Grounds	10	2.46	0.209	2.669	ns
Burnyard	8	0.02	0.083	0.103	ns
OLF_SLF	10	3.05	0.265	3.315	ns
S3	9	0.23	0.02	0.250	ns

^aInternal soil exposures result from direct uptake from soil.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.82. Radiation dose rates (mrad/d) for herbaceous plants exposed to radionuclides in soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil ^a	External dose: soil ^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	12	2.50	0.055	2.555	ns
Transect 2	10	0.62	0.028	0.648	ns
Transect 3	9	1.48	0.05	1.530	ns
Transect 4	11	1.08	0.061	1.141	ns
Transect 5	8	0.55	0.035	0.585	ns
Transect 6	10	3.50	0.064	3.564	ns
Transect 7	11	0.95	0.039	0.989	ns
Transect 8	9	0.61	0.035	0.645	ns
Transect 9	10	0.56	0.028	0.588	ns
Transect 10	8	0.94	0.029	0.969	ns
Transect 13	6	0.04	0.035	0.075	ns
<i>Source Areas</i>					
Creekside DBA	12	20.23	0.059	20.289	Plutonium-238 (70.6%)
Road site DBA	10	6.901	0.046	6.947	ns
Burial Grounds	10	0.05	0.209	0.259	ns
Burnyard	8	0.05	0.083	0.133	ns
OLF_SLF	10	0.33	0.265	0.595	ns
S3	9	0.47	0.02	0.490	ns

^aInternal soil exposures result from direct uptake from soil.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.83. Radiation dose rates (mrad/d) for short-tailed shrews exposed to radionuclides in food and soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil/food^a	External dose: soil^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	12	3.621	0.118	3.739	ns
Transect 2	10	0.69	0.045	0.735	ns
Transect 3	9	2.443	0.074	2.517	ns
Transect 4	11	2.067	0.092	2.159	ns
Transect 5	8	0.535	0.052	0.587	ns
Transect 6	10	3.836	0.096	3.932	ns
Transect 7	11	1.46	0.058	1.518	ns
Transect 8	9	0.554	0.052	0.606	ns
Transect 9	10	2.886	0.042	2.928	ns
Transect 10	8	0.761	0.044	0.805	ns
Transect 13	6	0.113	0.053	0.166	ns
<i>Source Areas</i>					
Creekside DBA	12	18.4	0.156	18.556	Plutonium-238 (66.1%)
Road site DBA	10	6.371	0.117	6.488	ns
Burial Grounds	10	2.301	0.314	2.615	ns
Burnyard	8	0.453	0.124	0.577	ns
OLF_SLF	10	2.296	0.398	2.694	ns
S3	9	0.034	0.03	0.064	ns

^aInternal soil exposures result from ingestion of terrestrial food and soil and inhalation of dust.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.84. Current radiation dose rates (mrad/d) for short-tailed shrews exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides detected	Overall dose rate* from water^a	Principle radionuclides (contribution to dose rate)
BC9.4-SS5	6	<0.001	ns
BCK 12.36	8	<0.001	ns
BCK 9.40	6	<0.001	ns
BCK S3	4	<0.001	ns
NT1	5	<0.001	ns
NT2	3	<0.001	ns
NT3	7	<0.001	ns
NT4	2	<0.001	ns
NT5	3	<0.001	ns
NT6	4	<0.001	ns
NT7	7	0.005	ns
NT8	8	0.015	ns
SS1	2	<0.001	ns
SS4	5	<0.001	ns
SS5	4	<0.001	ns
SS6	3	<0.001	ns
Upper BC	8	<0.001	ns

*Internal water exposures result from ingestion of water. External exposures are inconsequential for shrews.

ns = No significant contributors.

Table G.85. Radiation dose rates (mrad/d) for white-footed mice exposed to radionuclides in food and soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil/food^a	External dose: soil^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	12	2.378	0.118	2.496	ns
Transect 2	10	0.299	0.045	0.344	ns
Transect 3	9	1.322	0.074	1.396	ns
Transect 4	11	1.112	0.092	1.204	ns
Transect 5	8	0.483	0.052	0.535	ns
Transect 6	10	3.734	0.096	3.830	ns
Transect 7	11	0.816	0.058	0.874	ns
Transect 8	9	0.497	0.052	0.549	ns
Transect 9	10	0.487	0.042	0.529	ns
Transect 10	8	0.722	0.044	0.766	ns
Transect 13	6	0.047	0.053	0.100	ns
<i>Source Areas</i>					
Creekside DBA	12	18.35	0.156	18.506	Plutonium-238 (66.3%)
Road site DBA	10	6.297	0.117	6.414	ns
Burial Grounds	10	2.286	0.314	2.600	ns
Burnyard	8	0.047	0.124	0.171	ns
OLF_SLF	10	4.163	0.398	4.561	ns
S3	9	0.328	0.030	0.358	ns

^aInternal soil exposures result from ingestion of terrestrial food and soil and inhalation of dust.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.86. Current radiation dose rates (mrad/d) for white-footed mice exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides	Overall dose rate*	Principle radionuclides (contribution to dose rate)
BC9.4-SS5	6	<0.001	ns
BCK 12.36	8	<0.001	ns
BCK 9.40	6	<0.001	ns
BCK S3	4	<0.001	ns
NT1	5	<0.001	ns
NT2	3	<0.001	ns
NT3	7	<0.001	ns
NT4	2	<0.001	ns
NT5	3	<0.001	ns
NT6	4	<0.001	ns
NT7	7	0.005	ns
NT8	8	0.015	ns
SS1	2	<0.001	ns
SS4	5	<0.001	ns
SS5	4	<0.001	ns
SS6	3	<0.001	ns
Upper BC	8	<0.001	ns

*Internal water exposures result from ingestion of water. External exposures are inconsequential for mice.

ns = No significant contributors.

Table G.87. Radiation dose rates (mrad/d) for red fox exposed to radionuclides in food and soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil/food^a	External dose: soil^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	12	0.615	0.076	0.691	ns
Transect 2	10	0.083	0.024	0.107	ns
Transect 3	9	0.189	0.037	0.226	ns
Transect 4	11	0.214	0.046	0.260	ns
Transect 5	8	0.065	0.026	0.091	ns
Transect 6	10	0.358	0.048	0.406	ns
Transect 7	11	0.279	0.029	0.308	ns
Transect 8	9	0.095	0.026	0.121	ns
Transect 9	10	0.074	0.021	0.095	ns
Transect 10	8	0.095	0.022	0.117	ns
Transect 13	6	0.098	0.027	0.125	ns
<i>Source Areas</i>					
Creekside DBA	12	0.177	0.084	0.261	ns
Road site DBA	10	1.292	0.063	1.355	ns
Burial grounds	10	2.016	0.157	2.173	ns
Burn yard	8	0.792	0.062	0.854	ns
OLF_SLF	10	2.001	0.199	2.200	ns
S3	9	0.025	0.015	0.040	ns

^aInternal soil exposures result from ingestion of terrestrial food and soil and inhalation of dust.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.88. Current radiation dose rates (mrad/d) for red fox exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides	Overall dose rate^a	Principal radionuclides
BC9.4-SS5	6	0.004	ns
BCK 12.36	8	0.008	ns
BCK 9.40	6	0.004	ns
BCK S3	4	0.012	ns
NT1	5	<0.001	ns
NT2	3	<0.001	ns
NT3	7	0.035	ns
NT4	2	<0.001	ns
NT5	3	0.002	ns
NT6	4	<0.001	ns
NT7	7	0.002	ns
NT8	8	0.016	ns
SS1	2	0.001	ns
SS4	5	0.007	ns
SS5	4	0.003	ns
SS6	3	0.001	ns
Upper BC	8	0.008	ns

^aInternal water exposures result from ingestion of water. External exposures are inconsequential for foxes.

ns = No significant contributors.

Table G.89. Radiation dose rates (mrad/d) for white-tailed deer exposed to radionuclides in food and soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil/food^a	External dose: soil^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	12	0.172	0.055	0.227	ns
Transect 2	10	0.019	0.028	0.047	ns
Transect 3	9	0.104	0.050	0.154	ns
Transect 4	11	0.114	0.061	0.175	ns
Transect 5	8	0.010	0.035	0.045	ns
Transect 6	10	0.146	0.064	0.210	ns
Transect 7	11	0.125	0.039	0.164	ns
Transect 8	9	0.021	0.035	0.056	ns
Transect 9	10	0.011	0.028	0.039	ns
Transect 10	8	0.034	0.029	0.063	ns
Transect 13	6	0.013	0.035	0.048	ns
<i>Source Areas</i>					
Creekside DBA	12	0.104	0.059	0.163	ns
Road site DBA	10	0.72	0.046	0.766	ns
Burial grounds	10	0.849	0.209	1.058	ns
Burn yard	8	0.537	0.083	0.620	ns
OLF_SLF	10	0.838	0.265	1.103	ns
S3	9	0.015	0.020	0.035	ns

^aInternal soil exposures result from ingestion of terrestrial food and soil.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.90. Current radiation dose rates (mrad/d) for white-tailed deer exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides detected	Overall dose rate from water^a	Principle radionuclides (contribution to dose rate)
BC9.4-SS5	6	0.004	ns
BCK 12.36	8	0.008	ns
BCK 9.40	6	0.004	ns
BCK S3	4	0.012	ns
NT1	5	<0.001	ns
NT2	3	<0.001	ns
NT3	7	0.035	ns
NT4	2	<0.001	ns
NT5	3	0.002	ns
NT6	4	<0.001	ns
NT7	7	0.002	ns
NT8	8	0.017	ns
SS1	2	0.001	ns
SS4	5	0.007	ns
SS5	4	0.003	ns
SS6	3	0.001	ns
Upper BC	8	0.008	ns

^aInternal water exposures result from ingestion of water. External exposures to water are inconsequential for deer.

ns = No significant contributors.

Table G.91. Radiation dose rates (mrad/d) for red-tailed hawks exposed to radionuclides in food and soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil/food^a	External dose: soil^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	16	1.130	0.006	1.136	ns
Transect 2	18	0.164	0.003	0.167	ns
Transect 3	21	0.144	0.005	0.149	ns
Transect 4	21	0.122	0.006	0.128	ns
Transect 5	21	0.159	0.003	0.162	ns
Transect 6	21	0.452	0.006	0.458	ns
Transect 7	21	0.276	0.004	0.280	ns
Transect 8	21	0.202	0.003	0.205	ns
Transect 9	21	0.181	0.003	0.184	ns
Transect 10	21	0.141	0.003	0.144	ns
Transect 13	16	0.251	0.004	0.255	ns
<i>Source Areas</i>					
Creekside DBA	12	0.141	0.006	0.147	ns
Road site DBA	10	0.729	0.005	0.734	ns
Burial Grounds	10	2.285	0.021	2.306	ns
Burnyard	8	0.005	0.008	0.013	ns
OLF_SLF	10	2.273	0.027	2.300	ns
S3	9	0.005	0.002	0.007	ns

^aInternal soil exposures result from ingestion of terrestrial prey.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.92. Current radiation dose rates (mrad/d) for red-tailed hawk exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides detected	Overall dose rate from water^a	Principle radionuclides (contribution to dose rate)
BC9.4-SS5	6	0.165	ns
BCK 12.36	8	0.377	ns
BCK 9.40	6	0.207	ns
BCK S3	4	0.581	ns
NT1	5	0.040	ns
NT2	3	0.032	ns
NT3	7	1.623	ns
NT4	2	0.005	ns
NT5	3	0.76	ns
NT6	4	0.041	ns
NT7	7	0.088	ns
NT8	8	0.435	ns
SS1	2	0.062	ns
SS4	5	0.319	ns
SS5	4	0.157	ns
SS6	3	0.054	ns
Upper BC	8	0.390	ns

^aInternal water exposures result from ingestion of water. External exposures are inconsequential for hawks.

ns = No significant contributors.

Table G.93. Radiation dose rates (mrad/d) for mink exposed to radionuclides in food and soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Internal dose: soil/food^a	External dose: soil^b	Overall dose rate from soil	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>					
Transect 1	12	0.181	0.083	0.264	ns
Transect 2	10	0.027	0.03	0.057	ns
Transect 3	9	0.023	0.05	0.073	ns
Transect 4	11	0.018	0.061	0.079	ns
Transect 5	8	0.027	0.035	0.062	ns
Transect 6	10	0.073	0.064	0.137	ns
Transect 7	11	0.043	0.039	0.082	ns
Transect 8	9	0.033	0.035	0.068	ns
Transect 9	10	0.03	0.028	0.058	ns
Transect 10	8	0.023	0.029	0.052	ns
Transect 13	6	0.041	0.035	0.076	ns
<i>Source Areas</i>					
Creekside DBA	12	0.025	0.108	0.133	ns
Road site DBA	10	0.104	0.08	0.184	ns
Burial grounds	10	1.037	0.209	1.246	ns
Burn yard	8	0.03	0.083	0.113	ns
OLF_SLF	10	1.031	0.265	1.296	ns
S3	9	0.001	0.02	0.021	ns

^aInternal soil exposures result from ingestion of terrestrial food and soil and inhalation of dust.

^bExternal soil exposures result from direct radiation from soil.

ns = No significant contributors. No radionuclide contributes >5 mrad/d.

Table G.94. Current radiation dose rates (mrad/d) for mink exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides detected	Internal: water/fish^a	External: water^b	Overall dose rate from water	Principal radionuclides (contribution to dose rate)
BC9.4-SS5	6	0.023	<0.001	0.023	ns
BCK 12.36	8	0.055	<0.001	0.055	ns
BCK 9.40	6	0.030	<0.001	0.030	ns
BCK S3	4	0.081	<0.001	0.081	ns
NT1	5	0.006	<0.001	0.006	ns
NT2	3	0.004	<0.001	0.004	ns
NT3	7	0.234	<0.001	0.234	ns
NT4	2	<0.001	<0.001	<0.001	ns
NT5	3	0.011	<0.001	0.011	ns
NT6	4	0.007	<0.001	0.007	ns
NT7	7	0.017	<0.001	0.017	ns
NT8	8	1.993	<0.001	1.994	ns
SS1	2	0.009	<0.001	0.009	ns
SS4	5	0.044	<0.001	0.044	ns
SS5	4	0.022	<0.001	0.022	ns
SS6	3	0.007	<0.001	0.007	ns
Upper BC	8	0.056	<0.001	0.057	ns

^aInternal water exposures result from ingestion of water and fish.

^bExternal water exposures result from immersion in water or exposure at the water's surface.

ns = No significant contributors.

Table G.95. Radiation dose rates (mrad/d) for belted kingfishers exposed to radionuclides in food and soil at source areas and sites along Bear Creek

Location	Number of radionuclides detected	Overall dose rate from soil^a	Principal radionuclides (contribution to dose rate)
<i>Bear Creek sites</i>			
Transect 1	12	0.07	ns
Transect 2	10	0.04	ns
Transect 3	9	0.06	ns
Transect 4	11	0.08	ns
Transect 5	8	0.04	ns
Transect 6	10	0.08	ns
Transect 7	11	0.05	ns
Transect 8	9	0.04	ns
Transect 9	10	0.04	ns
Transect 10	8	0.04	ns
Transect 13	6	0.04	ns
<i>Source Areas</i>			
Creekside DBA	12	0.057	ns
Road site DBA	10	0.044	ns
Burial Grounds	10	0.27	ns
Burnyard	8	0.11	ns
OLF_SLF	10	0.32	ns
S3	9	0.03	ns

^aOverall soil exposures for kingfishers are entirely from external exposures resulting from direct radiation. The kingfisher diet is 100% aquatic organisms, and soil ingestion is assumed negligible. Thus, internal exposures from soil-related radionuclides are unlikely.

ns = No significant contributors. All radionuclides contribute <1 mrad/d.

Table G.96. Current radiation dose rates (mrad/d) for belted kingfishers exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides detected	Internal: water/fish ^a	External: water ^b	Overall dose rate from water	Principal radionuclides (contribution to dose rate)
BC9.4-SS5	6	1.813	<0.001	1.813	ns
BCK 12.36	8	4.150	<0.001	4.150	ns
BCK 9.40	6	2.281	<0.001	2.281	ns
BCK S3	4	6.395	<0.001	6.395	ns
NT1	5	0.440	<0.001	0.440	ns
NT2	3	0.347	<0.001	0.347	ns
NT3	7	17.864	<0.001	17.864	Uranium 238 (66.4%) Uranium 233/234 (31.9%)
NT4	2	0.052	<0.001	0.052	ns
NT5	3	0.841	<0.001	0.841	ns
NT6	4	0.455	<0.001	0.455	ns
NT7	7	0.971	<0.001	0.971	ns
NT8	8	8.253	<0.001	8.254	ns
SS1	2	0.683	<0.001	0.683	ns
SS4	5	3.513	<0.001	3.513	ns
SS5	4	1.728	<0.001	1.728	ns
SS6	3	0.593	<0.001	0.593	ns
Upper BC	8	4.288	<0.001	4.288	ns

^aInternal water exposures result from ingestion of water and fish.

^bExternal water exposures result from perching near the water surface.

ns = No significant contributors. No radionuclide contributed >5 mrad/d to the overall dose rate.

Table G.97. Future radiation dose rates (mrad/d) for short-tailed shrews exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides predicted	Overall dose rate from water^a [maximum]	Overall dose rate from water^a [minimum]	Principle radionuclides (contribution to dose rate)
NT1 (S3)	1	<0.001	<0.001	ns
NT3 (BYBY)	4	<0.001	<0.001	ns
NT7 (BG-A)	1	0.002	<0.001	ns
NT8 (CW)	3	<0.001	<0.001	ns
NT8 (WIP)	2	0.002	0.001	ns
NT8 (ALL)	5	0.002	0.001	ns

^aInternal water exposures result from ingestion of water. External exposures are inconsequential for shrews.

ns = No significant contributors.

Table G.98. Future radiation dose rates (mrad/d) for white-footed mice exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides predicted	Overall dose rate from water^a [maximum]	Overall dose rate from water^a [minimum]	Principle radionuclides (contribution to dose rate)
NT1 (S3)	1	<0.001	<0.001	ns
NT3 (BYBY)	4	<0.001	<0.001	ns
NT7 (BG-A)	1	0.002	<0.001	ns
NT8 (CW)	3	<0.001	<0.001	ns
NT8 (WIP)	2	0.002	0.001	ns
NT8 (ALL)	5	0.002	0.001	ns

^aInternal water exposures result from ingestion of water. External exposures are inconsequential for mice.

ns = No significant contributors.

Table G.99. Future radiation dose rates (mrad/d) for red fox exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides predicted	Overall dose rate from water^a [maximum]	Overall dose rate from water^a [minimum]	Principle radionuclides (contribution to dose rate)
NT1 (S3)	1	<0.001	<0.001	ns
NT3 (BYBY)	4	0.022	0.015	ns
NT7 (BG-A)	1	<0.001	<0.001	ns
NT8 (CW)	3	0.008	0.004	ns
NT8 (WIP)	2	<0.001	<0.001	ns
NT8 (ALL)	5	0.009	0.004	ns

^aInternal water exposures result from ingestion of water. External exposures are inconsequential for foxes.

ns = No significant contributors.

Table G.100. Future radiation dose rates (mrad/d) for white-tailed deer exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides predicted	Overall dose rate from water^a [maximum]	Overall dose rate from water^a [minimum]	Principle radionuclides (contribution to dose rate)
NT1 (S3)	1	<0.001	<0.001	ns
NT3 (BYBY)	4	0.022	0.015	ns
NT7 (BG-A)	1	<0.001	<0.001	ns
NT8 (CW)	3	0.008	0.004	ns
NT8 (WIP)	2	<0.001	<0.001	ns
NT8 (ALL)	5	0.009	0.004	ns

^aInternal water exposures result from ingestion of water. External exposures are inconsequential for deer.

ns = No significant contributors.

Table G.101. Future radiation dose rates (mrad/d) for red-tailed hawks exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides predicted	Overall dose rate from water ^a [maximum]	Overall dose rate from water ^a [minimum]	Principle radionuclides (contribution to dose rate)
NT1 (S3)	1	<0.001	<0.001	ns
NT3 (BYBY)	4	1.040	0.685	ns
NT7 (BG-A)	1	<0.001	<0.001	ns
NT8 (CW)	3	0.381	0.173	ns
NT8 (WIP)	2	<0.001	<0.001	ns
NT8 (ALL)	5	0.38	0.173	ns

^aInternal water exposures result from ingestion of water. External exposures are inconsequential for hawks.

ns = No significant contributors.

Table G.102. Future radiation dose rates (mrad/d) for mink exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides predicted	Overall dose rate from water ^a [maximum]	Overall dose rate from water ^a [minimum]	Principle radionuclides (contribution to dose rate)
NT1 (S3)	1	<0.001	<0.001	ns
NT3 (BYBY)	4	0.143	0.095	ns
NT7 (BG-A)	1	0.205	0.119	ns
NT8 (CW)	3	0.053	0.024	ns
NT8 (WIP)	2	0.215	0.147	ns
NT8 (ALL)	5	0.267	0.17	ns

^aInternal water exposures result from ingestion of water and fish. External water exposures result from immersion in water or exposure at the water's surface.

ns = No significant contributors.

Table G.103. Future radiation dose rates (mrad/d) for belted kingfishers exposed to radionuclides in water at sites along Bear Creek and its tributaries

Location	Number of radionuclides predicted	Overall dose rate from water ^a [maximum]	Overall dose rate from water ^a [minimum]	Principle radionuclides (contribution to dose rate)
NT1 (S3)	1	0.004	0.001	ns
NT3 (BYBY)	4	11.394	7.53	Uranium-238 (54.1%) Uranium-234 (44.1%)
NT7 (BG-A)	1	0.387	0.224	ns
NT8 (CW)	3	4.19	1.91	ns
NT8 (WIP)	2	0.408	0.279	ns
NT8 (ALL)	5	4.587	2.177	ns

^aInternal water exposures result from ingestion of water and fish. External water exposures result from perching near the water surface.

ns = No significant contributors.

Table G.104. Hypothetical^a future radiation dose rates (mrad/d) for terrestrial biota exposed to radionuclides in soil at the C-West, C-East, and A-North Burial Grounds

Receptor	C-West ^b	C-East ^c	A-North ^d
Plant (Browse, Canopy, Herbaceous)	3.875e+06	4.569e+04	1.043e+06
Earthworm	5.74e+06	5.276e+05	1.049e+06
Short-tailed shrew	5.235e+05	1.366e+05	5.266e+01
White-footed mouse	4.232e+05	1.104e+05	5.263e+01
Red fox	2.406e+05	6.279e+04	1.024e+01
White-tailed deer	1.688e+05	4.401e+04	5.235e+01
Red-tailed hawk	1.521e+04	3.959e+03	1.098e+01

^a Assuming failure of caps and exposure of biota to existing inventories

^b Evaluated inventory of ⁹⁹Tc and ²³⁸Th (3,440,000 and 5,900,000 pCi/g, respectively)

^c Evaluated inventory of ²³⁸Th (1,540,000 pCi/g)

^d Evaluated inventory of ⁹⁹Tc (970,000 pCi/g)

Table G.105. RBRGOs for reducing future risks to aquatic biota from chemicals for which adverse effects of predicted concentrations are possible or expected

Chemical	Modeled Location	Recommend ed RBRGO (mg/L)	Explanation
Barium	NT-2	5.8	LCV Daphnids
Beryllium	NT-7, NT-8, and BCK 9.47	0.0053	LCV Daphnids
Cadmium	NT-1, NT-7, and BCK 9.47	0.002	Chronic NAWQC ^a
Calcium	NT-1 and NT-2	116	LCV Daphnids
Copper	NT-7, NT-8, and BCK 9.47	0.0214	Chronic NAWQC ^a
Cyanide	NT-7, NT-8, and BCK 9.47	0.0052	Chronic NAWQC
Lead	NT-7 and NT-8	0.0077	Chronic NAWQC ^a
Lithium	NT-7, NT-8, and BCK 9.47	0.0144	Secondary Chronic Value
Mercury	NT-1	0.0013	Secondary Chronic Value
Nickel	NT-1, NT-7 and NT-8	0.015	background criteria (UTL)
Uranium	NT-1, NT-7, NT-8, and BCK 9.47	0.142	LCV Fish
Tetrachloroethene	NT-7	0.750	LCV Daphnids

^aBased on 200 mg/L hardness.

Table G.106. RBRGOs for reducing risks to the benthic invertebrate community from contaminants in water

Chemical	Location	Recommended RBRGO (mg/L) ^a	Explanation
Cadmium	Reach 1, Reach 2, and SS-1	0.002	Chronic NAWQC2 ^b
Calcium	Reach 1, NT-2, and SS-1	116	LCV Daphnids
Manganese	Reach 1	6.6	background criteria (UTL)
Nickel	Reach 1, SS-1, and potentially SS-4	0.015	background criteria (UTL)
Uranium	Reach 1 and potentially SS-4	0.142	LCV Fish

^aConcentrations are dissolved for phase.

^bBased on 200 mg/L hardness.

Table G.107. RBRGOs for reducing risks to benthic invertebrates inhabiting soft sediments from contaminants in sediments

Chemical	Location	Recommended RBRGO (mg/kg)	Explanation ^a
Manganese	NT-6 (SD 8)	7320	SSNAEL
Selenium	NT-6 (SD 8)	6.6	SSNAEL
2,4,5-T	NT-2 (SD 3) and NT-6 (SD 8)	0.013	SSNAEL

^aHighest concentration was among the following: generic probable effect levels, background UTL, and SSNAEL.

Table G.108. RBRGOs for reducing risks to the plant community from contaminants in soils

Chemical	Location	Recommended RBRGO (mg/kg)	Explanation*
Antimony	BYBY	5	benchmark concentration
Arsenic	BYBY, SL/OLF, BG	20	background criteria (UTL)
Barium	BYBY, Bear Creek Rd. Debris Burial area	500	benchmark concentration
Cadmium	TS01, TS03, BYBY, Bear Creek Rd. Debris Burial area	0.3	benchmark concentration
Chromium	BYBY, BG, Creekside Debris Burial area	80	background criteria (UTL)
Cobalt	BYBY, SL/OLF	40	background criteria (UTL)
Copper	BYBY, SL/OLF, Bear Creek Rd. Debris Burial area	100	benchmark concentration
Lead	TS01, BYBY	50	benchmark concentration
Lithium	TS01, TS03, TS04, BYBY, SL/OLF, BG	1	benchmark concentration
Manganese	BYBY, SL/OLF, BG	2220	background criteria (UTL)
Mercury	TS01, TS03, TS04, S3 ponds, BYBY, SL/OLF, Creekside Debris Burial area, Bear Creek Rd. Debris Burial area	0.7	SSNAEL
Molybdenum	BYBY	2	benchmark concentration
Nickel	TS03, S3 ponds, BYBY, SL/OLF, BG, Bear Creek Rd. Debris Burial area	57	background criteria (UTL)
Selenium	TS01, TS03, TS04, BYBY, BG, Creekside Debris Burial area, Bear Creek Rd. Debris Burial area	2.5	SSNAEL
Silver	S3 ponds, BYBY, SL/OLF, BG, Creekside Debris Burial area, Bear Creek Rd. Debris Burial area	2.8	background criteria (UTL)
Tin	BYBY	50	benchmark concentration
Vanadium	S3 ponds, BYBY, SL/OLF, BG	60	background criteria (UTL)
Zinc	S3 ponds, BYBY, SL/OLF, BG, Creekside Debris Burial area, Bear Creek Rd. Debris Burial area	108	background criteria (UTL)

*Highest concentration was among the following: benchmark, background UTL, and SSNAEL.

**Table G.109. RGOs for reducing risks to the plant community
from contaminants in soil solution**

Chemical	Location	Recommended RBRGO (mg/L)	Explanation*
Aluminum	SL/OLF near NT4, BG area near NT6, BG area near NT8	0.2	benchmark concentration
Chromium	SL/OLF near NT4	0.05	benchmark concentration
Cobalt	SL/OLF near NT4	0.06	benchmark concentration
Copper	BG area near NT8	0.05	benchmark concentration
Iron	SL/OLF near NT4, BG area near NT8	10	benchmark concentration
Lead	SL/OLF near NT4, BG area near NT6, BG area near NT7, BG area near NT8	0.02	benchmark concentration
Manganese	SL/OLF near NT4	4	benchmark concentration

*Highest concentration was among the following: benchmark, UTL, and SSNAEL.

Table G.110. RGOs for reducing risks to soil invertebrates from contaminants in soils

Chemical	Location	Recommended RBRGO (mg/kg)	Explanation*
Cadmium	BYBY	20	benchmark concentration
Chromium	BYBY, Creekside debris burial area, Bear Creek Rd. debris burial area	80	background criteria (UTL)
Copper	BYBY, SL/OLF, Bear Creek Rd. debris burial area	50	benchmark concentration
Lead	BYBY	500	benchmark concentration
Mercury	S3 ponds, BYBY, SL/OLF, Creekside debris burial area, Bear Creek Rd. debris burial area	0.7	SSNAEL
Nickel	BYBY	200	benchmark concentration
Zinc	BYBY, SL/OLF, Bear Creek Rd. debris burial area	200	benchmark concentration

*Highest concentration was among the following: benchmark, UTL, and SSNAEL.

Table G.111. Recommended RBRGOs for wildlife

Analyte	Calculated RBRGO (mg/kg)				Background concentration (mg/kg)	Suggested RBRGO (mg/kg)
	Short-tailed shrew ^a	White-footed mouse ^a	Red fox ^a	Belted kingfisher		
Antimony	10.80		47.00		ND	10.80
Cadmium	0.25	1.75			0.12	0.25
Chromium		65.00			39.30	65.00
Mercury	0.53	3.90	0.43	0.13	0.13	0.43
Vanadium	30.00				41.00	41.00
PCBs	0.27		1.50		NA	0.27

^aRGO represents the maximum allowable concentration in surface soil.

^bRGO represents the maximum allowable concentration in forage fish.

G.12 REFERENCES

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G.13 SUPPORTING INFORMATION FOR APPENDIX G

G.13.1 CHRONIC SEDIMENT TOXICITY TEST REPORT: BCVSD1

**Chronic Sediment Toxicity
Test Report:
BCVSD1**

**for the
Bear Creek Valley Floodplain Soil Sampling and Analysis
Sediment Toxicity Testing Task**

**Prepared for
DEPARTMENT OF ENERGY
Y-12 Plant
Lockheed Martin Energy Systems
Oak Ridge, Tennessee**

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September 15, 1995

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1. Objectives

- 1.1 Lockheed Martin Energy Systems is conducting an investigation of the Bear Creek Valley Floodplain at the Department of Energy's Oak Ridge Y-12 Site in Oak Ridge, Tennessee. One component of this investigation requires evaluation of sediment toxicity in Bear Creek. The Oak Ridge National Laboratory Environmental Science Division's Toxicology Laboratory (ORNL/ESD) was designated to conduct a sediment toxicity study for the Bear Creek Valley Floodplain Analysis project.
- 1.2 This report presents the results of the sediment toxicity study conducted between May 26 and June 28, 1995. The Methods and Materials section (section 2) summarizes sample collection and storage activities. It also outlines sediment toxicity study activities conducted at ORNL/ESD. Quality assurance and test uncertainties specific to this study are discussed under Data Quality (section 3). Section 4 presents the *Hyaella azteca* (Amphipoda) and *Daphnia magna* (Cladocera) toxicity test data, statistical analysis results, and toxicity test water chemistry analytical results. The toxicity test data and results are discussed in section 5 with respect to significance of differences in test organism survival and reproduction. Conclusions drawn from these data are summarized in section 6. The report concludes with the approval and release signature, references cited and the appendices.

2. Methods and Materials

2.1 Sample Collection

- 2.1.1 Sampling of sediment in test and reference sites within Bear Creek Valley was conducted by Science Applications International Corporation (SAIC) personnel. Preparation of the laboratory formulated control sediment was conducted by ORNL/ESD personnel. Sampling was conducted in accordance with SAIC and/or ORNL/ESD approved procedures. Copies of the original chain-of-custody forms are included in Appendix A. Original chain-of-custody forms were retained by ORNL/ESD until returned to SAIC with the sediment samples.
- 2.1.2 All test sites sampled are located in the Bear Creek Valley Floodplain. Seventeen test sites were selected and sampled. Duplicate samples were collected from each of two sites: SD04 and SD14. One reference sample, composed of equal volumes of sediment sampled from sites in three tributaries to Bear Creek: North Tributary (NT) NT11, NT13 and NT15, was collected. One homogenized, surface grab sample from each site was collected between May 17 and May 25, 1995. Collection times were all between 1022 and 1520 Daylight Savings Time. Sample bottles were placed on ice in coolers until hand carried to ORNL/ESD on May 26, 1995. All site identification codes and associated sample identification numbers are listed in Table 1.
- 2.1.3 A control, laboratory formulated sediment (LFS) was prepared by the ORNL/ESD Toxicology Laboratory. It consisted of an approximately equal volume mixture of clean, playground sand (particle size $\leq 500 \mu\text{m}$) and natural, clay-rich sediment obtained from the western-most pond located behind ORNL plant building 1504. The LFS was prepared on April 10, 1995 and was stored wet at 4°C.

Table 1: Sediment Sample Identification Information

Site Code	ID Number	Site Code	ID Number
SD01	D00111	SD11	D01111
SD02	D00211	SD12	D01211
SD03	D00311	SD13	D01311
SD04	D00411	SD14	D01411
SD04QA	D00401	SD14QA	D01401
SD05	D00511	SD15	D01511
SD06	D00611	SD16	D01611
SD07	D00711	SD17	D01711
SD08	D00811	RD21 (reference)	D02121
SD09	D00911		
SD10	D01011	ESD Control	LFS0495b

2.1.4 Temperatures in the coolers used to transport the samples were measured and recorded at the time of sample delivery on May 26, 1995. They were 0.1°C (cooler #100) and 0.4°C (cooler #OU1-07), both below the desired range ($4 \pm 2^\circ\text{C}$). However, since the samples were not frozen, the sample condition was judged to be acceptable. Sample temperatures were not measured at the time of delivery because of safety concerns related to potential radiological contamination in the sediment samples. Test site and laboratory control sediment samples were stored in a refrigerator in the ORNL/ESD Toxicology Laboratory, Building 1504, Room 10.

2.1.5 Sediment sample preparation and usage activities in the Toxicology Laboratory were documented on prepared log sheets. Copies of the log book pages where these log sheets are located are included in Appendix A.

2.2 Sample Analytical Methods

All standard operating procedures (SOPs) described below are located in the ORNL/ESD Toxicology Laboratory Quality Assurance Program Manual (Kszos 1989). Revisions to the SOPs were completed but not officially approved at the time of this study. Thus, the SOPs were used in draft form. A table of the test conditions (as used in this study) for each test, and a list of the test acceptability criteria for each test is included in Appendix B.

2.2.1 Toxicity Test Methods - *Hyaella azteca*

The SOP (#21) for the *H. azteca* whole sediment toxicity test used in this study is based on the U.S. Environmental Protection Agency (USEPA) whole sediment toxicity test method document (1994), and the American Society of Testing and Materials (ASTM) document (1991) guidelines. The USEPA (1994) sediment toxicity test manual also describes a water-only reference toxicant test for *H. azteca*. The SOP (#30) for conducting this reference toxicant test is based on guidance from that document.

2.2.2 Toxicity Test Methods - *Daphnia magna*

The USEPA (1994) sediment toxicity test manual does not include *D. magna* as a standard test organism. The SOP (#22) for testing sediment with this organism was developed from the ASTM document (1991), only. The water-only reference toxicant test for this organism is based on the acute reference toxicant test described for *Ceriodaphnia dubia* (USEPA, 1989). The SOP (#31) for conducting this reference toxicant test is based on guidance from that document.

2.3 Deviations from, and modifications to, standard operating procedures

2.3.1 Logistical constraints prevented all 21 sediment samples from being tested simultaneously. Instead, the samples were divided into three groups, and each group was tested independently with both test organisms. A laboratory formulated sediment control treatment was included with each *H. azteca* toxicity test and a water-only control treatment was included in each *D. magna* toxicity test. Each set of field duplicate samples was assigned to a different group (SD14 to Group 1; SD04 to Group 3). Due to a limitation in sample volume, the field reference sample (RD21) was included in the *H. azteca* toxicity test only once (Group 1), and in the *D. magna* toxicity test twice (Groups 1 and 3). The grouping is diagrammed in Table 2, below.

Table 2. Sample Grouping for each sediment toxicity test. Test initiation and test termination dates are included below each heading.

Group 1		Group 2		Group 3	
<i>H.azteca</i>	<i>D.magna</i>	<i>H.azteca</i>	<i>D.magna</i>	<i>H.azteca</i>	<i>D.magna</i>
5/30 - 6/9	5/31 - 6/14	6/6 - 6/16	5/5 - 5/19	6/13 - 6/23	6/12 - 6/26
1995	1995	1995	1995	1995	1995
SD17	SD17	SD16	SD16	SD15	SD15
SD14	SD14	SD12	SD12	SD13	SD13
SD14QA	SD14QA	SD10	SD10	SD09	SD09
SD08	SD08	SD07	SD07	SD04	SD04
SD06	SD06	SD05	SD05	SD04QA	SD04QA
		SD03	SD03	SD01	SD01
RD21	RD21	SD02	SD02	— ^b	RD21
LFS0495b ^a		LFS0495b		LFS0495b	LFS0495b
	Water-only Control		Water-only Control		Water-only Control

^aLaboratory Formulated Sediment (LFS) control treatment.

^bReference site (RD21) could not be retested Group 3 because of insufficient sample volume.

2.3.2 In order to minimize waste generation, test water collected from each test replicate, but not used for test water chemical analysis, was composited and saved for use in the *H. azteca* test take down. This water was used to sieve and rinse sediment from each test beaker during the recovery of test organisms.

- 2.3.3 Water containing *D. magna* neonates produced during the Group 1 *D. magna* test was inadvertently combined with the composited test/rinse water. These neonates were discovered while Group 1 *H. azteca* were being recovered and counted. The difference in appearance of these two organisms is such that positive identification of each is easy; misidentifying *D. magna* as *H. azteca* is highly improbable. The appearance of *D. magna* neonates among the *H. azteca* did not influence the results of the Group 1 *H. azteca* whole sediment toxicity test. On all subsequent test days, neonates were segregated from the composited test/rinse water.
- 2.3.4 The *H. azteca* toxicity test water change out syringes were used without the pipette tip attachment specified in the standard operating procedure. To ensure that no organisms were accidentally extracted from the test beaker during water change out activities, the water volume collected in the syringe was visually checked over a light board for extracted *H. azteca*. Any found in this way were carefully pipetted back into its respective test beaker. This proved to be an extremely effective procedural change for finding extracted organisms and minimizing organism loss by test activities.
- 2.3.5 The *H. azteca* toxicity test SOP specifies daily feeding with 1.0 mL of *Hyalella* food. This procedure was followed for the Group 1 sediment samples. The dissolved oxygen (D.O.) concentration in all treatments in that Group, however, steadily decreased over the course of the test. To evaluate whether this drop in D.O. was caused by low D.O. concentrations in the laboratory control water added to the test beakers, its D.O. concentration was measured on Day 5 of the test; it was 8.1 mg/L. We hypothesize that the decrease in D.O. concentration was caused by decomposition of excess *Hyalella* food. The Group 1 test was not fed for the last three days (Days 8, 9 and 10). The D.O. concentration increased after implementing this procedural change, as demonstrated by the following set of selected mean D.O. data:

Test Day:	1	3	5	8	10
Mean D.O. mg/L:	7.1	4.4	3.8	2.8	5.5

All subsequent *H. azteca* tests were fed at the rate of 0.5 mL per day. Dissolved oxygen concentrations in Group 2 and 3 tests improved considerably: 149 of the 150 D.O. measurements showed D.O. concentrations ≥ 4.4 mg/L.

- 2.3.6 The acceptable test temperature range for both test organisms is set at 22.0 to 24.0°C. The test temperature of the Group 1 *D. magna* whole sediment toxicity test was outside of the acceptable range on one day (21.6°C; Test Day 13, June 13, 1995). The test temperature of the Group 2 *D. magna* whole sediment toxicity test was outside of the acceptable range on one day (21.9°C; Test Day 10, June 15, 1995). On both days, the test chamber thermostat was adjusted to correct these non-conformances. The test temperature on all remaining test days was within the acceptable range. These non-conformances do not invalidate the *D. magna* toxicity test results.
- 2.3.7 Due to potential radiological hazard, the initial sample temperatures were not measured at the time of arrival. Instead, the cooler temperatures were taken and recorded at that time (May 26, 1995). All samples were immediately placed in a dark refrigerator kept between 2 and 8°C. The temperature of each sediment sample

was not determined until prepared for testing. Group 1 samples were stored in the refrigerator for three days and removed for test preparation activities on May 29. Group 2 samples were stored for 9 days before being used in test preparation activities on June 4. Finally, Group 3 samples were stored for a total of 16 days before being used in test preparation activities on June 11. See section 3.6.2 for a discussion of this procedural deviation.

- 2.3.8 *D. magna* are cultured at 25°C in our laboratory. The sediment toxicity test procedure calls for testing at $23 \pm 1^\circ\text{C}$. The organisms were not pre-acclimated to 23°C before test initiation. In our judgement, the difference in temperatures ($\Delta T = 2^\circ\text{C}$) was not great enough to require acclimation.
- 2.3.9 The conductivity meter was not verified on June 1 and June 16, 1995. The meter verification results from May 31 and June 2 are as follows: 200 $\mu\text{S}/\text{cm} = 199$ and 199, respectively; 720 $\mu\text{S}/\text{cm} = 712$ and 714, respectively. These results suggest that the meter should have been operating within acceptable limits on June 1. The same results from June 15 and 17 are as follows: 200 $\mu\text{S}/\text{cm} = 202$ and 199, respectively; 720 $\mu\text{S}/\text{cm} = 719$ and 699, respectively. These results suggest that the meter should have been operating within acceptable limits on June 16. These non-conformances do not invalidate the chemical analyses data obtained on June 1 or June 16, 1995.

2.4 Toxicity Test Water Chemistry Methods

Instruments were calibrated, verified and/or standardized according to manufacturer's instructions. All analyses were conducted on pooled test water samples collected from each set of replicates before test water renewal. Copies of the water chemistry data log sheets are included in Appendix F.

- 2.4.1 The pH was measured by EPA method 150.1 with an Orion pH meter. The meter was calibrated daily with pH 4.00 and pH 10.00 buffer solutions (traceable to the National Institute of Standards and Technology).
- 2.4.2 Conductance ($\mu\text{S}/\text{cm}$) was measured by EPA method 120.1 with a ACE meter. All values were corrected to 25°C. Instrument operation was verified daily by use of two conductivity standard solutions with conductivities of 200 and 720 $\mu\text{S}/\text{cm}$, respectively.
- 2.4.3 Dissolved oxygen (mg/L) was measured by EPA method 360.1 using a dissolved oxygen meter. The meter was calibrated daily in accordance with the manufacturer's instructions.
- 2.4.4 Alkalinity was measured by titrating 50-mL samples with 0.01 N HCl to an endpoint pH of 4.5 ± 0.04 (EPA method 310.1).
- 2.4.5 Hardness was determined by titrating 50-mL samples with EDTA to a colorimetric endpoint using Eriochrome Black T (EPA method 130.2).
- 2.4.6 Ammonia was determined by a variation of Standard Methods method 4500-NH₃ D (Verdouw, 1978).

2.5 Data Analytical Methods

The whole sediment toxicity test and reference toxicant test data were analyzed by Adrian Gonzalez with assistance from Lynn Kszos and John Beauchamp (ORNL/ESD). Copies of the LC_{50} calculations and control charts for the *H. azteca* reference toxicant test and the *D. magna* reference toxicant test are located in Appendix C and D, respectively. Copies of SAS® programs, data files and output for the *H. azteca* sediment toxicity test, the *D. magna* sediment toxicity test (survival endpoint) and the *D. magna* sediment toxicity test (reproduction endpoint) are located in Appendices G, H, and I, respectively.

In each instance, differences among mean responses (survival or young per surviving female) were tested for significance using the General Linear Model (GLM) procedure in SAS®. If significant differences were detected (i.e., $p < 0.05$), the source of significant difference was tested using either Dunnett's t-test or Tukey's Studentized Range test at a significance level of $\alpha = 0.05$. For *D. magna* survival significance tests, Fisher's Exact test was used. The *H. azteca* proportion survival data from the whole sediment toxicity tests were transformed by the arcsine transformation and analyzed for normality before being analyzed for significant differences using GLM. The following subsections detail which tests, analyses or comparisons were done and on which data sets they were done.

- 2.5.1 The *H. azteca* proportion survival data from the whole sediment toxicity tests were analyzed for significant differences using GLM. If $p < 0.05$, test sites were then compared to the reference site using Dunnett's t-test. The laboratory formulated sediment (LFS) control sample and the two field duplicate samples (SD04QA and SD14QA) were excluded from this analysis (section 4.2).
- 2.5.2 The *D. magna* survival data from the whole sediment toxicity tests were analyzed for significant differences using Fisher's Exact test. Replicates with missing organisms were not included in the analysis. This resulted in treatments with unequal replicates. Test sites were compared to the reference site for significant differences (section 4.3). Because there was insufficient reference site sample to run a sediment reference treatment during the Group 2 test, the Group 1 and Group 2 test site survival data were compared to the Group 1 reference site survival data. The Group 3 test site survival data were compared to the Group 3 reference site survival data. The laboratory formulated sediment (LFS) control, the water-only control and the two field duplicate samples (SD04-QA and SD14-QA) were excluded from this analysis.
- 2.5.3 The *D. magna* reproduction data from the whole sediment toxicity tests were analyzed for significant differences using GLM. If $p < 0.05$, test sites were then compared to the reference site using Dunnett's t-test (section 4.4). The laboratory formulated sediment (LFS) control, the water-only control and the two field duplicates (SD04-QA and SD14-QA) were excluded from this analysis.
- 2.5.4 An estimated LC_{50} for both test organisms was calculated from the respective reference toxicant test data using the trimmed Spearman-Kärber Method (section 3.1).
- 2.5.5 The *H. azteca* survival data from the two sets of field duplicate samples (SD04 (D00411 and D00401) and SD14 (D01411 and D01401)) were analyzed for significant difference among the duplicates (section 3.2.1).

- 2.5.6 The *D. magna* survival data from the two sets of field duplicate samples were analyzed for significant difference among the duplicates (section 3.2.2).
- 2.5.7 The *D. magna* reproduction data from the two sets of field duplicate samples were analyzed for significant difference among the duplicates (section 3.2.3).
- 2.5.8 Test data from the following tests were also evaluated for statistical difference among organism responses:
- (a) the repeated *D. magna* reference sediment treatment (Group 1 vs. Group 3; section 3.3),
 - (b) the repeated *D. magna* water-only control treatment (Group 1 vs. Group 2 vs Group 3; section 3.4),
 - (c) the repeated *H. azteca* laboratory control sediment treatment (Group 1 vs. Group 2 vs. Group 3; section 3.5),
 - (d) the field reference sediment treatment and the laboratory formulated control sediment treatment (*H. azteca* survival data, *D. magna* survival data and *D. magna* reproduction data; section 4.7),
 - (e) the *D. magna* water only control treatment and the *D. magna* laboratory formulated sediment control treatment (survival and reproduction data; section 4.8).
- 2.5.9 Each of the *D. magna* test replicates contains only one individual organism, so the survival in any given replicate could only have been 1 or 0. Calculating a standard deviation of mean survival is not appropriate in this case. Instead, 95% Confidence Limits (C.I.) were calculated using a relationship between the F distribution and the binomial distribution (Zar 1984), as follows:

$$L_1 = \text{Lower 95\% C.I.} = X \div [(X + (N - X + 1)F_{\alpha(2), v1, v2}]$$

where, $v1 = 2(N - X + 1)$

and $v2 = 2X$,

$$L_2 = \text{Upper 95\% C.I.} = [(X + 1)F_{\alpha(2), v'1, v'2}] \div [N - X + (X + 1)F_{\alpha(2), v'1, v'2}]$$

where, $v'1 = 2(X + 1) = (v2 + 2)$

and $v'2 = 2(N - X) = (v1 - 2)$

N = sample size (i.e., number of replicates per site),

X = number of observations (i.e., number alive out of n),

$F_{\alpha(2), v1, v2}$ = the value of the F-Distribution using a 2-sided level of significance with $v1$ (or $v'1$) degrees of freedom in the numerator and $v2$ (or $v'2$) degrees of freedom in the denominator.

3. Data Quality

3.1 Reference Toxicant Tests

One *H. azteca* water-only acute reference toxicant test and one *D. magna* water-only acute reference toxicant test were run during the whole sediment toxicity test period. A description of both reference toxicant tests is included in Appendix B. A copy of the LC₅₀ calculation and control charts for the *H. azteca* reference toxicant test is located in Appendix C. A copy of the LC₅₀ calculation and control charts for the *D. magna* reference toxicant test is located in Appendix D. Copies of the log sheet for both tests are located in Appendix E. The results of both tests are presented in the Table 3.

Table 3: Water-only Acute Reference Toxicant Test Results Summary.

Parameter	<i>Hyalella azteca</i>	<i>Daphnia magna</i>
Reference Toxicant Test No.	RTHA-9502	RTDM-9504
Test Start Date	May 29, 1995	June 12, 1995
Toxicant Used	Potassium Chloride	Potassium Chloride
Source of Toxicant	E.M. Science	E.M. Science
Toxicant Lot Number	6116	6116
LC ₅₀ (mg/L)	151.6	201.3
95% Conf. Interval (mg/L)	124.3 - 185.0	184.5 - 219.6
Central Tendency (mg/L): Mean $\pm$ 2 Standard deviations	151.1 $\pm$ 21.8	218.4 $\pm$ 49.6
N	4	4

3.2 Comparison of Toxicity Test Data from Field Duplicate Samples

One set of field duplicate samples was collected from each of two test sites: SD04 and SD14. Both sets were tested using both test species (three endpoints). The *H. azteca* proportion survival data, the *D. magna* proportion survival data, and the *D. magna* reproduction data were analyzed statistically for significant differences. Table 4 summarizes the field duplicate toxicity test data for all three tests. All statistical tests showed no significant difference among sample pairs with any test ($\alpha = 0.05$).

Table 4. Field duplicate data for test sites SD04 and SD14. Percent survival (mean and standard deviation, *H. azteca*; percent and 95% confidence limits, *D. magna*) and young per surviving female (mean and standard deviation).

Toxicity Test	Survival and Reproduction Data*			
	SD04	SD04QA	SD14	SD14QA
<i>Hyalella azteca</i> (survival)	77.5 (16.4)	80.0 (7.1)	75.0 (27.4)	95.0 (5.00)
<i>Daphnia magna</i> (survival)	100.0 (66.4,NA)	85.7 (42.1,NA)	88.9 (51.8,99.7)	90.0 (49.7,99.8)
<i>Daphnia magna</i> (reproduction)	14.1 (3.8)	14.8 (2.7)	16.6 (4.1)	14.4 (4.6)

H. azteca mean percent survival (Standard Deviation; $N = 4$); *D. magna* percent survival (95% Confidence Interval; N varies); *D. magna* mean young per surviving female (Standard Deviation; N varies)

3.2.1 Field Duplicate Samples - *Hyalella azteca* (survival)

Tables 5 and 6 provide summary statistic results of the GLM procedure on *H. azteca* proportion survival data (arsine transformed). Table 5 summarizes the analysis for site SD04 and Table 6 summarizes the analysis for site SD14. In both cases, the difference in survival among the sample pair was not significant ($p = 0.8997$ and 0.3011 , respectively; $\alpha = 0.05$; Appendix C).

Table 5. GLM analysis summary table for arsine-transformed *H. azteca* proportion survival in field duplicate samples from site SD04. The differences were not significant ($\alpha = 0.05$).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.0005	0.0000	0.02	0.8997
Error	6	0.1769	0.0295		
Corrected Total	7	0.1774			
		R-Square	CV	Root MSE	ARCSURV Mean
		0.0029	15.5281	0.1717	1.1056

Table 6. GLM analysis summary table of arsine-transformed *H. azteca* proportion survival in field duplicate samples from site SD14. The differences were not significant ($\alpha = 0.05$).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.1075	0.1075	1.28	0.3011
Error	6	0.5039	0.0840		
Corrected Total	7	0.6114			
		R-Square	CV	Root MSE	ARCSURV Mean
		0.1758	23.8589	0.2898	1.2146

3.2.2 Field Duplicate Samples - *Daphnia magna* (Survival)

Tables 7 and 8 present the Fisher's Exact test on *D. magna* survival data. Table 7 summarizes the analysis for site SD04 and Table 8 summarizes the analysis for site SD14. In both cases, the difference in survival among the sample pair was not significant ($\alpha = 0.05$).

Table 7. Fisher's Exact Test table of *D. magna* survival data in the duplicate samples from site SD04. The critical value for this Fisher's Exact Test is 3.019 ($\alpha = 0.05$). Survival among the duplicates was not significant.

Site	No. Alive	No. Dead	No. of Observations
SD04	9	0	9
SD04QA	6	1	7
Totals	15	1	16

Table 8. Fisher's Exact Test table of *D. magna* survival data in the duplicate samples from site SD14. The critical value for this Fisher's Exact Test is 4.050 ($\alpha = 0.05$). Survival among the duplicates was not significant.

Site	No. Alive	No. Dead	No. of Observations
SD14QA	9	1	10
SD14	8	1	9
Totals	17	2	19

3.2.3 Field Duplicate Samples - *Daphnia magna* (Reproduction)

Tables 9 and 10 provide summary statistic results of the GLM procedure on *D. magna* reproduction data. Table 9 summarizes the analysis for site SD04 and Table 10 summarizes the analysis for site SD14. In both cases, difference in reproduction among the duplicates was not significant. ($p = 0.6967$ and 0.3253 , respectively; $\alpha = 0.05$; Appendix C).

Table 9. GLM analysis summary table of *D. magna* reproduction in field duplicate samples from site SD04. The differences were not significant ($\alpha = 0.05$).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	1.8778	1.8778	0.16	0.6967
Error	13	153.7222	11.8248		
Corrected Total	14	155.6000			
		R-Square	CV	Root MSE	YOUNG Mean
		0.0121	23.8800	3.4387	14.4000

Table 10. GLM analysis summary table of *D. magna* reproduction in field duplicate samples from site SD14. The differences were not significant ($\alpha = 0.05$).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	20.1381	20.1381	1.03	0.3253
Error	15	292.0972	19.4731		
Corrected Total	16	312.2353			
		R-Square	CV	Root MSE	YOUNG Mean
		0.0645	28.5241	4.4128	15.4706

3.2.4 Field Duplicate Samples - Toxicity Test Water Chemistry

No formal statistical comparison of water quality chemistry data was done. A semi-quantitative analysis of the chemistry data presented in Table 11 is sufficient to argue that the chemistry of field duplicate sample test water was not dissimilar. The data are arranged by water quality parameter for each site. The mean of each water quality parameter from both toxicity tests are shown together: the top number is the mean value from the *H. azteca* toxicity test, and the bottom number is the mean from the *D. magna* toxicity test. A measure of water quality variation among the field duplicate samples is provided by the percent difference shown in the third and sixth columns. These were calculated as follows

$$100 \times (SD04 - SD04QA) / SD04 \quad \text{and} \quad 100 \times (SD14 - SD14QA) / SD14$$

Table 11. Field duplicate water quality data from *H. azteca* and *D. magna* toxicity tests of test sites SD04 and SD14. Data under the site designation represent mean water quality analysis results. Percent differences represent the magnitude of variation between the two values.

Water Quality Parameter	Water Quality Chemistry Data ^b					
	Top value = <i>H. azteca</i> Test			Bottom value = <i>D. magna</i> Test		
	SD04	SD04QA	%Diff ^c	SD14	SD14QA	%Diff ^c
D.O.^a mg/L	5.6	6.1	-8.9	4.8	5.0	-4.2
	7.1	7.1	0.0	7.2	7.4	-2.8
pH	7.73	7.78	-0.65	7.78	7.80	-0.26
	7.91	8.02	-1.4	8.09	8.10	-1.2
Conductivity $\mu\text{S}/\text{cm}$	296	289	2.4	283	281	0.71
	298	297	0.34	279	279	0.0
Alkalinity mg/L as CaCO_3	139	133	4.3	116	117	-0.86
	129	129	0.0	110	107	2.7
Hardness mg/L as CaCO_3	152	149	2.0	132	132	0.0
	155	149	3.9	132	129	2.3
Ammonia $\mu\text{g}/\text{L NH}_4\text{-N}$	290	229	21.0	211	161	23.7
	110	143	-30.0	13	21	61.5

^aD.O. = dissolved oxygen.

^bData under site designations represent mean values.

^c%Diff = percent difference between duplicate values calculated as follows:

$$100 \times (\text{SDNN} - \text{SDNNQA}) / \text{SDNN}$$

The data show that the water quality parameter concentrations are all within 9% of each other, and most often within 5% of each other, except for the ammonia concentrations. The relatively large percent difference in ammonia concentrations, however, is a function of the very low values measured (Note: concentrations are in $\mu\text{g}/\text{L NH}_4\text{-N}$). These percent differences have little meaning because the concentrations are so low. Thus the water quality data confirm the toxicity data from the field duplicates which suggest no significant difference in field duplicate samples.

3.3 Comparison of Repeated Reference Site Toxicity Tests.

Changes in sample characteristics, and/or organism response to the sample, over time in the reference sediment sample (RD21) from Bear Creek Valley were evaluated by repeat toxicity testing. This sample was included in two of the *D. magna* tests: Group 1 and Group 3. Differences in *D. magna* survival and reproduction among the two test events were analyzed for significance using Fisher's Exact Test and GLM followed by Tukey's Studentized Range Test, respectively. Table 12 presents the Fisher's Exact analysis of survival data. Table 13 provides summary statistic results of the GLM analysis. The difference in survival or reproduction among the two test events was not significant ($\alpha = 0.05$).

Table 12. Fisher's Exact Test table of *D. magna* survival data from the repeated reference site RD21 test. The critical value for this Fisher's Exact Test is 5.033 ($\alpha = 0.05$). Survival among the sample pair was not significant.

Site	No. Alive	No. Dead	No. of Observations
RD21 (Group 3)	10	0	10
RD21 (Group 1)	9	0	9
Totals	19	0	19

Table 13. GLM analysis summary table of *D. magna* reproduction data from the repeated reference site RD21 test. The differences among the two tests were not significant ($\alpha = 0.05$).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	107.6263	107.6263	1.35	0.2619
Error	17	1358.9000	79.9353		
Corrected Total	18	1466.5263			
		R-Square	CV	Root MSE	YOUNG Mean
		0.0734	32.9210	8.9407	27.1579

3.4 Comparison of Repeated Water-only *Daphnia magna* Toxicity Tests

A water-only control test is a more appropriate way of assessing the health and performance of *D. magna*, since it is a water-column, filter-feeding organism. A water-only control treatment was included in each of the three groups. The mean survival of *D. magna* was 80%, 100% and 90% in test Groups 1, 2 and 3, respectively. No formal statistical analysis was done on these survival results. The reproduction data from each of the three groups were analyzed for significant differences. Table 14 provides summary statistic results of the GLM analysis which showed significant differences among the three water-only treatments ($p < 0.0001$). Evaluated of the source of variation using Tukey's Studentized Range test at $\alpha = 0.05$ indicated that reproduction in the Group 2 water-only treatment (47.4 ± 9.3 young per surviving female) was significantly lower than reproduction in the Group 1 (82.9 ± 15.9 young per surviving female) and the Group 3 (74.3 ± 15.9 young per surviving female) water-only treatments.

Table 14. GLM analysis summary table of *D. magna* reproduction data from the repeated water-only control treatments. The analysis indicated significant differences among the three treatments ($p < 0.0001$; $\alpha = 0.05$).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	6341.3917	3170.6958	21.07	0.0001
Error	24	3611.2750	150.4698		
Corrected Total	26	9952.6667			
		R-Square	CV	Root MSE	YOUNG Mean
		0.6372	18.3388	12.2666	66.8889

3.5 Comparison of Repeated Laboratory Formulated Sediment Toxicity Tests.

Temporal changes in characteristics of, and/or organism response to, the laboratory formulated sediment (LFS0495b) were evaluated by repeat toxicity testing. The control sample was included in all three *H. azteca* tests. Mean percent survival ($\pm$ standard deviation) in each of the three tests are as follows: Group 1 = $80.0 \pm 18.3\%$; Group 2 = $92.5 \pm 8.3\%$; Group 3 = $95.0 \pm 8.7\%$. Differences in *H. azteca* survival between the three tests were analyzed for significance using GLM. Table 15 provides summary statistic results of that analysis. The differences in survival among the three tests were not significant ($p = 0.3129$).

Table 15. GLM analysis summary table for arsine-transformed *H. azteca* proportion survival from the repeated laboratory formulated sediment control treatment (LFS0495b). The differences were not significant ($\alpha = 0.05$).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.0995	0.0498	1.33	0.3129
Error	9	0.3378	0.0375		
Corrected Total	11	0.4373			
		R-Square	CV	Root MSE	ARCSURV Mean
		0.2275	15.4721	0.1937	1.2521

3.6 Sampling Uncertainties

This laboratory did not collect test site sediment samples. There are no uncertainties in the sampling activities for preparation of the laboratory formulated sediment.

3.7 Laboratory Analyses Uncertainties

3.7.1 Laboratory formulated sediment control

Sediments are uniquely complex, heterogeneous mixtures of sand, silt, clay, organic matter and other settled detritus. Consequently, an appropriate control sediment (i.e., one which is universally suitable for supporting test organisms) does not exist. The current practice of using sediment from a relatively pristine reference site introduces potential problems such as: (1) the reference site may itself be impacted to some degree, and (2) the physical characteristics of the reference site might lead to organism stress (e.g., the substrate is too silty, too sandy or lacks sufficient organic matter). To minimize the uncertainty inherent in reference sediments, a laboratory control sediment was formulated and used as a negative control in this study. The laboratory formulated sediment (LFS) consisted of a mixture of natural clay/silt (sieved through a 2.00-mm mesh sieve to remove large debris and gravel) obtained from a pond adjacent to the ORNL/ESD Toxicology Laboratory, and clean, playground sand obtained from a local vendor. This mixture was prepared and stored wet at 4°C until needed.

This control sediment was determined suitable for 10-day survival of *H. azteca*, however, the characteristics may or may not be equivalent to the various test sediment samples collected from Bear Creek Valley. Thus the uncertainty in organism response variability due to differences in sediment characteristics still exists even with the inclusion of this control sediment. For this reason, it was used primarily for two purposes: (1) to determine test acceptability by comparing sediment control survival to a predetermined criterion ($\geq 80\%$ mean survival), and (2) to evaluate the suitability of the Bear Creek Valley reference site sediment for use as a reference sample.

3.7.2 Sediment sample storage temperature

The USEPA has issued a standard guidance document outlining sediment toxicity evaluation procedures (1994). A discussion on sample collection and storage is provided in section 8 of that document. No specific sample holding time is specified; rather it states that "it is desirable to hold sediments in the dark at 4°C and start tests soon after collection in the field." Our Laboratory specified sample storage in the dark at $4 \pm 2^\circ\text{C}$ and beginning tests within 4 weeks of sample arrival.

Due to potential radiological hazard, however, sample temperatures were not measured at the time of arrival. Instead, the cooler temperatures were taken and recorded at that time. All samples were immediately placed in a dark refrigerator kept between 2 and 8°C. The temperature of each sediment sample was not determined until just before its preparation for testing. Mean sediment temperature (with ranges) and storage time before use for each of the three groups of samples are as follows:

- Group 1 = 9.4°C (8.0 - 10.6°C) for 3 days
- Group 2 = 7.4°C (7.0 - 7.9°C) for 9 days
- Group 3 = 4.0°C (3.3 - 4.8°C) for 16 days.

In our judgement, non-conformance of the Group 1 and 2 sediment sample temperatures to the specified storage temperature criteria does not invalidate the test

results. The short time over which the Group 1 samples experienced elevated temperature (i.e., 3 and 9 days), combined with the small, absolute magnitude of the temperature elevation (i.e., 2.0-4.6°C and 1.0-1.9°C), does not constitute a severe deviation from the storage temperature criteria. This is not a bad assumption when one considers the total amount of manipulation and alteration incurred by the sediment samples during field sampling, mixing, transport and testing.

3.8 Data Analysis Uncertainties

The nature of the *H. azteca* whole sediment toxicity test is such that organisms are often unaccounted for at test termination. Documentation exists (Society of Environmental Toxicology and Chemistry, 1994; Tomasovic, et. al., 1995) which suggests that amphipods decompose beyond recognition in less than 24 hours post-mortem. This implies that missing organisms may be assumed to be dead, which is the current practice. This is only an assumption, however. Since live organisms do burrow into the sieved debris and may remain hidden for quite some time, there is a very small probability that a missing organism may be alive. The survival data analysis presented below represents a conservative estimate of amphipod survival. This could introduce some Type I error (i.e., the treatment response yields a false positive; the sample is determined to be toxic when in fact it is not) into the conclusions.

For unknown reasons, a significant number of organisms in the *D. magna* toxicity tests were found missing during the tests. This is very unusual for a water-column dwelling species. Several of the more heterogeneous Group 1 samples (e.g., sediment with a high proportion of gravel and twig/leaf material) had a very unevenly distributed surface with many crevices and holes. It was thought that the organisms may have moved into these holes in the sediment surface, became trapped and died. Despite preparing subsequent sediment samples with a smooth, even surface, several organisms still were unaccounted for. The result was a fairly even distribution in number of missing organisms per sample grouping. It not likely that technician error or indigenous, carnivorous organisms account for the relatively high number of missing replicates. These "missing" replicates were excluded from all statistical analyses.

4. Results

4.1 General test information is presented in Table 16.

Table 16. Whole Sediment Toxicity Test - General Test Information

Test Parameter	<i>Hyalella azteca</i>	<i>Daphnia magna</i>
Test Identification Number:	BCVSD1HA	BCVSD1DM
<u>Group 1</u>		
Initiation day/time:	05/30/95 @ 0905	05/31/95 @ 0700
Termination day/time:	06/09/95 @ 1315	06/14/95 @ 0900
Temperature (Range), °C	23.2 (22.9 - 23.7)	22.9 (21.6 - 23.4)
<u>Group 2</u>		

Test Parameter	<i>Hyalella azteca</i>	<i>Daphnia magna</i>
Initiation day/time:	06/06/95 @ 0830	06/05/95 @ 0930
Termination day/time:	06/16/95 @ 1215	06/19/95 @ 0805
Temperature (Range), °C	23.1 (22.8 - 23.5)	22.9 (21.9 - 23.4)
Group 3		
Initiation day/time:	06/13/95 @ 0804	06/12/95 @ 1035
Termination day/time:	06/23/95 @ 1230	06/26/95 @ 0800
Temperature (Range), °C	23.1 (22.4 - 23.4)	23.1 (22.2 - 23.3)

4.2 Toxicity Test Results - *Hyalella azteca* (Survival)

The results of the *H. azteca* toxicity tests are summarized in Table 17. All sites are arranged numerically by test site identification number. The group in which the site was tested is indicated on the extreme right column. The individual replicate survival results are presented along with mean and standard deviation of survival in each site (N = 4). The sites are grouped according to the Tukey's Studentized Range Test results: either A or B or both. Mean *H. azteca* percent survival among all sites ranged between 55.0 and 100.0% with an overall mean percent survival of 88.4%; N = 23 (sites, controls and duplicates). The percent survival in the reference site and laboratory sediment control was 87.2% (N = 1) and 89.2% (N = 3), respectively. Mean survival in the three laboratory control sediment treatments were not significantly different (see section 3.5), so data from all three tests were combined to give an overall mean survival.

Table 17. Summary of the *H. azteca* toxicity test data (percent survival).

Site ID ^a	Percent Survival by Replicate				Mean (Std.Dev.) %Survival	Tukey Grouping ^b		Test Group No.
	1	2	3	4		A	B	
LFS0495b	100.0	80.0	86.7 ^c	50.0	80.0 (18.3)	NA	NA	1
	100.0	100.0	90.0	80.0	92.5 (8.3)			2
	100.0	80.0	100.0	100.0	95.0 (8.7)			3
RD21	80.0	80.0	80.0	100.0	87.2 (8.7)	A	B	1
SD17	70.0	20.0	90.0	44.4	55.0 (26.4)		B	1
SD16	80.0	70.0	100.0	100.0	87.5 (13.0)	A	B	2
SD15	100.0	100.0	100.0	100.0	100.0 (0.0)	A		3
SD14	70.0	33.3	100.0	100.0	75.0 (27.4)	A	B	1
SD14QA	90.0	100.0	90.0	100.0	95.0 (5.0)	NA	NA	1
SD13	100.0	90.0	100.0	100.0	97.5 (4.3)	A		3
SD12	60.0	100.0	100.0	100.0	90.0 (17.3)	A	B	2
SD11	90.0	100.0	100.0	90.0	97.4 (5.0)	A	B	1
SD10	80.0	100.0	80.0	80.0	85.0 (8.7)	A	B	2
SD09	100.0	100.0	90.0	90.0	95.0 (5.0)	A		3
SD08	70.0	90.0	70.0	100.0	84.6 (13.0)	A	B	1
SD07	100.0	100.0	90.0	100.0	97.5 (4.3)	A		2
SD06	100.0	80.0	66.7	70.0	77.5 (16.4)	A	B	1
SD05	90.0	100.0	100.0	100.0	97.5 (4.3)	A		2

Table 17. Summary of the *H. azteca* toxicity test data (percent survival).

Site ID ^a	Percent Survival by Replicate				Mean (Std.Dev.) %Survival	Tukey Grouping ^b		Test Group No.
	1	2	3	4		A	B	
SD04	80.0	50.0	90.0	90.0	77.5 (16.4)	A	B	3
SD04QA	80.0	70.0	80.0	90.0	80.0 (7.1)	NA	NA	3
SD03	90.0	100.0	100.0	100.0	97.5 (4.3)	A		2
SD02	100.0	90.0	90.0	100.0	95.0 (5.0)	A	B	2
SD01	100.0	100.0	80.0	100.0	95.0 (8.7)	A	B	3

^aLFS0495b = laboratory formulated sediment control; RD = Reference Designation; SD = Station Designation.

^bTukey Grouping: means with the same letter are not statistically different. NA = these treatments were excluded from the analysis.

^cWe suspect that 15 organisms were added to replicate #3 and only 5 organisms were added to replicate #4. We must, however, assume that 15 were added to replicate #3 and 10 were added to replicate #4.

NA = not applicable; these samples were excluded from the Tukey's analysis.

4.2.1 Summary Statistic Results - *Hyalella azteca* (survival)

Survival data from all sites (excluding the laboratory control sediment and the field duplicates) were analyzed for significant difference. Table 18 summarizes the results of the GLM analysis which showed significant differences among the sites ($p = 0.0092$). Evaluation of the source of variation using Tukey's Studentized Range test at $\alpha = 0.05$ indicated no significant difference between all sites except SD17 (Tukey's grouping 'A'; critical value of Tukey's Test = 5.179, minimum significant difference = 0.4894). The same analysis indicated that sites RD21, SD17, -16, -14, -12, -11, -10, -08, -06, -04, -02 and -01 were not significantly different (Tukey grouping 'B'). A similar evaluation of variation using Dunnett's t-test showed no significant difference (critical value of Dunnett's T = 2.969, minimum significant difference = 0.3967) between any test site and the reference site, RD21.

Table 18. GLM analysis summary table for arsine-transformed *H. azteca* proportion survival from all sites (excluding the laboratory formulated sediment control treatment and the field duplicates).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	1.4224	0.0837	2.34	0.0092
Error	54	1.9287	0.0357		
Corrected Total	71	3.3510			
		R-Square	CV	Root MSE	ARCSURV Mean
		0.4245	15.1357	0.1890	1.2486

4.3 Toxicity Test Results - *Daphnia magna* (Survival)

The percent survival data from the *D. magna* toxicity tests are summarized in Table 19. All sites are arranged numerically by test site identification number. The group in which the site was tested is indicated on the extreme right column. The number of replicates (N), the

percent survival and the lower and upper 95% confidence limits (95%C.L.) of the percent survival is also shown. Percent *D. magna* survival among all sites ranged between 55.6 and 100.0% resulting in an overall mean percent survival of 91.0%; N = 27 (sites, controls and duplicates). The percent survival in the reference site, the water-only control and the laboratory sediment control was 100.0% (N = 2), 100.0% (N = 3) and 90.0% (N = 1), respectively. Survival data from all sites (excluding the laboratory control sediment and the field duplicates) were analyzed for significant difference relative to the reference site (RD21) using Fisher's Exact Test at $\alpha = 0.05$. The data tables from which the analysis was done are located in Appendix H. Only survival in site SD17 was significantly lower than survival in reference site RD21.

Table 19. Summary of the *D. magna* toxicity test survival data. Sites which were found to be significantly different than the reference site RD21 (Fisher's Exact Test; $\alpha = 0.05$) are indicated by an asterisk (*).

Site ID ^a	N ^b	Percentage Survival	Lower 95%C.L. (L ₁) ^c	Upper 95%C.L. (L ₂) ^d	Fisher's Critical Value ^e	Test Group No.
RD21	9	100.0	66.4	NA	NA	1
	10	100.0	69.2	NA	NA	3
Water Control	8	100.0	63.0	NA	NA	1
	10	100.0	69.2	NA	NA	2
	9	100.0	66.9	NA	NA	3
LFS0495b	10	90.0	55.5	99.8	6.043	3
SD17 *	9	55.6 *	23.4	86.3	5.041	1
SD16	10	100.0	69.2	NA	5.033	2
SD15	10	100.0	69.2	NA	6.043	3
SD14	9	88.9	51.8	99.7	5.041	1
SD14QA	10	90.0	49.7	99.8	NA	1
SD13	9	77.8	40.0	97.2	5.033	3
SD12	10	100.0	69.2	NA	5.033	2
SD11	10	90.0	55.5	99.8	4.050	1
SD10	10	90.0	55.9	99.8	4.050	2
SD09	8	87.5	47.4	99.7	4.023	3
SD08	10	70.0	34.7	93.3	1.015	1
SD07	8	100.0	63.0	NA	4.029	2
SD06	7	85.7	42.1	99.6	3.019	1
SD05	10	90.0	55.5	99.8	4.050	2
SD04	9	100.0	66.4	NA	5.033	3
SD04QA	10	85.7	42.1	99.6	NA	3
SD03	9	66.7	29.9	92.5	5.041	2
SD02	10	100.0	69.2	NA	5.033	2
SD01	10	90.0	55.5	99.8	6.043	3

Table 19. Summary of the *D. magna* toxicity test survival data. Sites which were found to be significantly different than the reference site RD21 (Fisher's Exact Test; $\alpha = 0.05$) are indicated by an asterisk (*).

Site ID ^a	N ^b	Percentage Survival	Lower 95%C.L. (L ₁) ^c	Upper 95%C.L. (L ₂) ^d	Fisher's Critical Value ^e	Test Group No.
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^aLFS0495b = laboratory formulated sediment control; Water control = 30% Dilute Mineral Water (laboratory control water); RD = Reference Designation; SD = Station Designation;

^bN = number of replicates in treatment. Replicates with missing organisms were excluded from statistical analyses (N = 10 at test initiation).

^cLower 95% confidence interval calculated from Binomial Probability theory (see section 2.5.9).

^dUpper 95% confidence interval calculated from Binomial Probability theory (see section 2.5.9).

NA indicates that calculation of an upper 95% confidence limit for a percentage survival of 100% is not

appropriate.

^eValues were obtained from Fisher's Critical Value Tables using the data arranged as in Appendix I.

NA indicates that these control treatments and duplicate sites were not analyzed for significant difference against the reference site.

4.4 Toxicity Test Results - *Daphnia magna* (Reproduction)

The reproduction data (young produced per surviving female) from the *D. magna* toxicity tests are summarized in Table 20. All sites are arranged numerically by test site identification number. The group in which the site was tested is indicated on the extreme right column. The values shown under the "Replicate Data" columns are total young per female. Mean (and standard deviation) young per surviving female are presented in the next to last column. Adult *D. magna* which died at some time during the test are indicated by an 'x'. If the adult produced any young before dying, the number produced is given before the x. Missing organisms are indicated by an 'm'. Similarly, if the adult produced young before being lost, the number produced is given before the m. Young produced by adults which died or became lost at any point during the test were not included in the statistical analyses. Reproduction among all sites ranged between 8.8 (2.1) and 82.9 (15.9) young per surviving female. The overall mean was 26.5 (6.3) young per surviving female; N = 27 (including sites, controls and duplicates). Reproduction in the reference site, the water-only control and the laboratory sediment control was 27.3 ± 8.8 (N = 2), 68.2 ± 12.0 (N = 3), and 17.6 ± 6.7 (N = 1) young per surviving female, respectively.

Reproduction data were analyzed for significant differences. Table 21 summarizes the statistical results obtained from the GLM procedure on the data shown in Table 20. Summary statistic results of the GLM analysis are presented in Table 22 and indicate that there was significant reproduction differences among the test sites ($p < 0.0001$). The laboratory formulated sediment control, the water-only control and the duplicate sites were excluded from this analysis. Means are shown grouped under the appropriate Tukey group (A through M) as per the results of the Tukey's Studentized Range Test. Means in the same letter group are not significantly different ($\alpha = 0.05$).

The repeated field reference site tests indicated no significant difference among the two tests (see section 3.3). Therefore, these data were combined to give an overall mean young per surviving female for the reference site. This overall mean was used as the basis for the Dunnett's t-test comparison. Sites which were found to be significantly different than the reference site RD21 by Dunnett's t-test are indicated by an asterisk (*). Reproduction in all sites except SD17, SD11, SD08 and SD02 were found to be significantly lower than reproduction in the reference site RD21.

Table 20. Summary of *D. magna* toxicity test reproduction data. Mean and standard deviation values are young produced per surviving female (excluding young from missing, dead or invalid replicates).

Site ID ^a	Replicate Data ^b										Mean (Std Dev)	Test Group No.
	1	2	3	4	5	6	7	8	9	10		
RD21	28	36	46	m	37	22	23	36	31	8	29.7 (11.1)	1
	22	27	24	21	30	31	12	19	32	31	24.9 (6.5)	3
Water Control	100	13i	75	87	75	81	75	97	73	40i	82.9 (15.9)	1
	46	24	50	50	49	47	48	50	48	62	47.4 (9.3)	2
	66	64	84	70	96	6i	71	72	98	48	74.3 (15.9)	3
LFS0495b	10	x	22	28	25	12	21	16	14	10	17.6 (6.7)	3
SD17	3x	33	37	m	24	6x	31	x	x	37	32.4 (5.4)	1
SD16	15	17	17	23	27	16	12	39	13	23	20.2 (8.2)	2
SD15	17	16	22	28	20	25	20	15	22	22	20.7 (4.0)	3
SD14	15	26	16	15	14	x	14	14	m	19	16.6 (4.1)	1
SD14QA	x	23	12	17	19	10	15	8	13	13	14.4 (4.6)	1
SD13	14	16	17	20	15	12	x	m	12	x	15.1 (2.9)	3
SD12	17	15	5	19	13	17	20	19	17	14	15.6 (4.4)	2
SD11	13	4x	40	26	19	15	20	38	17	23	23.4 (9.7)	1
SD10	12	17	21	19	17	x	16	20	24	21	18.6 (3.5)	2
SD09	11	15	x	17	13	14	11	m	13	m	13.4 (2.1)	3
SD08	26	16	5x	30	x	x	30	32	27	18	25.6 (6.2)	1
SD07	18	13	9	11	m	9	13	14	13	m	12.5 (2.9)	2
SD06	3	m	22	m	6m	18	15	x	12	12	13.7 (6.5)	1
SD05	16	24	18	24	22	13	18	22	19	12x	19.6 (3.7)	2
SD04	17	11m	18	11	18	15	17	7	12	12	14.1 (3.8)	3
SD04QA	12	19	m	16	m	m	14	x	12	16	14.8 (2.7)	3
SD03	16	x	m	18	20	8x	32	34x	21	19	21.0 (5.7)	2
SD02	19	17	33	29	20	17	23	25	30	16	22.9 (6.1)	2
SD01	6	2x	9	7	11	13	9	10	9	5	8.8 (2.5)	3

^aLFS0495b = laboratory formulated sediment control; Water Control = 30% Dilute Mineral Water (laboratory control water); RD = Reference Designation; SD = Station Designation.

^bCodes: No. = adult alive, No. young produced; X = adult died; m = adult missing; i = Invalid, killed by technician.

Table 21. Statistical results of Tukey's Studentized Range test and Dunnett's t-test on *D. magna* reproduction data. Mean young per surviving female are categorized by Tukey grouping. Means in the same letter group are not significantly different. Sites which were found to be significantly different than the reference site RD21 using Dunnett's procedure ($\alpha = 0.05$) are indicated by an asterisk (*).

Site ID*	Mean Reproduction Arranged by Tukey Grouping												
	A	B	C	D	E	F	G	H	I	J	K	L	M
RD21	27.3	27.3											
SD17	32.4												
SD16 *			20.2	20.2	20.2	20.2							
SD15 *		20.7	20.7	20.7	20.7	20.7							
SD14 *			16.6	16.6	16.6	16.6	16.6						
SD13 *			15.1	15.1	15.1	15.1			15.1				
SD12 *			15.6	15.6	15.6	15.6		15.6					
SD11	23.4			23.4									
SD10 *			18.6	18.6	18.6	18.6							
SD09 *				13.4	13.4	13.4					13.4		
SD08	25.6		25.6										
SD07 *						12.5							
SD06 *				13.7	13.7	13.7						12.5	
SD05 *			19.6	19.6	19.6	19.6					13.7		
SD04 *				14.1	14.1	14.1				14.1			
SD03 *	21.0					21.0							
SD02	22.9				22.9								
SD01 *							8.8	8.8	8.8	8.8	8.8	8.8	8.8

*RD = Reference Designation; SD = Station Designation.

4.4.1 Summary Statistic Results - *D. magna* (reproduction)

The results of the GLM analysis of *D. magna* reproduction data are summarized in Table 22.

Table 22. The GLM analysis summary table for *D. magna* reproduction data from all sites (excluding the laboratory formulated sediment control, the water-only control and the field duplicate samples).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	4771.6475	280.6852	8.44	0.0001
Error	130	4324.8052	33.2677		
Corrected Total	147	9096.4527			
		R-Square	CV	Root MSE	YOUNG Mean
		0.5246	30.4544	5.7678	18.9392

4.5 Toxicity Test Water Chemistry Results

Water quality parameters were monitored during each toxicity test. Copies of the log sheets on which the data were recorded are included in Appendix F. The data suggest that all water quality parameters measured were within tolerance ranges of both test organisms. The results of the water quality measurements made during the *H. azteca* and *D. magna* toxicity tests are summarized in Tables 23 and 24, respectively. Note that the unit for the ammonia concentration is $\mu\text{g/L NH}_4\text{-N}$. *H. azteca* water chemistry data reported for the repeated laboratory formulated sediment control (LFS0495b) toxicity tests (Table 23) are listed individually in chronological order from top to bottom. *Daphnia magna* water chemistry data reported for the repeated reference site (RD21) and water-only control tests (Table 24) are listed individually in chronological order from top to bottom.

Table 23. Summary of *H. azteca* Toxicity Test Water Quality Analyses. Values are means and ranges.^a

Site ID ^b	Dissolved Oxygen mg/L	pH ^c	Conductivity μS/cm	Alkalinity mg/L as CaCO ₃	Hardness mg/L as CaCO ₃	Ammonia μg/L NH ₄ -N
LFS0495b	4.2 (2.0-7.3)	7.59 (7.42-7.84)	265 (242-302)	104 (97, 111)	125 (108, 142)	302 (138,465)
	5.9 (4.4-7.3)	7.79 (7.72-7.89)	268 (248-314)	113 (107, 119)	142 (134, 150)	273 (238,307)
	6.1 (5.4-6.9)	7.75 (7.61-8.00)	266 (247-313)	109 (100, 118)	129 (114, 144)	234 (202,305)
RD21	4.2 (2.7-6.5)	7.47 (7.36-7.57)	271 (259-288)	110 (107, 113)	122 (120, 124)	205 (108,302)
SD17	3.3 (1.8-6.6)	7.52 (7.33-7.80)	285 (264-303)	125 (113, 136)	131 (118, 144)	332 (273,390)
SD16	5.9 (4.5-7.0)	7.80 (7.71-7.97)	272 (258-295)	124 (111, 137)	140 (126, 154)	231 (166,295)
SD15	5.9 (4.9-7.0)	7.73 (7.61-7.81)	260 (249-270)	106 (102, 110)	124 (118, 130)	142 (50,233)
SD14	4.8 (3.7-7.4)	7.79 (7.62-8.02)	283 (249-336)	116 (100, 131)	132 (112, 152)	211 (70,352)
SD14QA	5.0 (3.6-7.9)	7.80 (7.63-8.03)	281 (249-338)	117 (101, 132)	132 (113, 150)	161 (20,302)
SD13	5.8 (5.0-6.8)	7.70 (7.57-7.80)	259 (254-269)	113 (110, 115)	132 (126, 138)	247 (149,345)
SD12	5.7 (3.6-7.0)	7.83 (7.62-7.94)	285 (245-413)	138 (117, 158)	166 (140, 192)	148 (142,154)
SD11	4.3 (2.3-6.5)	7.69 (7.56-7.90)	267 (254-279)	110 (105, 115)	125 (119, 130)	186 (79,293)
SD10	5.8 (4.3-6.5)	7.86 (7.75-7.97)	263 (243-286)	118 (109, 126)	146 (144, 148)	105 (88,121)
SD09	5.9 (5.2-6.8)	7.84 (7.84-7.93)	263 (258-270)	108 (106, 110)	132 (124, 140)	226 (99,353)
SD08	4.8 (3.5-7.7)	7.73 (7.59-7.96)	268 (252-281)	104 (101, 107)	117 (116, 117)	277 (169,384)
SD07	5.9 (4.7-6.8)	7.91 (7.84-8.02)	268 (249-302)	119 (110, 128)	146 (142, 150)	137 (105,169)
SD06	4.4 (2.7-6.9)	7.64 (7.51-7.80)	262 (238-281)	123 (105, 141)	111 (108, 114)	228 (113,343)
SD05	5.8 (4.5-6.8)	7.88 (7.78-8.05)	254 (241-263)	107 (104, 110)	123 (120, 126)	104 (58,149)
SD04	5.6 (4.8-6.8)	7.73 (7.58-7.98)	296 (276-363)	139 (117, 161)	152 (130, 174)	290 (243,337)
SD04QA	6.1 (5.5-6.9)	7.78 (7.68-7.98)	289 (273-342)	133 (115, 150)	149 (128, 170)	229 (174,283)
SD03	5.6 (4.4-6.9)	7.84 (7.75-8.08)	261 (252-272)	113 (109, 117)	135 (134, 136)	161 (91,231)
SD02	6.0 (4.8-7.0)	7.87 (7.78-7.99)	288 (262-316)	126 (104, 147)	149 (128, 170)	125 (82,167)
SD01	6.0 (4.9-6.7)	7.79 (7.72-7.93)	293 (260-381)	110 (104, 115)	131 (126, 136)	124 (7,240)

^aSample sizes for dissolved oxygen, pH and conductivity analyses N = 10 except for site SD02 (N = 9); sample sizes for alkalinity, hardness and ammonia analyses N = 2.

^bSite identification: LFS0495b = sediment control treatment; RD = Reference Designation; SD = Site Designation; SD14QA/SD04QA = Field Duplicate Samples.

^cMean pH calculated from hydrogen ion concentration: $[H^+] = 10^{-pH}$.

Table 24. Summary of *Daphnia magna* Toxicity Test Water Quality Analyses. Values are means and ranges.^a

Site ID ^b	Dissolved Oxygen mg/L	pH ^c	Conductivity μS/cm	Alkalinity mg/L as CaCO ₃	Hardness mg/L as CaCO ₃	Ammonia μg/L NH ₄ -N
RD21	7.3 (6.9-8.1)	7.81 (7.65-8.11)	214 (195-231)	82 (77-87)	99 (96-105)	29 (17-47)
	7.3 (6.9-8.0)	7.78 (7.63-7.96)	224 (216-237)	86 (81-89)	108 (100-116)	65 ((1-188)
Water Control	7.8 (7.0-8.3)	8.24 (8.12-8.34)	228 (210-241)	86 (81-90)	108 (102-112)	30 (22-41)
	7.5 (6.7-8.1)	8.19 (8.10-8.25)	232 (203-243)	90 (87-95)	115 (112-118)	100 (77-121)
	7.8 (7.2-8.3)	8.22 (8.00-8.35)	238 (228-248)	89 (88-90)	111 (108-116)	40 (8-157)
LFS0459b	7.4 (6.7-8.0)	8.01 (7.91-8.39)	259 (239-295)	102 (95-106)	123 (114-140)	112 ((1-321)
SD17	6.7 (5.7-7.8)	8.23 (8.02-8.39)	277 (251-312)	117 (109-124)	136 (127-142)	41 (17-72)
SD16	7.2 (6.5-7.8)	7.92 (7.69-8.15)	257 (234-283)	108 (99-116)	134 (126-146)	81 ((1-166)
SD15	7.2 (6.7-7.8)	7.99 (7.68-8.24)	249 (234-269)	96 (95-99)	122 (114-134)	40 ((1-106)
SD14	7.2 (6.5-8.2)	8.09 (7.99-8.17)	279 (247-361)	110 (106-117)	132 (126-140)	13 ((1-26)
SD14QA ^a	7.4 (6.6-8.0)	8.10 (7.93-8.20)	279 (245-361)	107 (101-115)	129 (124-134)	21 (18-25)
SD13	7.2 (6.3-7.7)	7.93 (7.60-8.22)	242 (214-273)	100 (94-112)	125 (108-138)	104 (29-252)
SD12	7.1 (6.3-8.1)	8.06 (7.79-8.25)	275 (248-295)	115 (110-119)	142 (134-154)	81 ((1-177)
SD11	7.2 (6.6-7.9)	8.01 (7.90-8.16)	243 (219-285)	96 (91-105)	113 (110-118)	9 (5-14)
SD10	7.5 (6.8-7.8)	8.11 (7.94-8.26)	250 (226-279)	107 (100-114)	131 (118-140)	14 ((1-24)
SD09	7.2 (6.4-7.9)	8.01 (7.88-8.08)	264 (256-272)	105 (101-109)	119 (116-124)	83 ((1-225)
SD08	7.2 (6.6-7.9)	7.95 (7.74-8.15)	231 (203-256)	89 (85-95)	109 (106-114)	66 (13-163)
SD07	7.3 (6.4-7.7)	8.04 (7.81-8.16)	266 (241-276)	109 (106-112)	131 (126-134)	57 ((1-147)
SD06	7.3 (6.4-7.7)	7.91 (7.74-8.06)	219 (201-231)	81 (78-85)	102 (100-106)	20 (13-26)
SD05	7.4 (6.7-7.8)	8.13 (7.96-8.31)	241 (221-255)	98 (96-99)	113 (112-114)	21 ((1-38)
SD04	7.1 (6.1-7.9)	8.02 (7.93-8.18)	298 (259-351)	129 (110-155)	155 (126-194)	110 ((1-289)
SD04QA	7.1 (6.0-7.7)	7.91 (7.70-8.04)	297 (251-337)	129 (113-154)	149 (132-180)	143 (16-261)
SD03	7.4 (6.6-7.9)	8.12 (8.04-8.23)	247 (225-269)	98 (94-102)	122 (116-126)	15 ((1-33)
SD02	7.3 (6.6-7.8)	8.07 (7.80-8.19)	298 (261-430)	120 (112-134)	153 (132-166)	12 ((1-20)
SD01	7.5 (6.9-8.1)	8.06 (7.98-8.12)	282 (233-368)	103 (98-114)	149 (128-184)	8 ((1-14)

^aSample sizes for dissolved oxygen, pH and conductivity analyses N = 14 except for site SD14QA (N = 13); sample sizes for alkalinity, hardness and ammonia analyses N = 3.

^bSite identification: LFS0459b = sediment control treatment; RD = Reference Designation; SD = Site Designation; SD14QA/SD04QA = Field Duplicate Samples.

^cMean pH calculated from hydrogen ion concentration: $[H^+] = 10^{-(pH)}$.

4.6 Test Acceptability Criteria

4.6.1 Control Treatment Survival

All sediment toxicity tests (Group 1, 2 and 3 *H. azteca* and Group 1, 2 and 3 *D. magna*) were determined to be valid tests based on control treatment survival. The mean *H. azteca* survival in the three laboratory control sediment treatments was 89.2% (80.0%, 92.5%, and 95.0%, respectively). The mean *D. magna* survival in the three water-only control treatment was 96.7% (100%, 100%, 90%, respectively).

4.6.2 Test Water Temperature

Mean test temperatures for all sediment toxicity tests (Group 1, 2 and 3 *H. azteca* and Group 1, 2 and 3 *D. magna*) were all within the acceptable range (22.0 - 24.0°C). The mean Group 1, 2 and 3 *H. azteca* test temperatures were 23.2°C, 23.1°C and 23.1°C, respectively. The mean Group 1, 2 and 3 *D. magna* test temperatures were 22.9°C, 22.9°C and 23.1°C, respectively (Table 16; section 4.1). The two instances of deviation from the acceptable daily test temperature range are discussed in section 2.3.6.

4.6.3 Test Water Chemistry Variation

The test acceptability guidelines specify that the hardness, alkalinity, pH and ammonia in the overlying water within a treatment (i.e., site) should not vary by more than 50% during the test. The percent difference between extreme values of each water quality chemistry parameter ($100 \times (\text{Maximum-Value} - \text{Minimum-Value}) / \text{Maximum-Value}$) was compared to this 50% criterion. Table 25 presents the percent differences for all sites in both toxicity tests. In each column, the value on the left corresponds to the *H. azteca* toxicity test water chemistry data and the value on the right corresponds to the *D. magna* toxicity test water chemistry data. The minimum and maximum chemistry values from the *H. azteca* and *D. magna* toxicity tests are taken from the ranges given in Tables 23 and 24, respectively. Data from repeated toxicity tests were combined to give overall measured extreme values; these were used to calculate percent differences.

The data show that variation in the water chemistry data was less than 50%, and most often less than 30%, except for some of the dissolved oxygen data and all of the ammonia data. The dissolved oxygen data which exceeded the 50% criterion were all from the Group 1 *H. azteca* toxicity test. The dissolved oxygen concentrations in that group were abnormally low due to the oxygen demand of excess *Hyalella* food. After adjusting the food volume, dissolved oxygen concentrations increased to acceptable levels. The percent difference between maximum and minimum dissolved oxygen concentrations in the Group 1 sediment control test was 72.6% (above the 50% criterion). The percent difference between maximum and minimum dissolved oxygen concentrations in the Group 2 and 3 laboratory formulated sediment control were 39.7% and 21.7%, respectively (both below the 50% criterion). The large percent difference in ammonia concentrations is a function of the very low values measured.

Table 25. Summary of Toxicity Test Water Chemistry variation for *H. azteca* and *D. magna* tests. Values are percent difference of measured extreme values from Tables 23 and 24, respectively.

Site ID ^a	Left Value = <i>H. azteca</i> Test				Percent Difference of Measured Extreme Values ^b				Right Value = <i>D. magna</i> Test			
	Dissolved Oxygen ^c mg/L	pH	Conductivity ^d μS/cm	Alkalinity mg/L as CaCO ₃	Hardness mg/L as CaCO ₃	Ammonia μg/L NH ₄ -N						
RD21	58.5	14.8	2.8	5.9	10.1	17.7	5.3	13.5	3.2	17.2	64.2	100
Water Control	NA	19.3	NA	4.2	NA	18.1	NA	14.7	NA	13.6	NA	94.9
LFS0459b	72.6	16.3	7.3	5.7	23.0	19.0	18.5	10.4	28.0	18.6	70.3	100
SD17	72.7	26.9	6.0	4.4	12.9	19.6	16.9	12.1	18.1	10.6	30.0	76.4
SD16	35.7	16.7	3.3	5.6	12.5	17.3	19.0	14.7	18.2	13.7	43.7	100
SD15	30.0	14.1	2.6	6.8	7.8	13.0	7.3	4.0	9.2	14.9	78.5	100
SD14	50.0	20.7	5.0	2.2	25.9	31.6	23.7	9.4	26.3	10.0	80.1	100
SD14QA ^a	54.4	17.5	5.0	3.3	26.3	32.1	23.5	12.2	24.7	7.5	93.4	28.0
SD13	26.5	18.2	2.9	7.5	5.6	21.6	4.3	16.1	8.7	21.7	56.8	88.5
SD12	48.6	22.2	4.0	5.6	40.7	15.9	25.9	7.6	27.1	13.0	7.8	100
SD11	64.6	16.5	4.3	3.2	9.0	23.2	8.7	13.3	8.5	6.8	73.0	64.3
SD10	33.8	12.8	2.8	3.9	15.0	19.0	13.5	12.3	2.7	15.7	27.3	100
SD09	23.5	19.0	1.1	2.5	4.4	5.9	3.6	8.3	11.4	6.5	72.0	100
SD08	54.5	16.5	4.6	5.0	10.3	20.7	5.6	10.5	0.8	57.0	56.0	92.0
SD07	30.9	16.9	2.2	4.3	17.5	12.7	14.1	5.4	5.3	6.0	37.9	100
SD06	60.9	16.9	3.7	4.0	15.3	13.0	25.5	8.2	5.3	5.7	67.1	50.0
SD05	33.8	14.9	3.4	3.1	8.4	13.3	5.5	3.0	4.8	1.8	61.1	100
SD04	29.4	22.8	5.0	3.1	24.0	26.2	27.3	29.0	25.3	35.1	27.9	100
SD04QA ^a	20.3	22.1	3.8	4.2	20.2	25.5	23.3	26.6	24.7	26.7	38.5	93.9
SD03	36.2	16.5	4.1	2.3	7.4	16.4	6.8	7.8	1.5	7.9	60.6	100
SD02	31.4	15.4	2.6	4.8	17.1	39.3	29.3	16.4	24.7	20.5	50.9	100
SD01	26.9	14.8	2.6	1.7	31.8	36.7	9.6	14.0	7.4	30.4	97.1	100

4.6.4 Organism age

The organisms used to start each *H. azteca* test were collected from a mixed-age culture tank at the ORNL/ESD Toxicology Laboratory. The mixed-age batch of organisms was separated into $>500\ \mu\text{m}$, $500\text{-}355\ \mu\text{m}$ and $<355\ \mu\text{m}$ size fractions. The organisms in the $500\text{-}355\ \mu\text{m}$ size range have been shown to correspond to 7-14 day old organisms. There were used in the toxicity tests. The organisms used to start each *D. magna* test were collected from static cultures at the ORNL/ESD Toxicology Laboratory. Adult (female) *D. magna* were placed in clean culture water on the afternoon prior to test initiation. Neonates released overnight and collected the following morning were known to be ≤ 24 hours old and were used in the toxicity tests.

4.6.5 Reference toxicant tests

Acute, water-only toxicity tests using solutions of a reference toxicant of known concentrations are commonly run to assess the condition of organism cultures. This procedure was followed with the two test species using potassium chloride as the reference toxicant in both reference tests. Additional test parameters and conditions are outlined in Appendix B (Table B.5 for the *H. azteca* test and Table B.6 for the *D. magna* test). To date, four reference toxicant tests have been run with each species under the conditions outlined in Appendix B. From these previous reference toxicant tests, a central tendency for the respective LC_{50}s was calculated (i.e., a running mean LC_{50}). The LC_{50}s calculated for the reference toxicant tests of this study were compared to the central tendency for each organism. Each shows close agreement with their respective central tendency. As shown in Table 3 (section 3.1), the *H. azteca* 96-h, KCl LC_{50} was $151.6\ \text{mg/L}$ while the central tendency for that test was $151.1 \pm 21.8\ \text{mg/L}$ (mean $\pm$ twice the standard deviation). Similarly, the *D. magna* 48-h, KCl LC_{50} was $201.3\ \text{mg/L}$ while the central tendency for that test was 218.4 ± 49.6 . The results suggest that test organism sensitivities were stable and within limits determined to be normal for those particular cultures.

4.6.6 Culture chemistry

The culture water from each test organism culture was analyzed for temperature, dissolved oxygen, pH, conductivity, alkalinity, hardness and ammonia on or around organism collection day. The results of these analyses, presented in Table 26, suggest that the culture water chemistry is very similar to the test water chemistry of the appropriate test control treatments. Thus, organism stress due to drastic changes in water chemistry was not an issue in this study.

Table 26. Water Chemistry Comparison - Culture Water vs. Test Water Quality

Chemical Parameter	Culture and Test Water Chemistry Results			
	Mean (range)			
	<i>Hyalella azteca</i>		<i>Daphnia magna</i>	
	Culture ^a	Test ^b	Culture ^a	Test ^b
Temperature °C ^c	22.6 (22.5 - 22.6)	23.2 (22.2 - 23.7)	NA	NA
Dissolved Oxygen mg/L	4.2 (3.3 - 5.2)	5.3 (1.8 - 7.9)	6.8 (6.5 - 7.0)	7.3 (5.7 - 8.3)
pH ^d	7.45 (7.29 - 7.77)	7.74 (7.33 - 8.08)	7.50 (7.20 - 7.84)	8.02 (7.60 - 8.39)
Conductivity μS/cm	256 (248 - 261)	272 (238 - 413)	221 (208 - 228)	256 (195 - 430)
Alkalinity mg/L as CaCO ₃	100 (98 - 102)	117 (97 - 161)	88 (86 - 89)	102 (77 - 155)
Hardness mg/L as CaCO ₃	126 (76 - 152)	134 (108 - 192)	107 (90 - 116)	125 (96 - 194)
Ammonia μg/L NH ₄ -N	21 (5 - 40)	203 (7 - 465)	532 (N=2) (91, 973)	53 (<1 - 321)

^aSample size is N = 3. Samples were taken on May 29, June 4 and June 11, 1995 except for the third *H. azteca* Ammonia sample which was taken on June 10, 1995. Sample size for *D. magna* ammonia is N = 2.

^bSample sizes (N) are as follows:

Parameter	Temp.	D.O.	pH	Cond.	Alkalinity	Hardness	Ammonia
<i>D. magna</i>	43	229	229	229	69	69	69
<i>H. azteca</i>	33	230	229	230	46	46	46

^cMeans were calculated from temperatures recorded on days corresponding to culture water sampling days (see table note a). NA = temperature comparison is not applicable (see section 2.3.8).

^dMean pH was calculated from hydrogen ion concentrations: $[H^+] = 10^{-pH}$.

4.7 Toxicity Test Results - Sediment Reference vs. Sediment Control

The reference sample used in this study was a composite of sediment collected from three, downstream tributaries to Bear Creek. It is presumed that the sediment in these tributaries are free of the gross contamination suspected to be present in the main creek channel and upstream tributaries. Although this may indeed be the case, the toxicological characteristics of the reference sediment were compared to the laboratory formulated sediment control sample known to be clean and amenable to *H. azteca* survival. The responses of both organisms to the reference and control sediment samples are presented in Table 27. The values represent mean (and standard deviation) *H. azteca* survival, mean (and 95% confidence limits) *D. magna* survival, and mean (and standard deviation) *D. magna* young per surviving female. For repeated tests, individual test results are given in chronological order from top to bottom. The *H. azteca* survival data, the *D. magna* survival data, and the *D. magna* reproduction data were analyzed statistically for significant differences. Statistical tests on the survival data showed no significant difference among sample pairs ($\alpha = 0.05$).

The *D. magna* data, however, were found to be significantly different. Reproduction was significantly greater in the reference sample than in the laboratory formulated sediment control.

Table 27. Reference site and laboratory control sediment data for all tests. Values represent mean percent survival (and standard deviation) for *H. azteca*; percent survival (and 95% confidence limits) for *D. magna*, and young per surviving female (mean and standard deviation). Results which are significantly different ($\alpha = 0.05$) are indicated by an asterisk (*).

Toxicity Test	Survival and Reproduction Data ^a	
	Reference Site RD21	Laboratory Control LFS0495b
<i>Hyaella azteca</i> (survival)	87.2 (8.7)	80.0 (18.3) 92.5 (8.3) 95.0 (8.7)
<i>Daphnia magna</i> (survival)	100.0 (66.4, NA) 100.0 (69.2, NA)	90.0 (55.5, 99.8)
<i>Daphnia magna</i> * (reproduction)	29.7 (11.1) 24.9 (6.5)	17.6 (6.7)

^a*H. azteca* mean percent survival (Standard Deviation; $N = 4$); *D. magna* percent survival (Lower 95% Confidence Limit, Upper 95% Confidence Limit; N varies); *D. magna* mean young per surviving female (Standard Deviation; N varies)

4.7.1 Statistical Results - *Hyaella azteca* (survival)

Table 28 provides summary statistic results of the GLM procedure on the *H. azteca* proportion survival data (arsine transformed). Survival among the sample pair was not significantly different ($p = 0.7145$; $\alpha = 0.05$; Appendix C).

Table 28. GLM analysis summary table of arsine-transformed *H. azteca* proportion survival in the reference site sample and the laboratory formulated control sample. The differences were not significant ($\alpha = 0.05$).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	0.0067	0.0067	0.15	0.7145
Error	6	0.2730	0.0455		
Corrected Total	7	0.2797			
		R-Square	CV	Root MSE	ARCSURV Mean
		0.0239	18.4769	0.2133	1.1544

4.7.2 Statistical Results - *Daphnia magna* (Survival)

Table 29 presents the Fisher's Exact procedure on the *D. magna* survival data from the reference site and the laboratory formulated control run side-by-side in Group 3. The difference in survival among the sample pair was not significant ($\alpha = 0.05$).

Table 29. Fisher's Exact Test table of *D. magna* survival data from the reference site and the laboratory control run (Group 3). The critical value for this Fisher's Exact Test is 6.043 ($\alpha = 0.05$). Survival among the sample pair was not significantly different.

Site	No. Alive	No. Dead	No. of Observations
RD21	10	0	10
LFS0495b	9	1	10
Totals	19	1	20

4.7.3 Statistical Results - *Daphnia magna* (Reproduction)

Table 30 provides summary statistic results of the GLM procedure on *D. magna* reproduction data from the reference sample and the laboratory formulated sediment control run side-by-side in Group 3. Difference in reproduction among the two sites was significant ($p = 0.0125$; $\alpha = 0.05$; Appendix C).

Table 30. GLM analysis summary table for *D. magna* reproduction in the reference sample and in the laboratory formulated sediment control. Tukey's Studentized Range Test showed a significant difference between reproduction in the two samples ($\alpha = 0.05$, critical value of Tukey's Test = 2.998, minimum significant difference = 9.126).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	660.0556	660.0556	7.92	0.0125
Error	16	1334.2222	83.3889		
Corrected Total	17	1994.2778			
		R-Square	CV	Root MSE	YOUNG Mean
		0.3310	38.6757	9.1318	23.6111

4.8 Toxicity Test Results - Water control vs. Sediment Control (*Daphnia magna*)

Since *D. magna* are filter-feeding organisms that dwell in the water-column, the inclusion of a water-only control is appropriate. Laboratory control water, which is used as the organism's culture medium, was selected as the test control water. In the Group 3 test set, a laboratory formulated sediment control was also included in the test design to determine the effects of the (clean) sediment on the organism. Reproduction (mean and standard deviation young per surviving female) in the Group 3 water-only and Group 3 sediment controls are presented in Table 31. The *D. magna* reproduction data were analyzed for significant differences. The differences among the water-only and sediment control data were significant ($p = 0.0001$).

Table 31. Water-only control and sediment control *D. magna* reproduction data from the Group 3 test. Values represent *D. magna* young per surviving female (mean and standard deviation). Reproduction was significantly different ($\alpha = 0.05$).

Toxicity Test	Young per surviving female: Mean (standard deviation)	
	Water-only Control 30% DMW	Sediment Control LFS0495b
<i>Daphnia magna</i> (reproduction)	74.3 (15.9)	17.6 (6.7)

4.8.1 Statistical Results - *Daphnia magna* (reproduction)

Table 32 provides summary statistic results of the GLM procedure on *D. magna* reproduction data from the Group 3 water-only and laboratory formulated sediment controls. Difference in reproduction between the sample pair was significant ($p = 0.0001$; $\alpha = 0.05$; Appendix C).

Table 32. GLM analysis summary table for *D. magna* reproduction in the Group 3 water-only control and laboratory formulated sediment control. Differences among sites was significant ($\alpha = 0.05$).

Source	df	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	18070.4322	18070.4322	235.07	0.0001
Error	15	1153.0972	76.8732		
Corrected Total	16	19223.5294			
		R-Square	CV	Root MSE	YOUNG Mean
		0.9400	18.1549	8.7677	48.2941

5. Discussion

The toxicity test data results were rather uninteresting. Except for site SD17, there was no significant difference in survival among test sites and reference site. The *D. magna* reproduction data were somewhat more ambiguous than the survival data. Reproduction in several sites was higher than in the reference site, one of which was site SD17. Given the absence of additional information such as sediment chemistry, site location and topography, hydrology, etc., discussion of site-specific characteristics affecting sediment toxicity can not be accurately provided. The results obtained in this study are discussed in the context of general sediment toxicity testing issues. These include comparison of test sites to both the reference site and to the laboratory control sample (to evaluate the applicability of using laboratory controls as reference treatments), the ecological conclusions that can be drawn from each comparison, and the significance of observed field variation as it relates to measuring sediment toxicity. Issues relating to the use of surrogate organisms to evaluate sediment toxicity are discussed, as well.

5.1 Toxicity Test Data - Comparison of Test Site to Reference Site

One of the more common ways ecological risk assessors treat toxicity in environmental media (sediment, water, etc.) is to compare endpoint data from field test sites (i.e., sites suspected to be impacted) to endpoint data from a local reference site within or near to the system under investigation. The goal of this approach is to include the natural variation inherent in natural field conditions when quantifying differences between test and reference sites. This study design results in a lot of experimental noise. A second approach is to use media (sediment, water, etc.) prepared in the laboratory as the reference entity to which field samples are compared. The laboratory control, however, is an idealized system designed to provide controlled, reproducible media to which organisms are exposed. In the context of ecological risk assessment, using a laboratory control reduces the noise inherent in the reference medium, but not in the test site(s). Any differences detected by this approach will have less ecological relevance since the laboratory control has little relationship to field conditions. The ecological impact of a medium to an organism at a test site seems only relevant in the context of the natural composition and variation of a field site. Unless one can construct a laboratory control that closely and accurately reproduces relevant field characteristics, use of laboratory controls may not be appropriate. For this reason, we used reference site to test site comparisons as the primary statistical analysis approach in this study.

Analysis of *H. azteca* survival data indicated significant variation among the sites tested. When the data were analyzed by Tukey's Studentized Range test, survival in site SD17 was found to be significantly lower than survival in all other test sites, including the reference site. When the data were compared to the reference site by Dunnett's t-test, none of the survival data comparisons were significantly different. This result is probably due to the level of significance chosen. Using Tukey's test at $\alpha = 0.05$, SD17 just barely exceeds the critical value while with Dunnett's t-test, the critical value is not exceeded. Observation of the raw data and of calculated standard deviations of mean survival showed relatively lower mean *H. azteca* survival in SD17 accompanied by a large within-replicate variation. This large variation may have masked the among-site variation and increased the level of significance at which significant differences were detected. In our judgement, site SD17 is a hit and warrants further investigation. Discussion of the location of this site, or the contaminants present at this site which have the potential of reducing *H. azteca* survival, is beyond the scope of this study.

The appropriateness of using *H. azteca* as a sediment toxicity test organism has been investigated extensively. The conclusions of these studies lead to its selection as one of three standard test organisms for the evaluation of sediment toxicity (USEPA 1994). Several studies (USEPA 1994) have looked at its sensitivity to individual chemical, both in water-only and in sediment matrices, and all have shown *H. azteca* to be quite sensitive to a broad range of chemicals. In this study, however, the overall survival (88.4%) is quite good, thus it is concluded that, except for site SD17, sediment samples from the sites investigated were not toxic to *H. azteca*.

The effects of sample storage time and temperature on sample toxicity are not precisely known for all cases. It is even more difficult to make statements about changes in toxicant bioavailability to *H. azteca* without having chemical information. Based on our test conditions, however, the magnitude and duration of the temperature deviations are, in our judgement, not a significant source of sample alteration. Although not a definitive test design, evaluation of sample alteration over time was attempted by the repeated laboratory

control and reference sediment sample toxicity tests. The repeat tests conducted showed excellent repeatability. A better test design would have included repeat testing of test sites (if known to be toxic).

The *D. magna* survival data were analyzed by Fisher's Exact test. With this test, SD17 was again the only site to show a significant reduction in survival relative to survival in the reference site. As was the case with the *H. azteca* results, the difference in survival was very close to the minimum significant difference at $\alpha = 0.05$: SD17 had 5 survivors and the minimum significant difference was 5.041. With a different level of significance, this result may be modified. Due to missing animals, and therefore smaller replicate numbers, the sensitivity of the tests to detect differences was impacted. The *D. magna* survival results are consistent with the significant reduction in *H. azteca* survival at site SD17 described above. We recommend further investigation of site SD17.

5.2 Issues Other Than Toxicity Impacting Study Results.

5.2.1 Use of surrogate organisms for sediment toxicity testing

The sediment characteristics that support the health (survival, growth and reproduction) of *H. azteca* have been investigated (Ankley et. al. 1994). This organism can tolerate a wide range of sediment types with widely varying proportions of sand, silt and clay, at least on a short term basis. This makes it a good test organism. However, in the field there are preferred environments in which one is more likely to find *H. azteca*. One obvious sediment characteristic affecting *H. azteca* survival might be sediment porosity or the degree of granular character. Since the amphipod is a burrowing organism, it will more abundant in softer, muddy sediments than in hard clay sediments. Several reasons for this exist: that they are more likely to evade predation with higher burrowing efficiency, soft-mud sediments typically have higher organic matter content which can be used as food substrate by the organism, etc. Blindly testing sediment samples in the laboratory minimizes this aspect of ecological risk. A hypothetical scenario might be: sediment sampled from a narrow, shallow creek on a relatively steep slope with relatively hard, clay sediment, is found to be toxic to *H. azteca*. In this case, one might argue that the probability of that site supporting an *H. azteca* population is very small anyway. *H. azteca* may not be an indigenous species; if introduced it may successfully colonize, or it may not. The interpretation of toxicity is not straightforward in such a case. Interpreting the absence of toxicity in the laboratory tests is similarly ambiguous. The burrowing efficiency of the organism may be low in this sediment, resulting in the effective contaminant exposure dose being lower. The toxicity results would be a reflection of dose differences not necessarily concentration/toxicity differences. Incidentally, this hypothetical stream may closely describe some of the areas of Bear Creek or its tributaries based on observations made of the sediment samples tested (e.g., sediment from site SD01). The same issues and arguments hold for *D. magna*.

5.2.2 Appropriateness of *D. magna* as a whole sediment toxicity test organism

The problem of missing *D. magna* suggests a more general problem with using a water-column organism for a whole sediment toxicity test. During the toxicity tests, the organisms were often observed swimming and foraging near the sediment-water interface, possibly trying to use sediment particles as food. The test design (i.e., the

configuration of the sediment surface, in this case) should not be a variable impacting the results of toxicity tests. This would be a very poor test design, indeed, if the organisms were being caught in surface crevices. We hoped that smoothing out the sediment surface during test preparation would provide a simple answer to this problem. However, even with this modification, several organisms were found missing. Interestingly, some organisms created holes in the sediment surface later in the test which were approximately the diameter of adult *D. magna*. Missing organisms has not been an issue in previous sediment toxicity studies.

Analysis of the *D. magna* reproduction data by GLM indicated significant differences among sites. Evaluation of the source of the variation by Dunnett's t-test showed a majority of the sites with significantly reduced reproduction relative to the reference site. However, site SD17 was not among that group. In fact, site SD17 had the highest reproduction (mean young per surviving female) of any of the sediment treatments. There was no obvious pattern to the reproduction results. This raises a second concern with using *D. magna* in whole sediment toxicity tests. It is possible that the presence of suspended solids in the test system has a negative effect on the organism health, and therefore on its response during the test. A marked difference in reproduction occurs between water-only and sediment controls (Table 31, section 4.8). This strongly suggests that feeding efficiencies decrease with the presence of sediment particles. No data on particle size of the samples in this study are available, so a thorough analysis of this problem is not possible. However, it would be quite interesting to test for a correlation between the fraction of fine-grain, easily suspended clay and silt components present in these sediments and the feeding efficiency (or growth and/or reproduction, indirectly) of *D. magna* in these tests. Some literature exists evaluating this phenomenon (Hart 1992), which has also been observed in other sediment toxicity test studies conducted by this laboratory (Gonzalez et. al. 1995). In the context of sediment toxicity, perhaps it would be more appropriate to evaluate pore water and elutriate toxicity with this organism, eliminating the presence of solid particles altogether.

The relationship between reproduction by *D. magna* and the sediment sample organic carbon content was examined. Sediment samples were qualitatively described during the preparatory stages of the study. These descriptions are recorded on the sediment handling and tracking log sheets (Appendix A). A rigorous analysis should include particle size distribution and particulate organic carbon data. These qualitative, non-standard descriptions of sediment characteristics are summarized, along with the corresponding *D. magna* reproduction, in Table 33. In most cases, samples described as "muddy" or "sandy" had relatively higher mean reproduction than samples described as "clay." This could suggest some interference of organismal physiology (e.g., feeding rates) by fine-grain particles. Muddy sediments are often associated with higher organic matter content and may have a beneficial effect. Sandy sediments, on the other hand, are composed primarily by relatively large particle sizes which settle out of the water column and might not be ingested. The strongest support for this idea is the difference in reproduction between the water control (no solids present) and all other (sediment-containing) treatments. As stated previously (section 5.2.1), no obvious relationship between sediment characteristic and *H. azteca* survival was observed.

Table 33. Effects of general sediment sample characteristics on *Daphnia magna* reproduction (young per surviving female).

Site ID*	Qualitative Sediment Description	Mean (Std. Deviation) Young/surviving female
RD21	sandy	29.7 (11.1)
Water Control	no solids present	24.9 (6.5)
		82.9 (15.9)
		47.4 (9.3)
LFS0495b	clay-sand; low %organic	74.3 (15.9)
SD17	muddy-silt; leaves/debris	17.6 (6.7)
SD16	sandy	32.4 (5.4)
SD15	sandy	20.2 (8.2)
SD14	sandy-clay; some debris	20.7 (4.0)
SD14QA	sandy-clay; some debris	16.6 (4.1)
SD13	silty-mud	14.4 (4.6)
SD12	No Description	15.1 (2.9)
SD11	sand; gravel	15.6 (4.4)
SD10	clay-sand	23.4 (9.7)
SD09	silty-sand	18.6 (3.5)
SD08	clay-silt	13.4 (2.1)
SD07	sandy-clay	25.6 (6.2)
SD06	sandy-silt; some debris	12.5 (2.9)
SD05	No Description	13.7 (6.5)
SD04	silty-gravel; debris	19.6 (3.7)
SD04QA	silty-gravel; debris	14.1 (3.8)
SD03	muddy-silt	14.8 (2.7)
SD02	clay-silt (orange)	21.0 (5.7)
SD01	Hard compact clay; red	22.9 (6.1)
		8.8 (2.5)

*LFS0495b = laboratory formulated sediment control; Water Control = 30% Dilute Mineral Water (laboratory control water); RD = Reference Designation; SD = Station Designation;.

6. Summary of Conclusions

- 6.1 Of the seventeen test sites tested, only site SD17 was found to have a significant (reducing) effect on *H. azteca* and *D. magna* survival relative to the reference site, RD21. *D. magna* reproduction results were less definitive, since reproduction in several test sites was greater than that in the reference site.
- 6.2 The reference site sediment sample was judged to be suitable as a reference substrate as determined by side-by-side testing with a clean, laboratory formulated sediment control. Comparison of *H. azteca* and *D. magna* survival data showed no significant difference between the sediment samples, and in the case of *D. magna* reproduction, the response was significantly better in the reference site than in the laboratory control sediment.
- 6.3 Reproduction of *D. magna* in the water-only control treatment was significantly higher than in any of the sediment treatments, including the clean laboratory formulated sediment control treatment. The effects of sediment particles in the test system has a drastic effect at least on sublethal responses. If this effect is correlated to particle size, it is possible that the *D. magna* reproduction data are systematically biased by particle size distribution of the sediment samples. In this particular study, the presence of sediment in the test system may have impacted survival as well, because several replicate treatments had missing organisms.

7. Report Review

This report has been reviewed and the data are released.

Reviewed by: _____

Date: _____

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G.13.2 TOXICITY TEST RESULTS, BEAR CREEK VALLEY FLOODPLAIN SOIL

Toxicity Test Results, Bear Creek Valley Floodplain Soil

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October 2, 1995

1. INTRODUCTION

The Bear Creek Valley Floodplain Soil Sampling and Analysis Plan presents the approach and rationale for characterizing potentially contaminated soils and sediments of the Bear Creek floodplain and the impact of contaminants on the floodplain ecosystem. One component of the plan is to evaluate the toxicity of floodplain sediments samples from sites near those sampled for stream sediments.

This technical memorandum reports the results of the floodplain sediments toxicity tests conducted during May 31 through July 20, 1995. The Materials and Methods section describes sampling activities conducted by Science Applications International Corporation (SAIC) and outlines procedures used to conduct the floodplain sediment toxicity tests at the Oak Ridge National Laboratory Environmental Sciences Division (ORNL/ESD). The outcomes of the earthworm (*Eisenia foetida*) survival, growth and reproduction tests and Buttercrunch lettuce (*Lactuca sativa*) germination and growth tests are summarized in the Results section of this report. Conclusions based on these data are presented in the Discussion section.

2. MATERIALS AND METHODS

2.1 SAMPLE COLLECTION

A 3.8-L volume sample of floodplain sediment was collected from each location by SAIC personnel. The sampling locations were on selected transects of the floodplain. The transect locations, in turn, were selected to be in areas of stream deposition. The floodplain sediment samples were collected from a 0- to 16-inch depth, so as provide testing information relevant to organisms living within the most biologically active zone of the sediment. The samples were collected on May 5-26, 1995, and on June 9, 1995. They were delivered to ORNL/ESD by SAIC.

2.2 SAMPLE ANALYTICAL METHODS

The handling and storage of the samples, and the toxicity test methods used to assess the samples, followed procedures outlined in the ORNL/ESD Quality Assurance Program Standard Operations Procedures (SOPs). The soil samples were coarsely sieved in the field to remove stones and large debris before being taken to ORNL/ESD.

E. foetida (earthworm) and *L. sativa* (lettuce) were selected for use in the soil tests both for regulatory and scientific reasons. The EPA recommends the use of *E. foetida* in toxicity screening-level assessments of soil from hazardous waste sites (Greene et al. 1988); *E. foetida* also can be readily cultured and is sensitive to various toxicants (Greg-Smith 1992). These animals grow rapidly and are large enough so that changes in growth can be measured as changes in weight over reasonable periods of time (Gibbs et al. 1995). The EPA also recommends use of Buttercrunch lettuce for screening-level assessments of potentially-contaminated soils for the following reasons: the seeds of this plant have a high germination rate; they are commercially available; the seeds germinate rapidly; and the plants have a uniform growth pattern. The EPA also has an established method for a lettuce seed germination toxicity test, which further confirmed our decision for using this species.

The earthworm survival, growth and reproduction test used to assess Bear Creek sediments is a procedure developed by Gibbs et al. (1995). This method evolved from a 14-d earthworm survival

test, developed originally by Greene et al. (1988), for EPA purposes. Key modifications of the method used here, compared to the method proposed by Greene, include: the use of more replicates per sample (10 vs 4); the use of fewer worms per replicate (2 vs 10); the use of punctured plastic bags rather than 1-pint canning jars with screw-top lids as test units; a smaller quantity of soil per replicate (150 g vs 200 g); and the use of longer test period (21 d vs 14 d), which permits the acquisition of information about earthworm reproduction. The earthworm tests included an artificial soil control and samples of soil from reference sites, as recommended by the U.S. Environmental Protection Agency (EPA) (Greene et al. 1988). A food supplement was added to each sample being tested (Van Gestel 1989, Gibbs et al. 1995).

The lettuce germination and growth test used to assess Bear Creek sediments is also a derived from a procedures described by Greene et al. (1988). Key modifications of the method, compared to the method described by Greene et al. (1988), include: the use of more replicates per sample (5 versus 3); the use of fewer seeds per replicate (20 versus 40); and the use of longer a test period (21 d versus 5 d), which permits the acquisition of information about lettuce growth. The procedure outlined by Greene et al. (1988) assesses germination only; using the 21 d test procedure, both germination and above-ground growth is measured. The lettuce tests included a laboratory artificial soil as a negative control, as well soil samples from several reference sites. The artificial soil was a commercially available potting medium (PremierTM Promix^R BX).

Duplicate soil samples (G10307, G10317) were taken from one site, and "repeat" tests of soil samples from three sites (G02317, G07317 and G08617) were tested on different days, both with earthworms and lettuce. The repeat testing design was used to assess reproducibility of the test procedures; it allowed estimation of the magnitude of temporal variation, which then could be compared to the amount of variation attributable to differences among sites.

2.3 DATA ANALYSIS METHODS

Data from the earthworm and lettuce tests were analyzed using computer programs based on the Statistical Analysis System (SAS Institute 1985a,b). First, analysis of variance (ANOVA) was used to determine if the response variable in question (e.g., earthworm survival or growth, lettuce germination or growth) differed significantly among sites. In this phase of analysis, differences among sites (based on means for the response variable) were considered to be statistically significant if that outcome would be expected on the basis of chance alone less than 5% of the time (i.e., $p < 0.05$). If statistically significant differences among the sites are detected by ANOVA, Duncan's multiple range test was used to determine which site or sites were different, in comparison to the reference sites. Duncan's multiple range test is described in various statistical textbooks (cf. Steel and Torrie 1960).

2.3.1 Earthworm Survival and Growth

The weight of all cocoons produced by *E. foetida* in any replicate during the tests was added to the final weight of the earthworms in that replicate at the end of the test to calculate the final estimate of growth. Cocoon weight was added to the increases in worm weights because reproduction, like growth, is a healthy response, and energy required for cocoon production reduces the amount of energy available for adult growth. By including dry cocoon mass as a component of worm growth, a more accurate indication of the earthworms' response to their environment is obtained. Thus, growth of the earthworms was computed as measured dry weight of the earthworms at the end of the test, plus measured dry weight of the cocoons (if any) at the end of the test, minus the estimated dry weight of the earthworms added to the soil at the start of the test. The dry weight of the living

earthworms added to each replicate at the start of the test was estimated by application of a wet-weight to dry-weight regression developed previously. This regression used an intercept forced through zero:

$$(1) \text{ dry weight} = 0.09787 * (\text{wet weight})$$

The adjusted R^2 for the regression was 0.985 ($N=49$), for individuals with wet-weight values ranging from 113.3 mg to 622.6 mg. The earthworms weighed at the beginning of the soil tests had weights within the range encompassed by values used to establish the regression.

The ANOVAs used to test for differences in worm growth among sites used mean growth as the response variable. In some cases, one or both earthworms in a given replicate died before the test had ended. In such cases, no replicate-specific estimate of growth could be made. Ten replicates (each containing two live worms at the start of the test) were used to assess each soil sample, so the number of observations used to calculate worm mean growth for each sample being tested was 10 minus the number of replicates in which the proportion of worms surviving was less than one.

2.3.2 Lettuce Germination and Growth

Each soil sample was assessed using five replicate petri dishes (20 mm deep x 100 mm diameter); 20 lettuce seeds were added to the soil surface in each replicate. Soil was added to a depth of approximately 1 cm in each dish before the seeds were added. The proportion of seeds that had germinated, by the end of the seventh day of testing, was used as one endpoint of the lettuce test. If more than 50% of the seeds had germinated, the number of shoots was thinned to 10 per replicate immediately after the germination data had been collected. Thinning was required to reduce the possibility of reductions in growth due to intraspecific competition (Harper 1977), which could interfere with the detection of contaminant effects on plant growth. At the end of the test, the plants were harvested at soil level. The above-ground tissues were dried at 60°C and weighed to obtain estimates of plant growth.

One ANOVA was used to test for differences in plant growth among sites, using mean growth per plant as the response variable. Another ANOVA was used to test for differences in lettuce seed germination among sites, using the proportion of seeds germinating per replicate as the response variable. A third ANOVA was used to assess reproducibility of the test procedures, by application to lettuce test data from repeat tests.

2.3.4 Detecting Differences Among Sites

To establish a broader context for considering the results of the earthworm and lettuce soil toxicity tests, we first considered responses of both types of tests to two groups of sites (reference sites versus nonreference sites). In these ANOVAs, response variables were identical to those described previously (e.g., earthworm growth and cocoon production, lettuce seed germination and seedling growth). Significant differences among sites within each group were explored using Duncan's Multiple-Range Test. This test compares each treatment with every other treatment mean (Steel and Torrie, 1960); it provides a convenient display of the results, sorted by magnitude of the means for the parameter of interest. Using the Dunnett's T-test differences among sites were considered to be statistically significant when p was < 0.05 . An important advantage of this procedure is the simultaneous consideration of all available reference sites.

2.3.5. Analysis of Results of Repeat Tests

Floodplain sediment samples from three sites were tested on two different days, with earthworms and lettuce on both occasions. The results of these tests were inspected by ANOVA to estimate the importance of temporal variation (i.e., run 1 versus run 2) compared to the amount of variation attributable to differences among sites (G02317, G07317 and G08617). Two presumptions were behind this analysis. First, one might hope that, even with a limited subset of sites, that the amount of "explainable" variation in worm or plant growth (using site or test number as explanatory factors) would be statistically significant and at least moderately large. Second, we felt that the temporal variation should be demonstrably small relative to variation among sites, even within a limited set of sites. Falsification of the latter hypothesis would suggest that the test methods might not be able to reliably estimate the magnitude of differences in biological quality of the sediment samples derived from different sites.

3. RESULTS

3.1 GENERAL DESCRIPTION OF RESULTS

3.1.1. Results of Earthworm Tests - Survival

The results of the earthworm tests are summarized in Table 1. Earthworm survival among all sites ranged from 80% to 100 % (Table 1). The survival was lowest at one of the reference sites (G00111); it ranged from 85% to 100% at the other sites. No further statistical analyses of earthworm survival were needed, for two reasons. First, earthworm survival in each of the reference sites was higher than the EPA guidelines for test acceptability (≥ 0.80) (Horning and Weber 1985). Second, earthworm survival in floodplain sediment from all non-reference sites had mean survival values that were equal to or greater than those in floodplain sediment from the reference sites.

3.1.2 Results of Earthworm Tests - Growth

ANOVA was used to examine earthworm growth (plus cocoon production) data in the context of "site type." For this analysis, three types of "sites" were considered: artificial soil (N=1), reference sites (N=3), and potentially contaminated sites (N=16). Differences in earthworm growth among these three types of sites were statistically significant ($p < 0.0001$), but the amount of variation in growth explained by the type of site was relatively small ($R^2 = 0.229$). Most of the difference in earthworm growth among the three types of sites was attributed to low growth in the three reference sites: the mean growth of earthworms for the reference sites, the artificial soil and the non-reference sites was 14.76, 81.29 and 82.39 mg/pair respectively.

ANOVA was also used to inspect earthworm growth data from all 20 "sites" (with data from the one artificial soil, the three reference sites and the sixteen non-reference sites being considered together). In this analysis, "site" explained slightly more variation in worm growth ($R^2=0.530$; $p < 0.0001$). Duncan's test, applied to this analysis, revealed six broadly overlapping groups of sites, with the reference sites and the artificial control at the low end of the spectrum. The ranks of the sites, based on mean growth of earthworms, is shown in Fig. 1.

The seven sites with highest mean growth were collectively grouped into one category by Duncan's procedure. The mean growth of earthworms in this group of seven sites was 106.1 mg/pair. Only three non-reference sites had mean growth values that were less than 50% of the mean for the

seven sites where growth was greatest. These three "poor quality" sites were G09217, with 30.78 mg/pair; G10317, with 44.43 mg/pair; and F12517, with 51.96 mg/pair.

ANOVA was also used to assess earthworm growth among the 16 potentially contaminated sites only (i.e., data from the three reference sites and the artificial control were excluded). In this examination, site explained a significant amount of variation ($R^2=0.380$, $p < 0.0001$), and Duncan's procedure, applied to the ANOVA, revealed 7 broadly overlapping groups of sites. The three sites identified previously as "poor quality", plus one more (G01617, with mean growth being 62.16 mg/pair), segregated into one of these seven groups. This group, though, overlapped extensively with the next group.

3.1.3 Results of Earthworm Tests - Reproduction

The number of cocoons produced by earthworms in the various samples ranged from zero, in floodplain sediment from G00111, to 27, in floodplain sediment from G04117. A positive association was found between the number of cocoons produced and the mean growth of earthworms, on a per-sample basis: the correlation (R) between the earthworm mean growth and the number of cocoons produced was 0.44 ($\rho = 0.052$, for $N = 20$).

3.2.1 Results of Lettuce Tests - Germination

Data for lettuce germination and growth tests are summarized in Table 2. Germination of lettuce among all sites ranged from 0.26 to 0.84 (Table 2). Germination of lettuce was lowest at F12517 (0.26), and highest at G00211 and G08617 (0.84). Lettuce germination data from all 20 "sites" (including the control, the three reference sites, and the 16 non-reference sites) were analyzed by ANOVA and Duncan's procedure as described previously. In this analysis, "site" explained a significant proportion of the variation in lettuce germination ($R^2=0.372$, $p < 0.0025$). Duncan's procedure identified three groups of sites; each group overlapped the other two.

With all duplicates, re-tests and sites included, site explained approximately 33% of the variation in lettuce germination. With this data set, the contrast between reference site and non-reference site was statistically significant ($p = 0.037$), but the amount of variation explained by the type of site was trivial (3.6%). The mean proportion of seeds germinating in the reference sites was 0.773, and the mean proportion germinating in the non-reference sites was 0.637.

3.2.2 Results of Lettuce Tests - Growth

Lettuce growth data from all 20 "sites" (including the control, the three reference sites, and the 16 non-reference sites) were analyzed by ANOVA and Duncan's procedure as described previously. In this analysis, "site" explained a highly significant proportion of the variation in lettuce growth ($R^2=0.749$, $p < 0.0001$). Duncan's procedure identified nine overlapping groups of sites in this analysis (Fig. 2).

The ANOVA inspecting lettuce mean growth in relation to "site type", with site type being represented by the Promix^R control ($N=1$), the reference sites ($N=3$), and the potentially contaminated sites ($N=16$), was statistically significant ($p < 0.0001$). However, in this analysis the type of site explained only a small proportion of the overall variation in lettuce growth ($R^2=0.269$). Mean growth of lettuce in the control soil, in floodplain sediment from the reference sites, and in floodplain sediment from the non-reference sites was 0.88 mg/replicate, 1.57 mg/replicate and 2.96 mg/replicate respectively. Duncan's procedure showed that lettuce growth in floodplain sediment from the non-reference sites was greater than in floodplain sediment from the reference sites or in

the control soil: lettuce mean growth for the group of non-reference sites did not overlap with the group that contained the three reference sites and the control.

Lettuce growth in floodplain sediment just from the non-reference sites was also analyzed by ANOVA and Duncan's procedure. This ANOVA revealed significant differences among the sites ($R^2 = 0.656$, $p < 0.0001$); Duncan's procedure identified six groups of sites, all of which overlapped with neighboring groups. Mean growth in the two "best" sites – G13217 and G06417 – was 5.03 mg/replicate and 4.37 mg/replicate respectively. Mean growth in the two "worst" sites – G04217 and G04117 – was 1.35 mg/replicate and 1.54 mg/replicate respectively.

3.3 Concordance of Growth Responses – Earthworms versus Lettuce Seedlings

Quantification of concordance, or the level of agreement in responses of two or more test systems that are used to assess the same set of samples, can be used to support interpretation of toxicity test outcomes by weight-of-evidence (Stewart 1995). For the tests reported here, concordance was computed as the Spearman correlation between earthworm growth, earthworm reproduction, and lettuce growth (ranks for each parameter). This analysis included data from the control, the reference sites, and the non-reference sites. For earthworm growth versus plant growth, the correlation was positive and significant ($R = 0.466$; $\rho = 0.0383$, for $N = 20$). Thus, floodplain sediment samples that were "bad" for plant growth also tended to be "bad" for earthworm growth, and vice versa. The correlation between earthworm reproduction (the number of cocoons produced by all replicates, on a per-sample basis) versus earthworm growth (mg per pair) was 0.443 ($\rho = 0.0504$), close to statistical significance. The correlations between earthworm reproduction (either rank of cocoons produced per sample, or the number of cocoons per sample) versus plant growth (either rank, or mg per replicate) were not significant ($\rho > |0.80|$).

The similarity in ranking of soil quality based on earthworm growth and lettuce growth suggests that the two test methods were responding similarly over the range of soil-quality conditions encompassed by the Bear Creek Valley floodplain sediment samples. Gibbs et al. (1995) found that earthworm growth and reproduction tended to be negatively related, because under favorable conditions the worms would allocate energy into reproduction rather than growth. This finding justified the inclusion of cocoon weight as a component of earthworm growth (cf. Table 1). Based on the findings of Gibbs et al., we expected that the correlation between the number of earthworm cocoons produced and plant growth would be positive and significant. Instead, we found that the correlation was non-significant ($\rho = 0.944$). While it is likely that physicochemical attributes such as soil organic matter content, clay content, pH, and/or cation exchange capacity contributed to the concordance noted between earthworm growth and lettuce seedling growth, the reason(s) for lack of a significant correlation between earthworm reproduction and plant growth remains obscure.

3.4 UNCERTAINTIES

3.4.1 Laboratory Analyses Uncertainties

Beyond the general uncertainties inherent in using organisms as biological indicators (i.e., natural variability), several additional factors arose during the course of the soil toxicity tests which contributed to uncertainty. For example, several of the soil samples delivered to the Toxicology Laboratory contained earthworms, presumably from natural populations. These animals were removed, when detected, before the soil was tested. However, undiscovered earthworms could compete with test earthworms for resources and thus potentially affect the outcome of the test. Furthermore, cocoons left by the naturally occurring species may be confused with cocoons of the

test earthworms. This latter possibility is deemed unlikely, because only unhatched (recent) cocoons were counted. Thus, this situation was not expected to significantly affect the test results or compromise test interpretation.

In tests conducted to support an ecological risk assessment for the Portsmouth Gaseous Diffusion Plant, mean initial wet-weight of *Eisenia foetida* added to soil samples was 532 ± 114 mg per pair (Gibbs et al. 1995). The mean initial wet-weights of *E. foetida* used to assess In tests reported here, to assess floodplain sediment samples from Bear Creek Valley, mean initial wet-weight of *E. foetida* added to the soil samples was $1,175 \pm 272$ mg/pair. By use of the wet-weight to dry weight conversion regression, the mean dry weights of the worms used to initiate the Portsmouth and Bear Creek Valley tests were estimated to be 52.1 mg per pair and 115.0 mg per pair respectively. Mean growth of the worms in these two situations differed, in absolute terms: in the Portsmouth tests, the overall mean growth (i.e., change in dry weight) was 43.7 mg per pair, and in Bear Creek floodplain sediment samples, overall mean growth was 76.9 mg per pair. Thus, the growth of *E. foetida* in the two situations, expressed as a percentage of the initial (predicted) dry weights of the worms, was 83.9% for the Portsmouth tests and 66.9% for the Bear Creek Valley tests. It is probable that earthworm growth (expressed as a percentage of estimated initial dry weight) was slightly lower in the Bear Creek tests because larger worms were used to start the Bear Creek tests. For most species, growth rates of juveniles is greater than the growth rates of adults, which invest a larger proportion of their energy into reproduction rather than additional growth. Some evidence supporting this idea was found. In the Portsmouth tests, mean cocoon production (computed over all replicates having 100% survival) was 0.3 per replicate, whereas for Bear Creek Valley tests, mean cocoon production (computed over all sites where survival was 100%) was 1.4 per replicate.

In the Bear Creek Valley Floodplain Soil Sampling and Analysis Plan, *Arabidopsis thaliana* was the species of plant identified to be used for conducting the soil toxicity tests. In fact, the tests were originally set up with this species. Unfortunately, very few *Arabidopsis* seeds germinated, even though the seeds were fresh. Dr. Scott Cunningham, who has considerable experience in phytoremediation and soil toxicity testing at the DuPont's Glasgow Site in Newark, Delaware, was contacted about this problem. Dr. Cunningham suggested that lettuce (*Lactuca sativa*) would probably be more suitable than *Arabidopsis* for testing soils, for various reasons. Based on this recommendation, the tests were immediately re-started using seeds of Buttercrunch lettuce. The greatest uncertainty associated with this change is that there are no prior data for lettuce-growth tests of whole soils using *Arabidopsis* testing procedures. Thus, while the various within-test comparisons developed here based on lettuce responses seem valid and appropriate, we are unable to reliably judge the outcomes of the lettuce tests in a larger context: no assessment of test-to-test variation can be made. For some toxicity test systems used to assess ambient water quality (e.g., fathead minnow tests), test-to-test variation in growth typically rivals or exceeds site-to-site variation in growth, making it very difficult to extract reliable information about site-to-site differences, typically an important objective. Although the level of test-to-test variation cannot be estimated for the lettuce tests reported here, the range in mean growth of lettuce among the twenty Bear Creek Valley samples was large (from 0.75 mg/replicate at G00111, to 5.13 mg/replicate at G13217; a site-to-site difference factor of 6.8). By comparison, fathead minnow mean growth among ambient sites in Bear Creek typically varies by a factor of only 1.1 to 1.5 (mean of 1.32, with SD = 0.11, for 8 ambient test periods reported in Table 3.2; Hinzman 1995). The relatively large range in responses of lettuce growth among sites assessed in this report, compared to the relatively small range in responses of minnow growth among Bear Creek sites, suggest that uncertainty about test-to-test variation in lettuce growth is unlikely to be an important problem.

3.4.2 Data Analysis Uncertainties

Statistical tests are based on underlying assumptions and thus are subject to inherent limitations. Statistical significance does not imply biological significance (Yoccoz 1991). Detailed discussions of the statistical test used for BCV soil toxicity data analyses and the limitation of these tests can be found in Steel and Torrie (1960) and the SAS/STAT User's Guide (1985b).

The largest source of uncertainty about data analysis in this study was associated with the low mean growth values of earthworms and lettuce seedlings in reference-site soils (note Figures 1 and 2). The inclusion of data from reference sites into ANOVAs designed to test for possible "toxicity" responses of earthworms or lettuce in soil from non-reference sites is statistically appropriate but, in this case, biologically questionable: the responses of the two species in the reference-site samples suggests that these reference sites were not well-matched to non-reference sites, with respect to biologically significant factors unrelated to the presence or absence of contaminants. Additionally, the range in responses of the test organisms to the three reference site soils was moderately large (mean growth ranged from 0.75 mg/replicate to 2.20 mg/replicate for lettuce seedlings, and from -6.1 mg/pair to +38.2 mg/pair for earthworms). The variation in growth of both species in the reference-site soils was great enough to suggest that more than three reference sites would have been advantageous in the Bear Creek Valley assessment.

4. DISCUSSION

4.1 INTERPRETATION OF RESULTS

4.1.1 Earthworm Test Interpretation

Based on the results of the earthworm tests, only one non-reference site -- G09217 -- might be considered to be suspect for toxicity. In floodplain sediment from this site, earthworm growth was 34.1 mg/pair; this amount of growth is only about 29% as great as the mean value for earthworm growth at the three "best" sites. Earthworm growth was lower than 34.1 mg/pair in only three other samples -- the control, and two reference sites. Earthworms reproduced in all non-reference floodplain sediment samples; mean cocoon production among these samples ranged from 0.4 cocoons per replicate (in F12517) to 2.7 cocoons per replicate (in G04117) (Table 1). Since the "low growth" sample (G09217) supported a moderate level of earthworm reproduction (0.9 cocoons per replicate), the evidence for "toxicity" at this site seems weak.

4.1.2 Lettuce Test Interpretation

Based on the results of the lettuce tests, three non-reference sites -- G04217, G04117 and G03417 -- might be considered to be suspect for toxicity. In floodplain sediment from these sites, lettuce seedling mean growth ranged from 1.35 mg/replicate to 2.08 mg/replicate; this level of growth is only 31% to 48% as great as mean growth of lettuce in floodplain sediment from the three "best" sites. Lettuce seedling growth was lower than 1.35 mg/replicate only in the control and in soil from one reference site. However, the low growth values for lettuce seedlings in the control and the reference-site soils suggests that factors other than toxicants, such as nutrient regimes, soil organic content, etc. had a strong influence on plant growth. Accordingly, it would be difficult to disentangle the influences of nutrients (which could cause greater growth) and toxicants (which could reduce growth).

4.1.3 Comparison of Results of the Bear Creek Valley Tests to Other Studies

In whole-soil tests with earthworms conducted to support an ecological risk assessment at the Portsmouth Gaseous Diffusion Plant, earthworm mean growth values typically ranged from about 16 mg/pair to 67 mg/pair (Gibbs et al. 1995). About half of the Bear Creek Valley floodplain sediment samples yielded mean growth values that exceeded the highest mean value reported in the study by Gibbs et al. (1995). In the Portsmouth assessment, the difference in earthworm mean growth between the "best" and the "worst" sites was about 50.6 mg/pair; in the Bear Creek Valley assessment, the corresponding difference, among non-reference sites, was 69.3 mg/pair. Thus, the range in earthworm mean growth across "bad" to "good" sites in the two field-scale assessments was similar. This finding supports the idea that test-to-test variation in earthworm growth probably is low enough to allow reasonably effective discrimination of poor-quality sites from good-quality sites. Accordingly, the earthworm test procedure, as applied to the Bear Creek Valley situation, appears to have generated data of acceptable quality. Considering the growth and reproduction data together, the earthworm tests of the Bear Creek Valley samples do not support the idea that any of the tested sites contains contaminants at a concentration great enough to adversely influence either growth or reproduction of *E. foetida*.

No lettuce tests were conducted in the Portsmouth assessment (*Arabidopsis* was used, instead). Thus, no comparisons at the field-scale can be made to support interpretation of the lettuce tests used to assess Bear Creek Valley samples.

4.2 GENERAL UNCERTAINTIES

Toxicity test results for ambient samples must be considered in the context of contaminant data before concluding that a particular site is toxic, because test organisms can be affected strongly and adversely not only by contaminants in environmental media, but by non-chemical media parameters, such as soil particle size distribution, organic matter content, types of organic matter present, and recent history of the soil with respect to nutrient and water conditions.

5. CONCLUSIONS

6. REFERENCES

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TABLE 1: Summary of soil moisture fraction and earthworm survival, mean growth of worms and cocoons (mg dry weight, and cocoon reproduction, based on ten replicates per sample* at each site.

Site	Bear Creek (km)	Moisture Fracture	Survival (%)	Mean ($\pm$ SD) Growth (worms + cocoons)	Rank of worm Growth	No. of Cocoons Produced (range among replicates)	Rank of worm repro.
Control	-	0.343	100	20.9 $\pm$ 15.3	18	19 (0-7)	4
G00111	12.1	0.285	80	-6.1 $\pm$ 59.2	20	0 (0)	20
G00211	10.7	0.373	95	38.2 $\pm$ 39.9	16	3 (0-2)	18
G00311	10.1	0.268	85	5.5 $\pm$ 12.4	19	2 (0-1)	19
G01217	12.1	0.320	95	85.7 $\pm$ 50.2	8	17 (0-5)	6.5
G01617	12.0	0.249	100	62.2 $\pm$ 19.5	13	13 (0-4)	9
G02317	10.7	0.233	100	86.3 $\pm$ 25.1	7	6 (0-2)	15
G02417	10.7	0.352	95	77.6 $\pm$ 54.6	—	7 (0-3)	12
G03317	10.1	0.298	95	106.4 $\pm$ 65.3	5	20 (0-4)	3
G03417	10.1	0.285	100	81.6 $\pm$ 26.3	9	24 (0-6)	3
G05117	9.2	0.245	100	67.7 $\pm$ 45.0	12	6 (0-2)	15
G06417	8.7	0.258	90	108.3 $\pm$ 20.0	4	17 (0-8)	6.5
G06317	8.6	0.272	100	114.3 $\pm$ 32.3	—	18 (0-4)	—
G07317	7.7	0.225	100	114.3 $\pm$ 28.9	2	11 (0-3)	10
G07317	7.7	0.222	100	125.3 $\pm$ 41.8	—	5 (0-3)	—
G07117	7.5	0.278	100	121.3 $\pm$ 33.7	1	14 (0-4)	8.5
F12517	7.2	0.266	100	52.0 $\pm$ 16.0	14	4 (0-2)	17
G08617	6.8	0.293	100	72.6 $\pm$ 26.3	11	14 (0-3)	8.5
G08617	6.8	0.273	100	141.0 $\pm$ 97.7	—	26 (0-6)	—
G09217	5.2	0.226	95	34.1 $\pm$ 18.3	17	9 (0-2)	11
G10307	4.8	0.231	100	97.1 $\pm$ 37.5	—	21 (0-6)	—
G10317	4.8	0.233	85	44.4 $\pm$ 24.2	15	26 (0-5)	2
G13217	1.9	0.268	100	92.4 $\pm$ 19.6	6	6 (0-2)	15
G04117	NT8	0.348	100	113.7 $\pm$ 34.1	3	27 (1-4)	1
G04217	NT8	0.334	100	65.1 $\pm$ 11.8	10	16 (0-4)	—

*Replicates where one or more earthworms died could not be analyzed for growth. Thus, n<10 for samples containing those replicates.

Table 2. Summary of Buttercrunch lettuce germination and mean above-ground growth (mg dry weight) per plant (5 replicates per sample) at each site.

Site	Bear Creek (km)	Proportion germinated (mean $\pm$ S.D.)	Rank of lettuce germination	Growth (mg) per plant (mean $\pm$ S.D.)	Rank of lettuce growth
Promix	-	0.71 $\pm$ 0.27	10	0.89 $\pm$ 0.06	19
G00111	12.1	0.74 $\pm$ 0.09	7	0.75 $\pm$ 0.01	20
G00211	10.7	0.84 $\pm$ 0.11	1	1.77 $\pm$ 0.03	16
G00311	10.1	0.74 $\pm$ 0.16	8	2.20 $\pm$ 0.05	14
G01217	12.1	0.76 $\pm$ 0.14	6	3.69 $\pm$ 0.04	3
G01617	12.0	0.66 $\pm$ 0.34	13	3.35 $\pm$ 0.06	5
G02317	10.7	0.82 $\pm$ 0.21	4	3.06 $\pm$ 0.02	7
G02417	10.7	0.53 $\pm$ 0.20	—	1.35 $\pm$ 0.01	—
G03317	10.1	0.45 $\pm$ 0.23	19	2.65 $\pm$ 0.03	10
G03417	10.1	0.77 $\pm$ 0.12	5	2.08 $\pm$ 0.05	15
G05117	9.2	0.57 $\pm$ 0.42	16	2.62 $\pm$ 0.15	11
G06417	8.7	0.70 $\pm$ 0.26	11	4.37 $\pm$ 0.05	2
G06317	8.6	0.44 $\pm$ 0.17	—	3.84 $\pm$ 0.04	—
G07317	7.7	0.63 $\pm$ 0.28	14	2.62 $\pm$ 0.06	12
G07317	7.7	0.62 $\pm$ 0.27	—	3.22 $\pm$ 0.06	—
G07117	7.5	0.55 $\pm$ 0.22	17	3.56 $\pm$ 0.03	4
F12517	7.2	0.26 $\pm$ 0.18	20	2.82 $\pm$ 0.14	9
G08617	6.8	0.70 $\pm$ 0.37	2	2.62 $\pm$ 0.05	6
G08617	6.8	0.84 $\pm$ 0.06	—	3.26 $\pm$ 0.05	—
G09217	5.2	0.82 $\pm$ 0.04	3	2.83 $\pm$ 0.04	8
G10307	4.8	0.70 $\pm$ 0.16	—	3.39 $\pm$ 0.07	—
G10317	4.8	0.68 $\pm$ 0.10	12	2.54 $\pm$ 0.01	13
G13217	1.9	0.74 $\pm$ 0.14	9	5.03 $\pm$ 0.15	1
G04117	NT8	0.61 $\pm$ 0.10	15	1.59 $\pm$ 0.03	17
G04217	NT8	0.52 $\pm$ 0.23	18	2.29 $\pm$ 0.04	18

Fig. 1. Rank of *Eisenia foetida* growth in control soil (♦) and in reference (■) and non-reference (●) floodplain sediments from Bear Creek Valley.

Fig. 2. Rank of *Lactuca sativa* growth in control soil (♦) and in reference (■) and non-reference (●) floodplain sediments from Bear Creek Valley.

G.13.3 TOXICITY PROFILES FOR BEAR CREEK

Aluminum

Aluminum (Al) is an ubiquitous metal, being the third most abundant element in the earth's crust (Krueger et al., 1984). It can be highly toxic to aquatic biota under some circumstances, but its toxicity is strongly dependent on pH, hardness, and organic matter content. Aluminum is amphoteric, i.e., it is more soluble in both acidic and basic solutions than in approximately neutral solutions. EPA's water quality criteria for aluminum (EPA, 1988-Al) assume a pH range of 6.5 to 9.0 within which aluminum occurs primarily in the form of monomeric, dimeric, and polymeric hydroxides. Toxicities of aluminum in the field may be substantially lower than indicated by dissolved aluminum analysis values because of complexation with humic and fulvic acids. At pH values below 6.5, however, aluminum may be substantially more toxic than indicated by the EPA criteria because low pH favors the formation and solubilization of cationic aluminum (Al^{3+}).

Toxicity in Water to Aquatic Life Between pH 6.5 and 9.0, acute toxicities of aluminum reported by EPA ranged between 1.9 mg/L for *Ceriodaphnia dubia* and >79.9 mg/L for midge larvae (*Tanytarsus dissimilis*). Acute toxicity tests of aluminum on the nematode, *Caenorhabditis elegans*, ranged from 1.8 to 79 mg/L (Williams and Dusenbery, 1990). Acute toxicities for fish ranged from 3.6 mg/L to >50.0 mg/L. Chronic values for aluminum reported by EPA ranged from 0.742 to 3.288 mg/L.

Aluminum inhibited the growth of *Cyclotella meneghiniana*, a diatom, at 0.810 mg/L and caused mortality at 6.48 mg/L. Concentrations of aluminum ranging from 0.40 to 0.90 mg/L were chronically toxic to the green algae, *Selenastrum capricornutum*.

Estimated steadystate bioconcentration factors for aluminum in brook trout, which were inversely related to pH, were 215 at pH 5.3, 123 at pH 6.1 and 36 at pH 7.2 (Cleveland et. al., 1991). Mortality of fish exposed to aluminum and low pH may be the result of respiratory stress caused by gill damage and mucous clogging of the gill membrane and to the loss of sodium and chloride ions (Brumbaugh and Kane, 1985). Sublethal concentrations of aluminum have been shown to cause histopathological changes in the liver, kidney, skin, muscle, and gills and interfere with reproductive physiology in trout. The acute and chronic NAWQ criteria for the protection of aquatic organisms for aluminum are 0.750 and 0.087 mg/L, respectively.

Toxicity in Soil to Plants The effects of Al in acidic solutions on tree growth has been evaluated by several authors. Norway spruce was more sensitive than Scots pine to Al in solution (pH 3.8) with a 33% reduction in root weight after 21 d at 8.1 ppm Al (5.4 ppm had no effect) (Gorransson and Eldhuset, 1991). Pine shoot growth rate was reduced 40% with 270 ppm, while 162 ppm Al had no effect. Root growth of 1-yr old Douglas fir seedlings in solution with Al added as AlCl_3 (pH 3) was reduced 32% by 32 ppm Al (Keltjens, 1990). Citrus rootstock seedlings grown in nutrient solution with Al added as $\text{Al}_2(\text{SO}_4)_3$ (pH 4) showed equal or greater sensitivity to Al than coniferous evergreen trees. After 60 d, three of the five rootstocks had reduced weight at 8.3 ppm Al (22-45% reductions). Root length of another was decreased 21% at 2.7 ppm Al, and weight of a mandarin rootstock was reduced 30% at 24.4 ppm.

Sensitivities of horticultural and field crops, and grasses have also been tested. Wheeler and Follet (1991) evaluated the effect of Al as $\text{Al}_2(\text{SO}_4)_3$ in solution culture (pH 4.7) on onion, asparagus, and squash growth (approximately 30d). Concentrations reducing growth ranged from 0.05 ppm Al (68% reduction in onion root weight) to 0.27 ppm (25% reduction in squash root weight). McLean

and Gilbert (1927) evaluated the effect of Al in solution culture on carrot, radish, turnip, and beet growth (77 to 126 d). Concentrations reducing growth ranged from 1.8 ppm Al (25% reduction in beet seedling weight) to 7.2 ppm (39% reduction in turnip top weight). Wallace and Romney (1977a) grew rice and soybean seedlings in solution culture containing Al as $\text{Al}_2(\text{SO}_4)_3$ for 13 d. Rice plant weight was reduced 28% by 2.7 ppm Al, and leaf weight of soybeans was reduced 33% by the same concentration. Thirty to 50% reductions in barley weights occurred after 30d growth in solution to which 6 to 10 ppm Al had been added as AlCl_3 (pH 4.3) (MacLeod and Jackson, 1967). Wong and Bradshaw (1982) evaluated the effect of Al on root and shoot length of Rye grass root growth was reduced 29% after 14 d growth in solution (pH 7) with 0.63 ppm Al added as $\text{KAl}(\text{SO}_4)_2$.

Al interferes with cell division in roots, decreases root respiration, fixes P in unavailable forms in roots, interferes with uptake, transport, and use of Ca, Mg, P, K, and water, and interferes with enzyme activities (Foy et al., 1978). Symptoms of toxicity include stubby, brittle roots, stunting, late maturity, and collapse of growing points. Seedlings are more susceptible to damage from Al toxicity than are older plants.

Toxicity to Wildlife Relative to other metals, the toxicity of aluminum is low (Sorensen et al., 1974). The oral LD_{50} for mice ranges from 770 to 980 mg aluminum/kg body weight (Ondreicka et al., 1966). The principal effect of aluminum is to interfere with phosphorous metabolism; in the alimentary canal, aluminum forms insoluble compounds with phosphorous resulting in an imbalance of calcium and phosphorous (Carrerie et al., 1986). Other effects of aluminum include neurotoxicity. Rats exposed to aluminum display behavioral abnormalities and have reduced acetylcholinesterase activity (Krueger et al., 1984). Mice consuming diets containing 500 to 1000 ppm aluminum displayed ataxia and paralysis of the hind limbs (Golub et al., 1987). In humans, aluminum has been associated with several degenerative diseases of the nervous system, including Alzheimer's disease, Parkinson's disease, and amyotrophic lateral sclerosis (Ganrot, 1986).

Ondreicka et al. (1966) evaluated the effects of aluminum on mammalian reproduction. Mice received 19.3 mg aluminum/kg bodyweight/day (as AlCl_3) in drinking water for three generations. While the number of litters and offspring per litter was not reduced, growth was significantly reduced among all offspring in the second and third generations. In a similar study, rats received daily intragastric doses of 0, 180, 360, or 720 mg aluminum/kg body weight/day (Domingo et al., 1987) for one generation. Growth and survival of young was reduced among the groups that received 360 and 720 mg aluminum/kg/day. Other studies also report that while aluminum does not appear to affect the number of litters or number of offspring/litter, growth and survival of offspring of aluminum exposed parents is reduced (Golub et al., 1987; Paternain et al. 1988).

Due to its interference with phosphorous and calcium metabolism, it has been suggested that aluminum may impair eggshell formation by birds, resulting in eggshell thinning (Nyholm, 1981). To test this hypothesis, Carriere et al. (1986) fed breeding ring doves (*Streptopelia risoria*) a diet containing 1000 ppm aluminum (and adequate but reduced calcium and phosphorous) and observed reproduction. While no reproductive effects or embryonic malformations were observed at this dosage level, significant reproductive effects resulted when birds were fed a diet deficient in calcium and phosphorous that contained 750 ppm aluminum. Therefore, among birds it appears that the manifestation of toxic effects of aluminum are dependent upon the nutritional quality of their diet.

Table 1. Toxicity of Aluminum to Aquatic Organisms in circumneutral water.

Concentration (mg/L)	Effect
>79.9	Midge larvae (<i>Tanytarsus dissimilis</i>) LC50
79.0	Nematode (<i>Caenorhabditis elegans</i>) 24hr LC50
>50.0	Green sunfish (<i>Lepomis cyanellus</i>) LC50
>49.8	Yellow perch (<i>Perca flavescens</i>) LC50
>47.9	Channel catfish (<i>Ictalurus punctatus</i>) LC50
40.0	Chinook salmon (<i>Oncorhynchus tshawytsca</i>) LC50
38.2	Cladoceran (<i>Daphnia magna</i>) EC50
35.0	Fathead minnow (<i>Pimephales promelas</i>) LC50
30.6	Snail (<i>Physa</i> sp.) LC50
>23.0	Planaria (<i>Dugasia tigrina</i>) LC50
>22.6	Stonefly (<i>Acroneuria</i> sp.) LC50
22.0	Amphipod (<i>Gammarus pseudolimnaeus</i>) LC50
10.4	Rainbow trout (<i>Oncorhynchus mykiss</i>) LC50
3.69	Cladoceran (<i>Ceriodaphnia</i> sp.) EC50
3.60	Brook trout (<i>Salvelinus fontinalis</i>) LC50
3.29	Fathead minnow (<i>Pimephales promelas</i>) CV
2.0	Nematode (<i>Caenorhabditis elegans</i>) 48hr LC50
1.91	Cladoceran (<i>Ceriodaphnia dubia</i>) CV
1.90	Cladoceran (<i>Ceriodaphnia dubia</i>) EC50
1.90	Nematode (<i>Caenorhabditis elegans</i>) 72hr LC50
1.80	Nematode (<i>Caenorhabditis elegans</i>) 96hr LC50
0.750	Acute NAWQC
0.742	Cladoceran (<i>Daphnia magna</i>) CV
0.0870	Chronic NAWQC

Antimony

Antimony (Sb) is a naturally occurring metalloid element (displaying both metallic and nonmetallic properties) existing in valence states of 3 and 5 (Budavari, 1989; ATSDR, 1990). Metallic antimony and a few trivalent antimony compounds are the most significant regarding exposure potential and toxicity (ATSDR, 1990). Antimony is used in metallurgical processes, paints

and enamels, various textiles, rubber, and fire retardation (antimony trioxide). Some antimonials such as potassium antimony tartrate have been used medicinally as parasiticides (Beliles, 1979)

Toxicity in Sediment to Benthic Invertebrates The data available for the toxicity of antimony in sediment is not available for freshwater organisms. Data from Commencement Bay, Washington indicated that toxicity to both *Rhepoxynius abronius* and the larvae of the oyster *Crassostrea gigas* increased with increasing antimony concentrations in the sediment (Long and Morgan, 1991). Moderate toxicity to both species ranged from 2.0 to 5.5 mg/kg of antimony, whereas sediments that were most highly toxic ranged from 91.5 to 184.3 and 27.5 to 101.5 mg/kg of antimony. However, data collected from San Francisco Bay showed no relation between toxicity to amphipods and antimony concentration. Sediments that were least toxic or not toxic had higher antimony concentrations than sediments that were most toxic or significantly toxic. For example, *R. abronius* mortality (19.2%) was highest at mean antimony concentrations of 4.3 mg/kg, while the lowest mortality (6.8%) for *R. abronius* had higher mean antimony concentrations of 10.9 mg/kg. These data suggest that some other sediment characteristic had a greater influence upon the toxic response than antimony. The suggested Effects Range-Low (ER-L) and Effects Range-Medium (ER-M) values are 2.0 mg/kg and 25 mg/kg, respectively.

Toxicity to Wildlife Antimony is only slowly absorbed from the gastrointestinal tract. Based on animal data, gastrointestinal absorption of antimony was estimated to be 2 to 7% (Felicetti et al., 1974; Gerber et al., 1982). The specific chemical form will determine the absorption efficiency of ingested antimony. The primary target organ for acute oral exposure to antimony appears to be the gastrointestinal tract (irritation, diarrhea, vomiting) and targets for long-term exposure are the blood (hematological disorders) and liver (mild hepatotoxicity) (ATSDR, 1990). Inhalation exposure to antimony affects the respiratory tract (pneumoconiosis, restrictive airway disorders), with secondary targets being the cardiovascular system (altered blood pressure and electrocardiograms) and kidneys (histological changes) (Renes, 1953; Breiger et al., 1954). Only limited evidence exists for reproductive disorders due to antimony exposure (Belyaeva, 1967).

Toxic effects ranging from gastrointestinal disorders to death have been documented for animals following acute oral exposure to antimonials. Bradley and Frederick (1941) reported that a single dose (300 mg Sb/kg) of the organic antimonial, potassium antimony tartrate, induced myocardial infarction and death in rats. However, several studies using inorganic antimonials (metallic antimony, antimony oxide, or antimony trioxide) reported that doses as high as 27,410 mg Sb/kg were not fatal to rats (ATSDR, 1990).

Subchronic (24-week) exposure of rats to metallic antimony at doses of 500 to 1,000 mg/kg/day decreased plasma protein levels, hemoglobin levels, and hematocrit (Sungawa, 1981; Hiraoka, 1986). Sungawa (1981) also reported mild hepatotoxicity in rats receiving 418 mg Sb/kg/day (as antimony trioxide) or 500 mg Sb/kg/day (as metallic antimony). A decrease in red blood cell count was reported by Sungawa (1981) for rats given 418 mg Sb/kg/day (as antimony trioxide) for 24 weeks, and an increase reported by Smyth and Thompson (1945) in rats treated with same compound at a dose of 894 mg Sb/kg/day for 30 days. Fleming (1982) reported that dogs receiving antimony trioxide (6,644 mg Sb/kg/day) for 32 days exhibited severe weight loss, vomiting, and muscle weakness and dyskinesia of the hind limbs. A lower dose (84 mg Sb/kg/day) produced severe diarrhea. Using data from Fleming (1982), ATSDR (1990) reported a no-observed-adverse-effect-level (NOAEL) of 501 mg Sb/kg for rats receiving the compound for 20 days. Exposure of CD-1 mice to potassium antimony tartrate in the drinking water (5 ppm for 540 days) significantly reduced the lifespan of both males and females (Kanisawa and Schroeder, 1969). Schroeder et al. (1968) also provided data showing that long-term exposure of mice to 5 ppm potassium antimony tartrate in the drinking water resulted in decreased lifespan.

Arsenic

Arsenic (As) is present in the earth's crust at approximately 2 ppm. Arsenic may be released into aquatic ecosystems by a variety of sources including electric generating stations, manufacturing companies, mineral or strip mines, and smelting operations. The major agricultural source of arsenic is the manufacture and use of arsenical defoliants and pesticides. Arsenic is known as one of the most toxic elements to fish with acute exposures resulting in immediate death (Sorensen, 1991).

Toxicity in Sediment to Benthic Invertebrates Sediments of Waukegan Harbor, Wisconsin, which had more than 47 mg/kg arsenic caused 34% mortality in *Hyalella azteca*. Sediment from the Sheboygan River, Wisconsin, which had 2.7 mg/kg arsenic caused significant mortality to the freshwater prawn, *Macrobrachium rosenbergii*. However, this sediment also was contaminated with metals and polychlorinated biphenyls (PCBs). At 2 rivers in Illinois, a low number of benthic macroinvertebrate taxa was associated with arsenic concentrations of 7.4 and 3.7 mg/kg. However, a high number of taxa were associated with 5.9 and 5.0 mg/kg arsenic in the same two rivers (studies cited in Long and Morgan, 1991).

Long et al., (1995) reported ER-L and ER-M values of 8.2 and 70 mg/kg, respectively. Only 11% of these documented studies indicated biological effects at concentrations between the ER-L and ER-M, while 63% of the studies at concentrations above the ER-M indicated biological effects. There freshwater NAWQ criteria for the acute and chronic toxicity of arsenic (III) are 0.360 mg/L and 0.19 mg/L (Suter and Mabrey, 1994).

Toxicity in Soil to Plants Mhatre and Chaphekar (1982) found no effect of As(III) (As_2O_3), up to 1 ppm As, on germination of seeds of sorghum, alfalfa, mung bean, cluster bean, and radish. After 5 d, reductions in root length occurred between 0.001 ppm As (29% reduction in cluster bean) and 1 ppm As (55 and 87% reductions in alfalfa and mung bean). The concentrations of As (V), from Na_2HAsO_4 , required for a 50% reduction in seed germination and root length of mustard after 3 d exposure in solution (pH 7.3), was reported by Fargasova (1994) to be 30 ppm. The EC_{50} for root length was 5.5 ppm As.

Arsenic is not essential for plant growth. It is taken up actively by roots, with arsenate being more easily absorbed than arsenite. Arsenic and phosphate ions are likely taken up by the same carrier (Asher and Reay, 1979). The phytotoxicity is strongly affected by the form in which it occurs in soils. Arsenite (III) is more toxic than arsenate (V), and both are considerably more toxic than organic forms (Peterson et al., 1981). In experiments with toxic levels of As, rice and legumes appear to be more sensitive than other plants. Symptoms include wilting of new-cycle leaves, followed by retardation of root and top growth, and leaf necrosis (Aller et al., 1990). As is chemically similar to P, it is translocated in the plant in a similar manner and is able to replace P in many cell reactions. Arsenic (III) probably reacts with sulphydryl enzymes leading to membrane degradation and cell death. Arsenic (V) is known to uncouple phosphorylation and affect enzyme systems (Peterson et al., 1981). The mechanism of toxicity of organo-arsenicals is unclear.

Toxicity to Wildlife Tissues of animals generally contain an average of <0.5 ppm (Venugopal and Luckey, 1978). Arsenic is a carcinogen and teratogen. Other effects include reduced growth, hearing/sight loss, liver/kidney damage, and death (Eisler, 1988a). Inorganic arsenic is usually more toxic than organic arsenic compounds. Arsenic may be a required micronutrient; growth, survival, and reproduction of goats is poor if the diet contains <0.05 ppm As (NAS, 1977). Wildlife mortality and malformations have been observed for chronic doses of 1-10 mg As/kg bw and dietary concentrations of 5-50 ppm (Eisler, 1988a). Acute LD_{50} s for mammals of 35-100 mg calcium

arsenate/kg body weight and 10-50 mg lead arsenate/kg body weight have been reported (NRCC, 1978).

Schroeder and Mitchner (1971) exposed mice to 5 ppm sodium arsenite in drinking water for three generations. While mice fed arsenic survived well, litter size decreased in subsequent generations. A dose of 0.38 mg arsenic/kg over a lifetime was sufficient to cause a slight decrease in the median lifespan of laboratory mice (Schroeder and Balassa, 1967), but it had no effect on growth. As little as 3 mg arsenic trioxide/kg body weight or 1 mg sodium arsenite/kg body weight can be lethal (NAS, 1977).

Because metabolism of arsenic in rats is unlike that in other animals, results of toxicity studies using rats generally should not be extrapolated to other species (Eisler, 1988a).

Among birds, LD₅₀s for arsenic compounds range from 17.4 to 3300 mg/kg bw (Eisler, 1988a). While no mortality was observed among mallard ducks fed a diet containing 100 ppm sodium arsenite for 128 days, 12% to 92% mortality was observed for ducks fed diets containing 250 to 1000 ppm arsenite (USFWS, 1964). Camardese et al. (1990) and Whitworth et al. (1991) fed mallards diets containing 30, 100, or 300 ppm sodium arsenate. While no effects were observed on behavior, growth was reduced for male ducks consuming 300 ppm arsenic and for female ducks at all exposure levels.

Barium

Barium (Ba) is found in the more common mineral forms barite (BaSO₄) and witherite (BaCO₃) (Oehme, 1979). Barium fluorosilicate and carbonate are forms often used as pesticides. Approximately 400 ppm of barium is found in the earth's crust. Some plants accumulate barium from the soil. Barium has industrial applications in areas such as paper manufacturing, fabric printing and dyeing, and synthetic rubber production. Barium in groundwater has been found to range from 0 to over 20 mg/L (Gilkeson et al., 1983)

Toxicity in Water to Aquatic Life There is relatively little information of the aquatic toxicity of barium, and none has been found for fish. Biesinger and Christensen (1972) reported a 48-hr LC₅₀ of 14.5 mg/L without food added. The CV of 5.8 mg/L, resulting in 16% reproductive impairment, was based on a 3-week toxicity test on *Daphnia magna*. LeBlanc (1980; cited in Suter and Mabrey, 1994) reported an acute value of 410 mg/L for the water flea, *Daphnia magna*. The lowest acute value of 0.33 mg/L for the Gastropod snail was reported by Vareille-Morel (1990; cited in Suter and Mabrey, 1994). In marine water barium sulfate and chloride were lethal to yellow crabs (*Cancer anthonyi*) in 7-d exposures at 1,000 and 100 mg/L, respectively (MacDonald et al., 1988). Barium inhibited growth of duckweed by 50% at 102 to 400 mg/L in various ambient waters (Wang, 1988). Barium inhibited calcification of the freshwater green alga *Goeotaenium* at 50.0 mg/L (Prasad, 1984). The state of Illinois has a water quality standard for indigenous aquatic life of 5.0 mg/L (Wang, 1988). Barium is bioconcentrated from water by algae and vascular plants, but is not bioaccumulated through food chains (Moore, 1991).

Toxicity in Sediment to Benthic Invertebrates The benchmarks used for barium are based on background because sediment toxicity data were not found (Hull and Suter, 1994). The EPA Region V Sediment Classifications of Nonpolluted (less than 20 mg/kg), Moderately Polluted (between 20 and 60 mg/kg), and Heavily Polluted (greater than 60 mg/kg) are poorly founded scientifically and considered adequate only for determining the suitability of dredged material for open water disposal.

Boron

Boron (B) is found in the earth's crust at an average concentration of 16 ppm (Oehme, 1979). Borax ($\text{Na}_2\text{B}_4\text{O}_7$), the most important mineral, is used in soldering and welding to remove oxide film, for softening water, in soaps, and in glass, pottery, and enamels. Boron is found in natural water supplies and is essential to plants.

Toxicity in Water to Aquatic Life Relatively little aquatic toxicity information is available for boron. The only standard data are LC50s and CVs for *Daphnia magna* exposed to boric acid in relatively hard water. Lewis and Valentine (1981) reported a 48-hr LC50 of 226 mg/L and a CV of 8.83 mg/L of boron. The no kill concentration was <200 mg/L of boron. Gersich (1984) reported a LC50 of 133 mg/L and a CV of 9.33 mg/L. Toxic concentrations from nonstandard and poorly documented tests fall within this range.

Cadmium

While there is little information to indicate that this relatively rare metal is biologically essential or beneficial, Cd has been suggested as the cause of various deleterious effects to wildlife (Eisler 1985a). Mammals and birds are comparatively resistant to the biocidal properties of Cd, which include growth retardation, anemia, and testicular damage. Cd tends to bioaccumulate the liver and kidney, eventually acting as a cumulative toxin. Cd residues of 2 ppm whole body fresh weight are evidence of Cd contamination, and residues >5 ppm whole animal fresh weight may be life-threatening (Eisler 1985a).

The lowest oral dose resulting in death for rats was 250 mg Cd/kg body weight (EPA 1980a). Weigel et al. (1987) fed rats 0.24, 0.85, or 2.25 mg/kg Cd in diet for 8 weeks. Concentrations ≥ 0.85 mg/kg resulted in reduced food intake, reduced body weights, and reduced enzyme activity, but no hematological effects were noted. Ma et al. (1991) determined that an average cadmium intake of 15 mg/kg/day corresponded with critical renal metal loads of 120 mg/kg, a level indicative of adverse health effects. Rats on a diet with 5 ppm Cd suffered shortened lifespans (Schroeder et al. 1965). Cd at 50 ppm in the diet depleted iron from rat livers (Whanger 1973). Rats eating diets with 7.15 ppm Cd (as CdO) exhibited growth reductions, but those consuming a diet with 2.80 ppm Cd did not (Weigel et al. 1984). In a 3 generation reproductive study, the population of mice exposed to 1 ppm CdCl_2 in their drinking water died out after the second generation (Schroeder and Mitchner 1971). Rats receiving >6 mg Cd/kg body weight daily during pregnancy gave birth to malformed fetuses (Ferm and Layton 1981).

No mortality was observed among adult mallard ducks fed diets containing 0, 2, 20, and 200 ppm Cd, however egg production was significantly reduced in the group consuming 200 ppm Cd (White and Finley 1978). In addition, the testes of males in the 200 ppm Cd group atrophied and the spermatogenic process was disrupted (White et al. 1978). Among mallard ducklings, 20 ppm Cd in the diet produces mild to severe kidney lesions, reduces packed cell volume and hemoglobin concentrations in the blood (Cain et al. 1983). Avoidance behavior of black ducklings is impaired by diets containing 40 ppm Cd (Heinz and Haseltine 1983).

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Table 2. Toxicity of Cadmium to Aquatic Organisms.

Concentration (mg/L)		Effect
100 mg/L hardness	200 mg/L hardness	
24.6	72.8	goldfish (<i>Carassius auratus</i>) LC50
18	18	stonefly LC50 ^a
17.7	38.7	mayfly (<i>Ephemera grandis</i>) LC50
17.3	37.8	Tubificid worm (<i>Rhyacodrilus montana</i>) LC50
16.8	36.7	mosquitofish (<i>Gambusia affinis</i>) LC50
16.5	36	white perch (<i>Morone americana</i>) LC50
15.1	33	Tubificid worm (<i>Stylodrilus heringlanus</i>) LC50
12.7	23.2	bluegill (<i>Lepomis macrochirus</i>) LC50
12.5	27.3	channel catfish (<i>Ictalurus punctatus</i>) LC50
12.4	27	Tubificid worm (<i>Spirosperma nikolskyl</i>) LC50
10.9	23.8	threespine stickleback (<i>Gasterosteus aculeatus</i>) LC50
10.4	22.8	Tubificid worm (<i>Varichaeta pacifica</i>) LC50
9.62	21.02	Tubificid worm (<i>Spirosperma ferox</i>) LC50
8.79	19.22	Tubificid worm (<i>Quistadrilus multisetosus</i>) LC50

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Table 2 (continued)

Concentration (mg/L)		Effect
100 mg/L hardness	200 mg/L hardness	
8.79	19.22	Tubificid worm (<i>Tubifex tubifex</i>) LC50
8.3	18.15	snail (<i>Amicola</i> sp.) LC50
7.8	17.5	guppy (<i>Poecilia reticulata</i>) LC50
7.68	16.79	white sucker (<i>Catostomus commersoni</i>) LC50
7.43	16.24	caddisfly LC50
6.86	12.85	green sunfish (<i>Lepomis cyanellus</i>) LC50
6.59	14.41	Tubificid worm (<i>Branchiura sowerbyi</i>) LC50
6.31	13.79	flagfish (<i>Jordanella floridae</i>) LC50
5.24	11.46	northern squawfish (<i>Ptychocheilus oregonensis</i>) LC50
5.05	11.04	mayfly (<i>Paraleptophlebia praepedita</i>) LC50
4.67	10.21	Tubificid worm (<i>Limnodrilus hoffmeisteri</i>) LC50
3.71	8.12	worm (<i>Nais</i> sp.) LC50
2.94	6.43	pumpkinseed (<i>Lepomis gibbosus</i>) LC50
2.62	5.73	midge (<i>Chironomus</i> sp.) LC50
1.61	3.52	American eel (<i>Anguilla rostrata</i>) LC50
0.875	1.913	isopod (<i>Asellus bicrenata</i>) LC50
0.705	1.542	crayfish (<i>Orconectes limosus</i>) LC50
0.484	1.06	bryozoan (<i>Plumatella emarginata</i>) LC50
0.471	1.03	common carp (<i>Cyprinus carpio</i>) LC50
0.448	0.979	amphipod (<i>Hyaella azteca</i>) LC50
0.343	0.749	snail (<i>Physa gyrina</i>) LC50
0.311	0.681	bryozoan (<i>Pectinatella magnifica</i>) LC50
0.227	0.497	snail (<i>Aplexa hypnorum</i>) LC50
0.216	0.472	banded killifish (<i>Fundulus diaphanus</i>) LC50
0.181	0.397	<i>Ceriodaphnia reticulata</i> EC50
0.153	0.334	amphipod (<i>Gammarus</i> sp.) LC50
0.132	0.288	amphipod (<i>Gammarus pseudolimnaeus</i>) LC50
0.122	0.266	<i>Daphnia pulex</i> EC50
0.1	0.219	cladoceran (<i>Simocephalus serralatus</i>) EC50
0.0935	0.2044	isopod (<i>Lirceus alabamiae</i>) LC50
91	0.1989	cladoceran (<i>Simocephalus vetulus</i>) EC50

Table 2 (continued)

Concentration (mg/L)		Effect
100 mg/L hardness	200 mg/L hardness	
0.0891	0.1948	cladoceran (<i>Molina macrocopa</i>) EC50
0.072	0.1699	fathead minnow (<i>Pimephales promelas</i>) LC50
0.0667	0.1459	bryozoan (<i>Lophopodella carteri</i>) LC50
0.0281	0.0485	bluegill (<i>Lepomis macrochirus</i>) CV
0.0266	0.0582	<i>Daphnia magna</i> EC50
0.0262	0.0452	fathead minnow (<i>Pimephales promelas</i>) CV
0.0141	0.0243	Atlantic salmon (<i>Salmo salar</i>) CV
0.0141	0.0243	smallmouth bass (<i>Micropterus dolomieu</i>) CV
0.014	0.0242	Northern pike (<i>Esox lucius</i>) CV
0.014	0.0242	lake trout (<i>Salvelinus namaycush</i>) CV
0.0135	0.0233	white sucker (<i>Catostomas commersoni</i>) CV
0.0129	0.0282	coho salmon (<i>Oncorhynchus kisutch</i>) LC50
0.0127	0.0219	brown trout (<i>Salmo trutta</i>) CV
0.0093	0.02032	chinook salmon (<i>Oncorhynchus tshawytscha</i>) LC50
0.0092	0.01586	flagfish (<i>Jordanella floridae</i>) CV
0.00834	0.01438	snail (<i>Aplexa hypnorum</i>) CV
0.00784	0.01714	rainbow trout (<i>Oncorhynchus mykiss</i>) LC50
0.00739	0.01274	coho salmon (<i>Oncorhynchus kisutch</i>) CV
0.00678	0.01168	cladoceran (<i>Ceriodaphnia reticulata</i>) CV
0.00464	0.008	chinook salmon (<i>Oncorhynchus kisutch</i>) CV
0.00407	0.00701	brook trout (<i>Salvelinus fontinalis</i>) CV
0.0039	0.0086	acute NAWQC
0.00358	0.00782	brown trout (<i>Salmo trutta</i>) LC50
0.0011	0.002	chronic NAWQC
0.00033	0.00057	cladoceran (<i>Molna macrocopa</i>) CV
0.000233	0.000401	cladoceran (<i>Daphnia magna</i>) CV

* The stonefly acute test did not specify the hardness of the water.

Calcium

Calcium (Ca) is the third most abundant metal and makes up an average concentration of 3.64 ppm of the earth's crust. It is an essential nutrient and occurs in surface waters primarily as calcium carbonate (CaCO₃). Calcium, as dissolved cations in freshwater, is chiefly responsible for

water hardness and reduces the toxicity of several other metals (Rand and Petrocelli, 1985). Calcium, essential to plant and animal life, is present in bones, teeth, eggshell, coral, and many soils. Calcium is non-toxic to plants even at high concentrations and is effective in detoxifying high concentrations of other mineral elements in plants (Marschner, 1986).

Toxicity in Water to Aquatic Organisms Although calcium is not known to be toxic in ambient waters, acute and chronic toxicity values for *Daphnia magna* were determined in laboratory tests by Biesinger and Christensen (1972). The 48-hr LC50s were 464.0 and 52.0 mg/L with and without food added, respectively. Chronic (3 week) exposure to 11.6 mg/L with food added caused a 16% decrease in reproduction. The tests conducted with calcium chloride, which is likely to result in a higher rate of dissociation than calcium carbonate. Therefore, measured concentrations of calcium carbonate in ambient waters are likely to over estimate the Ca(II) fraction. There are no NAWQ criteria for calcium.

Chromium

Chromium occurs as either chromium (III) or chromium (VI). Trivalent chromium is an essential metal in man and wildlife, playing an important role in insulin metabolism (Larngard and Norseth, 1979). Hexavalent chromium is more toxic than chromium (III) because of its high oxidation potential and the ease with which it penetrates biological membranes (Steven et al., 1979; Taylor and Parr, 1978). However, it is unlikely that all chromium in soil would be chromium (VI) because it is a highly oxidizing chemical species which is usually reduced by soil organic matter to chromium (III). Chromium (III) solubility decreases with increasing pH, and it is completely precipitated at a pH above 5.5. In most soils, chromium is primarily present as precipitated chromium (III) and is not bioavailable. Most chromium in soil and sediments is unavailable to living organisms, and there is little evidence of chromium biomagnifying through food chains in its inorganic form (Eisler, 1986).

Toxicity in Sediment to Benthic Organisms. There is relatively little consistency in the effects data presented in the NOAA report (Long and Morgan, 1991). This may be due to the lack of chromium speciation data in the NOAA studies. All of the data were reported as total chromium, whereas the hexavalent form has been reported to be the most toxic. In Lake Union, Washington, a concentration of 20 mg/kg resulted in 95% mortality of *Hyaella azteca*. However, in the Dupage and Kishwaukee rivers in Illinois chromium levels of 34 and 29 mg/kg, respectively, had the highest number of benthic macroinvertebrate taxa, while concentrations of 60 and 43 mg/kg, respectively, has the lowest number of benthic macroinvertebrate taxa. In the Keweenaw Waterway of Michigan, 36 mg/kg of chromium was not toxic to *Daphnia magna*, but levels of 109 mg/kg were significantly toxic. In Torch Lake, Michigan, concentrations of 180 mg/kg of chromium resulted in significant mortality to *Daphnia magna* and *Hexagenia sp.* (studies cited in Long and Morgan, 1991). Long et al., (1995) reported ER-L and ER-M values of 81 and 370 mg/kg for chromium. The incidence of adverse effects was 95% in the probable-effects range for chromium, however, the incidence of effects in the probable-effects range was greatly influenced and exaggerated by data from multiple tests conducted in only two field surveys.

Toxicity to Wildlife At high concentrations, chromium is a mutagen, teratogen and carcinogen (Eisler, 1986). The LD₅₀ for chromium (III) in mice is 260 mg/kg bw and 5 mg/kg bw for chromium (VI) (Steven et al., 1976). Rats fed chromium (VI) reached a toxic threshold at 1000 ppm (Steven et al., 1976). Pregnant hamsters injected with 5 to 15 mg CrO₃ [chromium (VI)]/kg bw displayed a dose-dependent increase in the number of resorbed and malformed fetuses (Gale, 1978). Guinea pigs fed 50 ppm chromium (III) for 21 weeks showed no adverse effects

(Preston et al., 1976). Similar results were observed among rats consuming water containing 25 ppm chromium (VI) for 1 year (Mackenzie et al., 1958).

Injection of 0.002 to 0.05 mg CrO_3 [chromium (VI)]/chicken egg produced a dose-dependent decrease in egg viability and increased frequency of malformed embryos (Gilani and Marano, 1979). In contrast, adult black ducks fed a diet containing 0, 10, or 50 ppm chromium (III) for 10 months displayed normal growth and reproduction (Haseltine et al., unpublished manuscript). While no malformations were observed among ducklings from treated birds, growth and survivorship was reduced. Heinz and Haseltine (1981) observed no effects on avoidance behavior of black ducklings fed a diet containing 20 or 200 ppm chromium (III).

Cobalt

Cobalt (Co), a hard, silvery white metal, is strategically important in the production of high-temperature alloys and permanent magnets (Brobst and Pratt, 1973). It is found in the earth's crust at an average concentration of 20 ppm. Cobalt is an essential element making up approximately one-half of the contents of vitamin B12 which is necessary in the prevention of pernicious anemia (Oehme, 1979).

Toxicity in Water to Aquatic Life Comparatively little is known about the toxicity of cobalt. Acute and chronic toxicity tests using fathead minnows (*Pimephales promelas*) and *Daphnia magna* were conducted in relatively hard water (Kimball, date unknown). Acute toxicity values for cobalt ranged from 3.61 mg/L for fathead minnows to 6.68 mg/L for *D. magna*. Chronic toxicity values ranged from .0011 mg/L for fathead minnows to 0.0051 mg/L for *D. magna*. Biesinger and Christensen (1972) reported 48-hr LC50's of 1.11 and 1.62 mg/L with and without food added, respectively. Chronic (3 week) exposure to 0.010 mg/L with food added caused a 16% decrease in reproduction.

Copper

Copper occurs in natural waters primarily as the divalent cupric ion in free and complexed forms (EPA 1985-Cu). Copper is a minor nutrient for both plants and animals at low concentrations, but is toxic to aquatic life at concentrations only slightly higher. Concentrations of 0.001 to 0.010 mg/L are usually reported for unpolluted surface waters in the United States. Common copper salts, such as the sulfate, carbonate, cyanide, oxide, and sulfide are used as fungicides, as components of ceramics and pyrotechnics, for electroplating, and for numerous other industrial applications (ACGIH, 1986). The largest anthropogenic releases of copper to the environment result from mining operations, agriculture, solid waste, and sludge from sewage treatment plants.

Toxicity in Water to Aquatic Life The toxicity of copper to aquatic life is related primarily to activity of the cupric (Cu^{2+}) ion, and possibly to the hydroxy complexes. The cupric ion is highly reactive, forms moderate to strong complexes and precipitates with inorganic and organic constituents (e.g., carbonate, phosphate, amino acids), and is readily sorbed onto surfaces of suspended solids. The proportion of free cupric ion may be less than 1 percent in eutrophic waters where complexation predominates. These complexes appear to be much less toxic than free cupric ions, thus reducing toxicity. Hence, even dissolved copper measurements may overestimate copper exposure relative to laboratory test waters due to dissolved organic and inorganic ligands (EPA 1985-Cu; Benson et al., 1994).

Toxicity of copper appears to be a function of calcium hardness and associated carbonate alkalinity. Therefore, the concentrations in Table 3 are corrected for hardness of 100 and 200 mg/L. The sensitivities of the aquatic plants are highly variable, bracketing those of animals. Copper is not known to be appreciably bioaccumulated by fish, but some algae and bivalve molluscs do bioconcentrate or bioaccumulate copper by factors of over 1000 (EPA 1985-Cu).

Toxicity in Sediments to Benthic Organisms A concentration of 156 mg/kg Cu caused 95% mortality to *Hyalella azteca* at Lake Union, Washington. In Waukegan Harbor, Illinois, there was 34% mortality to the same species at a concentration of 19.5 mg/kg. In Illinois, a high number of benthic invertebrate taxa were found in one river with a sediment copper concentration of 62 mg/kg; although another Illinois river had a high number of taxa at 19.5 mg/kg and a low number of taxa at a concentration of 45 mg/kg (studies cited in Long and Morgan, 1991). Long et al., (1995) reported ER-L and ER-M values of 34 and 270 mg/kg for copper. Confidence in these values is high because 84% of the studies at concentrations above the ER-M indicated biological effects.

Toxicity in Soil to Plants The effect of Cu on stem diameter increase and plant weight of red pine, maple, dogwood, and honeysuckle was examined by Heale and Ormrod (1982). All seedlings (90-d old) grown for 110 d in nutrient solution containing 4 ppm Cu from CuSO_4 (lowest concentration tested) were affected. Reductions in rate of stem diameter increase and in plant weight were 41 and 50%, 79 and 67%, and 97 and 74% for maple, dogwood, and honeysuckle, respectively. Red pine experienced a 28% decrease in plant weight at 4 ppm Cu but the stem diameter increase was unaffected up to 20 ppm Cu (highest concentration tested).

Wong and Bradshaw (1982) measured a 71% reduction in length of longest root in rye grass grown for 14 d in nutrient solution (pH 7) to which 0.031 ppm Cu as CuSO_4 was added (lowest concentration tested). After 4 d, root length of rice seedlings was reduced 64% by 64 ppm Cu (6.4 ppm had no effect) added as CuSO_4 to nutrient solution (Gupta and Mukherji, 1977).

Maize seedlings germinated and grown for 10 d in solution containing CuSO_4 had a 40% reduction in total fresh weight in the 0.06 ppm Cu treatment (lowest concentration tested) (Stiborova et al., 1986). This same concentration caused a 45% reduction in root weight of chrysanthemums grown for 21 d in nutrient solution with CuSO_4 added (Patel et al., 1976).

Copper is a micronutrient essential for plant nutrition. It is required as a co-factor for many enzymes and is an essential part of a copper protein involved in photosynthesis. Copper occurs as part of enzymes and enzyme systems. Root absorption appears to be passive, perhaps in organo-copper complexes (Jarvis and Whitehead, 1983), and active through a specific carrier (Fernandes and Henriques, 1991). Copper may be deficient in low-copper soils because the metal is adsorbed to cells in the root system. The form in which it is taken into the root affects its binding there (Wallace and Romney, 1977b). Copper can be transported in the xylem and phloem of plants complexed with amino acids.

The most common toxicity symptoms include reduced growth, poorly developed root system, and leaf chlorosis (Wong and Bradshaw, 1982). The basic deleterious effect of Cu is related to the root system where it interferes with enzyme functioning (Mukherji and Das Gupta, 1972). It also strongly interferes with photosynthesis and fatty acid synthesis (Smith et al., 1985).

Toxicity to Wildlife Copper is a component of a number of metalloenzymes such as catalase, peroxidases, and cytochrome oxidase and is essential for the utilization of iron (Goyer, 1991; Stokinger, 1981). Although most copper salts occur in two valence states, as cuprous (Cu^+) or cupric (Cu^{2+}) ions, the biological availability and toxicity of copper is most likely associated with

the divalent state (ATSDR, 1990). Copper sulfate is the most common copper salt. Copper is soluble in nitric acid and hot sulfuric acid, very slightly soluble in hydrochloric acid and ammonia, and insoluble in water (Stokinger, 1981).

The metabolism of copper involves mainly its transfer to and from various organic ligands, most notably sulfhydryl and imidazole groups on amino acids and proteins (ATSDR, 1990). The liver is one of the main organs involved in the storage and metabolism of copper. Absorption of ingested copper occurs primarily in the upper gastrointestinal tract (EPA, 1987c). Soluble copper compounds (oxides, hydroxides, citrates) are readily absorbed but water-insoluble compounds (sulfides) are poorly absorbed (Venugopal and Luckey, 1978). Zinc, molybdenum, and other metals may decrease dietary copper absorption (USAF, 1990).

In animal studies, oral exposure to copper caused hepatic and renal accumulation of copper, liver and kidney necrosis at doses of ≥ 100 mg/kg/day, and hematological effects at doses of 40 mg/kg/day (EPA, 1986; Haywood, 1985; Rana and Kumar, 1978; Gopinath et al., 1974; Kline et al., 1971). Oral or intravenous administration of copper sulfate can increase fetal mortality and developmental abnormalities in experimental animals (Lecyk, 1980; Ferm and Hanlon, 1974). Rat oral LD₅₀ values for various copper compounds are 140 mg/kg for copper chloride (CuCl₂); 470 mg/kg for copper oxide (Cu₂O); 940 mg/kg for copper nitrate (Cu(NO₃)₂·3H₂O); and 960 mg/kg for copper sulfate (CuSO₄·5 H₂O) (Stokinger, 1981). Deaths in animals given lethal doses of copper have been attributed to extensive hepatic centrilobular necrosis (USAF, 1990).

In a 90-day subchronic study with copper cyanide (CuCN), high mortality, attributed to hemolytic anemia, was seen in both male and female rats receiving 50 mg/kg/day by gavage, but not in those receiving ≤ 5 mg/kg/day (EPA 1986c). In general, male rats appeared to be more sensitive to the effects of CuCN than female rats. Rats receiving 500 ppm copper in their diet (about 5 mg/day) appeared normal, while rats receiving 1000 ppm exhibited depressed growth, those at 2000 ppm hardly grew at all, and those on a 4000 ppm diet lost weight rapidly and died (Boyden et al., 1938). Salt licks containing 5–9% copper sulfate caused anorexia, hemolytic anemia, icterus, and hemoglobinuria, followed by death within 2 days in sheep using the licks (Gopinath et al., 1974). The estimated ingested dose was 40–49 g over a 25- to 86-day period. Lecyk (1980) observed reduced litter size, decreased fetal weights, and skeletal abnormalities in the offspring of mice fed diets supplemented with 3000 or 4000 ppm copper sulfate (155 or 207 mg copper/kg/day, respectively) for one month prior to gestation and on days 0–19 of gestation.

Aulerich et al., (1982) reported an increased mortality rate in the offspring of minks fed a diet supplemented with >3 mg copper/kg/day as copper sulfate for 50 weeks. Although kit mortality was greater and litter mass was reduced relative to controls, reproductive performance of mink fed diets supplemented with up to 200 ppm copper for 357 days was within the normal range for the species (Aulerich et al., 1982). Lifetime exposure to 42.4 mg copper/kg/day (as copper gluconate) in drinking water caused a 12.8% decrease in the maximal lifespan in mice (Massie and Aiello, 1984).

Domestic chicks on diets ≥ 324 ppm copper grew slowly; mortality increased with dietary copper concentrations of 1270 ppm (Mayo et al., 1956). Arthur et al., (1958) observed no ill effects in chicks fed ≤ 500 ppm copper in diet up to 8 weeks of age. Dietary copper levels from 588–1176 ppm for 10 weeks exerted a toxic effect on chick growth; the minimum toxic level of copper appeared to be about 500 ppm (Mehring et al., 1960). Turkey poults tolerated 676 ppm copper in starter diets for 21 days with no deleterious effects, but copper was definitely toxic at levels >1620 ppm (Vohra and Kratzer, 1968). Chickens given a daily dose of >70 mg/kg of CuCO₃ died while those receiving <60 mg/kg exhibited slight symptoms of copper poisoning but survived (Pullar,

1940). No symptoms of copper poisoning were observed in domestic mallards ingesting ≤ 29 mg/kg/day of CuCO_3 , but daily intakes ≥ 55 mg/kg/day were toxic (Pullar, 1940).

Table 3. Toxicity of Copper to Aquatic Organisms.

Concentration (mg/L)		Effect
100 mg/L hardness	200 mg/L hardness	
19.6757	37.8060	Stonefly (<i>Acroneuria lycorias</i>) LC50
11.2597	21.6351	White perch (<i>Morone americana</i>) LC50
8.2719	15.8940	American eel (<i>Anguilla rostrata</i>) LC50
3.8237	7.3471	Crayfish (<i>Procambarus clarkii</i>) LC50
3.6066	6.9299	Snail (<i>Campeloma decisum</i>) LC50
2.6843	5.1577	Crayfish (<i>Orconectes limosus</i>) LC50
1.7293	3.3228	Snail (<i>Amnicola</i>) LC50
1.6653	3.1999	Blacknose dace (<i>Rhinichthys atratulus</i>) LC50
1.6653	3.1999	Rainbow darter (<i>Etheostoma caeruleum</i>) LC50
1.6134	3.1002	Creek chub (<i>Semotilus atromaculatus</i>) LC50
1.7434	2.9887	Bluegill (<i>Lepomis macrochirus</i>) LC50
1.5191	2.9189	Banded killifish (<i>Fundulus diaphanus</i>) LC50
1.3414	2.5774	Brown bullhead (<i>Ictalurus nebulosus</i>) LC50
1.3149	2.5264	Mozambique tilapia (<i>Tilapia mossambica</i>) LC50
1.2315	2.3662	Pumpkinseed (<i>Lepomis gibbosus</i>) LC50
0.6375	1.2250	Striped shiner (<i>Notropis chrysocephalus</i>) LC50
0.4663	0.8960	Worm (<i>Lumbriculus variegatus</i>) LC50
0.4492	0.8632	Sockeye salmon (<i>Oncorhynchus nerka</i>) LC50
0.4423	0.8499	Orangethroat darter (<i>Etheostoma spectabile</i>) LC50
0.3207	0.8254	Guppy (<i>Poecilia reticulata</i>) LC50
0.3789	0.7281	Midge (<i>Chironomus tentans</i>) LC50
0.3778	0.7258	Atlantic salmon (<i>Salmo salar</i>) LC50
0.3768	0.7240	Mosquitofish (<i>Gambusia affinis</i>) LC50
0.3217	0.6180	Northern squawfish (<i>Ptychocheilus oregonensis</i>) LC50
0.3193	0.6136	Snail (<i>Goniobasis livescens</i>) LC50
0.2644	0.6053	Fathead minnow (<i>Pimephales promelas</i>) LC50
0.3019	0.5800	Goldfish (<i>Carassius auratus</i>) LC50
0.3013	0.5789	Common carp (<i>Cyprinus carpio</i>) LC50
0.2594	0.4984	Bryozoan (<i>Pectinatella magnifica</i>) LC50

Table 3 (continued)

Concentration (mg/L)		Effect
100 mg/L hardness	200 mg/L hardness	
0.2556	0.4910	Chiselmouth (<i>Acrocheilus alutaceus</i>) LC50
0.2121	0.4076	Brook trout (<i>Salvelinus fontinalis</i>) LC50
0.1729	0.3323	Worm (<i>Nais</i>) LC50
0.1509	0.2900	Central stoneroller (<i>Campostoma anomalum</i>) LC50
0.1387	0.2664	Bluntnose minnow (<i>Pimephales notatus</i>) LC50
0.1350	0.2594	Coho salmon (<i>Oncorhynchus kisutch</i>) LC50
0.1270	0.2441	Northern pike (<i>Esox lucius</i>) CV
0.1217	0.2234	Cutthroat trout (<i>Salmo clarki</i>) LC50
0.1080	0.2075	Snail (<i>Gyraulus circumstriatus</i>) LC50
0.1020	0.1960	Tubifed worm (<i>Limnodrilus hoffmeisteri</i>) LC50
0.0828	0.1590	Snail (<i>Physa integra</i>) LC50
0.0787	0.1457	Rainbow trout (<i>Salmo gairdneri</i>) LC50
0.0712	0.1368	Bryozoan (<i>Lophodella carteri</i>) LC50
0.0712	0.1368	Bryozoan (<i>Plumatella emarginata</i>) LC50
0.0690	0.1326	Snail (<i>Physa heterostrophia</i>) LC50
0.0656	0.1260	Brook trout (<i>Salvelinus fontinalis</i>) CV
0.0649	0.1247	Brown trout (<i>Salmo trutta</i>) CV
0.0642	0.1234	Lake trout (<i>Salvelinus namaycush</i>) CV
0.0615	0.1182	Bluegill (<i>Lepomis macrochirus</i>) CV
0.0576	0.1108	Midge (<i>Chironomus</i>) LC50
0.0553	0.1063	Amphipod (<i>Gammarus pulex</i>) LC50
0.0645	0.0983	Chinook salmon (<i>Oncorhynchus tshawytscha</i>) LC50
0.0488	0.0939	Cladoceran (<i>Ceriodaphnia pulex</i>) EC50
0.0436	0.0900	Cladoceran (<i>Ceriodaphnia magna</i>) EC50
0.0439	0.0844	White sucker (<i>Catostomus commersoni</i>) CV
0.0434	0.0835	Fathead minnow (<i>Pimephales promelas</i>) CV
0.0424	0.0816	Amphipod (<i>Gammarus pseudolimnaeus</i>) LC50
0.0400	0.0769	Rainbow trout (<i>Salmo gairdneri</i>) CV
0.0393	0.0756	Fathead minnow (<i>Pimephales promelas</i>) CV
0.0370	0.0710	Caddisfly (<i>Clistornia magnifica</i>) CV
0.0361	0.0693	Cladoceran (<i>Ceriodaphnia reticulata</i>) EC50

Table 3 (continued)

Concentration (mg/L)		Effect
100 mg/L hardness	200 mg/L hardness	
0.0296	0.0568	Chinook salmon (<i>Oncorhynchus tshawytscha</i>) CV
0.0273	0.0524	Brook trout (<i>Salvelinus fontinalis</i>) CV
0.0236	0.0454	Snail (<i>Campeloma decisum</i>) CV
0.0236	0.0454	Snail (<i>Physa integra</i>) CV
0.0039	0.0086	NAWQC Acute Value
0.0144	0.0277	Fathead minnow (<i>Pimephales promelas</i>) CV
0.0296	0.0249	Cladoceran (<i>Daphnia magna</i>) CV
0.0129	0.0247	Amphipod (<i>Gammarus pseudolimnaeus</i>) CV
0.0150	0.0243	Cladoceran (<i>Ceriodaphnia pulicaria</i>) EC50
0.0183	0.0219	Fathead minnow (<i>Pimephales promelas</i>) CV
0.0011	0.002	NAWQC Chronic Value
0.0098	0.0188	Brook trout (<i>Salvelinus fontinalis</i>) CV
0.0115	0.0097	Cladoceran (<i>Daphnia magna</i>) CV
0.0115	0.0097	Cladoceran (<i>Daphnia magna</i>) CV
0.0047	0.0091	Bluntnose minnow (<i>Pimephales notatus</i>) CV

^a McKim et al. (1978)^b Arthur and Leonard (1970)^c Chapman et al. n.d.^d McKim and Benoit (1971)^e Mount (1968), Mount and Stephan (1969)^f Benoit (1975)^g Nebeker et al. (1984)^h Horning and Neiheisel (1979)

Cyanide

Cyanide found in water may occur in the form of hydrocyanic acid (HCN), the cyanide ion (CN⁻), simple cyanides, metalocyanide complexes, and as simple chain and complex ring organic compounds. Free cyanide (CN), defined as the sum of the cyanides present as HCN and as CN⁻, is the primary toxic agent of concern. Although HCN has the highest toxicity of the two forms, CN⁻ may readily convert to HCN (Eisler et al., 1991). Various cyanides found in the aquatic environment can be modified by water pH, temperature, and oxygen content. For example, when pH is <8 and the temperature is <25°C, at least 94 percent of the free cyanide exists as HCN. When pH and/or temperature are higher, a greater percentage of free cyanide exist as CN⁻ (EPA, 1984-CN).

Toxicity in Water to Aquatic Life The following cyanide concentrations are expressed as free cyanide (CN), because it is the more reliable index of toxicity to aquatic life. Acute toxicity values for aquatic animals range between 0.04473 and 2.490 mg/L. The LC₅₀ for the fathead minnow

(*Pimephales promelas*) was reported at 0.1251 mg/L. Fish were found to be the most sensitive aquatic organisms. Juveniles of the more sensitive fish appear even more sensitive as temperature is reduced. This sensitivity is related to the life stage and species of the fish. Embryos, sac fry, and warmwater species were found to be the most resistant, with the embryos of fathead minnows even less sensitive than other aquatic organisms. Concentrations between 0.005 and 0.0072 mg/L of cyanide showed adverse effects on swimming and reproduction, with lethal effects on the sensitive fish occurring between 0.020 and 0.076 mg/L (Eisler et al., 1991). Chronic toxicity values for aquatic animals range between 0.007849 and 0.03406 mg/L. The CV for fathead minnows (*Pimephales promelas*) were reported at 0.01639 mg/L. Reduced reproduction was the most sensitive adverse effect of cyanide on the fathead minnow. Adverse effects of cyanide on plants are unlikely at concentrations that were found to cause acute effects in aquatic animals. The natural sources of cyanide include various bacteria, algae, fungi, and higher plants. These higher plants may be adversely affected by cyanide through cytochrome oxidase inhibition (Eisler et al., 1991).

Studies of bioaccumulation and biomagnification of cyanide have not been reported. Although cyanide is taken up by aquatic organisms, bioaccumulation cannot be demonstrated because it is readily metabolized (EPA, 1984-CN).

Cyanides are absorbed by aquatic organisms through respiratory surfaces, ingestion, or skin contact and then distributed throughout the body by the blood. Reactions can occur in seconds leading to death in only minutes depending on the amount absorbed. The toxic effect of cyanide occurs with the inhibition of cytochrome oxidase. Respiratory arrest and death occur after blockage of aerobic ATP synthesis (Eisler et al., 1991).

The EPA would like to provide a free cyanide measurement to establish criteria for cyanide, but the methods for such a measurement have not been approved; therefore, the EPA continues to recommend the conservatively protective total cyanide method. The EPA criteria involving a four-day average concentration of cyanide should not exceed 0.0052 mg/L more than once every three years on the average and the one-hour average concentration should not exceed 0.022 mg/L more than once every three years on the average. According to Eisler, free cyanide criteria currently proposed for natural resource protection include a <0.003 mg/L value for aquatic life.

Table 4. Toxicity of Cyanide to Aquatic Organisms.

Concentration (mg/L)	Effect
2.49	Midge (<i>Tanytarsus dissimilis</i>) LC50
2.326	Isopod (<i>Asellus communis</i>) LC50
0.432	Snail (<i>Physa heterostrophia</i>) LC50
0.426	Stonefly (<i>Pteronarcys dorsata</i>) LC50
0.318	Goldfish (<i>Carassius auratus</i>) LC50
0.167	Amphipod (<i>Gammarus pseudolimnaeus</i>) LC50
0.160	Cladoceran (<i>Daphnia magna</i>) EC50
0.147	Guppy (<i>Poecilia reticulata</i>) LC50
0.1251	Fathead minnow (<i>Pimephales promelas</i>) LC50

Table 4 (continued)

Concentration (mg/L)	Effect
0.102	Largemouth bass (<i>Micropterus salmoides</i>) LC50
0.102	Black crappie (<i>Pomoxis nigromaculatus</i>) LC50
0.09928	Bluegill (<i>Lepomis macrochirus</i>) LC50
0.09555	Cladoceran (<i>Daphnia pulex</i>) EC50
0.09264	Yellow perch (<i>Perca flavescens</i>) LC50
0.09	Atlantic salmon (<i>Salmo salar</i>) LC50
0.0858	Brook trout (<i>Salvelinus fontinalis</i>) LC50
0.04473	Rainbow trout (<i>Salmo gairdneri</i>) LC50
0.03406	Isopod (<i>Asellus communis</i>) CV
0.01833	Amphipod (<i>Gammarus pseudolimnaeus</i>) CV
0.01639	Fathead minnow (<i>Pimephales promelas</i>) CV
0.01357	Bluegill (<i>Lepomis macrochirus</i>) CV
0.007849	Brook trout (<i>Salvelinus fontinalis</i>) CV

Iron

Because iron is the fourth most abundant element in the earth's crust, it commonly occurs at high concentrations in whole water analyses. Dissolved concentrations in water are dependent upon redox conditions and pH. The most common dissolved inorganic form of iron is $\text{Fe}(\text{OH})_2^+$ (Dave 1984). Toxicity of iron to aquatic organisms has received little attention because it is observed in unusual circumstances such as acid mine drainage or discharge of acidic metal working wastes.

Toxicity in Water to Aquatic Life Iron is acutely toxic to freshwater fish and invertebrates at concentrations ranging from 0.300 mg/L to 2.0 mg/L (Train, 1979; cited in Dave, 1984). Reproduction of *Daphnia magna* was stimulated at concentrations up to 0.001 mg/L, and reproduction and survival were inhibited by iron at 0.158 mg/L and 0.256 mg/L, respectively (Dave, 1984). This is considerably lower than the 4.380 mg/L concentration causing 16% reproductive decrement in another test with *Daphnia magna* (Biesinger and Christensen, 1972). Dave argued that his result was more applicable to a situation in which "an acidic iron-containing waste water is discharged into a lake or a river" where it is neutralized, but Biesinger and Christensen's (1972) result "is probably more close to the steady-state situation in natural freshwater without any point source of iron." Survival of brown trout alevin (swim-up fry) and eyed-eggs was reduced at an average iron concentration of 5.170 mg/L (Geertz-Hansen and Mortensen 1983).

Toxicity of iron to aquatic plants was not reported. Bioconcentration factors and toxicities of body burdens were also not determined for iron. The chronic NAWQ criteria for freshwater aquatic life of 1.0 mg/L is not based on the standard method for criteria derivation. Rather, it is based on effects observed at acid mine drainage sites.

Toxicity in Sediment to Benthic Organisms There is minimal information on the toxicity of iron in sediment to benthic invertebrates. However, Hull and Suter (1994) describe sediment criteria which are utilized as screening benchmarks. The Ontario Ministry of the Environment (MOE) has prepared provincial sediment quality guidelines (SQGs). These values are based on Ontario sediments and benthic species from a wide range of geographical areas within the province. The lowest effect level (low) is the level at which actual ecotoxic effects become apparent. The severe effects level (severe) represents contaminant levels that could potentially eliminate most of the benthic organisms. These "low" and "severe" effects levels are 3% (30,000 mg/kg) and 4% (40,000 mg/kg), respectively (Hull and Suter, 1994).

Beak Consultants in Canada also developed potential SQGs for Ontario MOE using the background approach. A SQG of 5.9% (59,000 mg/kg) represents a background level to which the site contaminant concentration should be compared. This sediment guideline is not based on/or related to biological effects (Hull and Suter, 1994).

The EPA Region V Sediment Classification guidelines are for sediments of Great Lakes Harbors. The "polluted" values ranging from 17,000-25,000 mg/kg are qualified as being "moderately polluted" in the guidelines. The Region V values are poorly founded scientifically and are considered adequate only for determining the suitability of dredged material for open water disposal (Hull and Suter, 1994).

Lead

Lead is a comparatively rare metal, averaging 16 ppm in the earth's crust, that is neither essential nor beneficial in living organisms (Eisler, 1988b). Lead has adverse effects on survival, growth, reproduction, development, behavior, learning, and metabolism. In general, organic lead compounds are more toxic than inorganic compounds, biomagnification of lead is minimal, and younger organisms are more susceptible to lead toxicity (Eisler, 1988b). Although lead occurs in a variety of forms in the aquatic environment, the relative toxicities of these forms are not well defined (EPA, 1985-Pb).

Toxicity in Water to Aquatic Life Acute and chronic lead toxicity increases as hardness decreases (EPA, 1985-Pb). Therefore, the lead toxicities values to aquatic life, listed in Table 5, are normalized to 100 and 200 mg/L hardness using the slopes calculated by the EPA (1985-Pb). Acute toxicities of lead, normalized to 100 mg/L, range from 0.3446 to 570.201 mg/L and acute toxicities, normalized to 200 mg/L, range from 0.8328 to 1377.968 mg/L. Chronic toxicities, normalized to 100 mg/L, range from 0.0167 to 0.3874 mg/L and chronic toxicities, normalized to 200 mg/L, range from 0.0405 to 0.0362 mg/L. In general, invertebrates are more sensitive to lead than fish. Bioconcentration was observed in four invertebrate and two fish species with concentration factors ranging from 42 to 1700. Toxicities of body burdens were not determined. The acute and chronic NAWQ criteria for lead are 0.082 and 0.0032 mg/L at a hardness of 100 mg/L as CaCO₃. Biesinger and Christensen (1972) reported a 48-hr LC50 of 0.45 mg/L without food added. The 3-week CV of 0.030 mg/L with food added caused 16% reproductive impairment.

Toxicity in Sediment to Benthic Organisms Although a relatively large amount of data exists for lead and measures of effects in sediments, there are no spiked sediment bioassays and there is a wide concentration range associated with effects (Long and Morgan, 1991). Freshwater biota may be more sensitive to lead than marine species (Eisler, 1988).

Significant effects were observed in *Daphnia magna* exposed to Keweenaw Waterway sediments containing 27 mg/kg lead. Taxa richness of macroinvertebrate communities in the Kishwaukee River were reduced in sediments containing 31 mg/kg and taxa-rich in sediment containing 21 mg/kg. Significant toxicity to *D. magna* and *Hexagenia limbata* was observed at 110 mg/kg in sediments of Torch Lake, Michigan (studies cited in Long and Morgan, 1991). Long et al., (1995) reported ER-L and ER-M values of 46.7 and 218 mg/kg for lead. Confidence is high for these values because 90% of the studies at concentrations above the ER-M indicated biological effects.

Toxicity in Soil to Plants Experimental evidence indicates that trees may be more sensitive to Pb in soil than grasses and horticultural crops. Dixon (1988) measured a 26% reduction in weight of red oak seedlings grown for 16 weeks in a sandy loam soil (pH 6, % organic matter 1.5) with addition of 50 ppm Pb (PbCl_2 ; 20 ppm had no effect). Carlson and Bazzaz (1977) measured a 30% reduction in foliage biomass of 2 to 3-year old American sycamore saplings associated with 90 days exposure to 50 ppm Pb (lowest concentration tested) added as PbCl_2 to a silty clay loam soil. Four-week old Sitka-spruce seedlings, grown for 12 weeks in a mixture of acidic peaty gley soil and sand with 100 ppm Pb added as PbCl_2 , experienced 25% reduction in weight (Burton et al., 1984).

Miles and Parker (1979b) found approximately 52% reductions in plant weight of little bluestem grown from seed for 12 weeks in a sandy soil (pH 7.8, % organic matter 2.5), when 450 ppm Pb as PbCl_2 was added. This was the only concentration tested. Root growth was reduced in a second sandy soil (pH 4.8, % organic matter 1.9) by 22% with the addition of 450 ppm Pb (only concentration tested). Carlson and Rolfe (1979) found that 5000 ppm Pb added as PbCl_2 to a soil was necessary to give 46 and 31% reductions in clipping weight of rye grass and fescue grown in a silt loam soil (pH 5.9) from seed. The addition of 1000 ppm Pb, as PbO added to an alluvial soil (pH 6), reduced root weight of wheat grown from seed to maturity (300 ppm had no effect) (Muramoto et al., 1990). In a study using Brown earth soil, Khan and Frankland (1984) investigated the effects of Pb added as PbCl_2 , the less soluble PbO, or a combination, on root weight of wheat and oats after 42 days (1984). Wheat root weight was reduced 34% by the addition of 1000 ppm Pb as PbCl_2 , while 500 ppm had no effect. Oat growth was reduced 37% by the addition of 500 ppm Pb as PbCl_2 , while 100 ppm had no effect.

Hassett et al., (1976) measured a 48% reduction in corn root length after seven days growth from seed in a loamy sand soil (pH 6.5, % organic matter 2) to which 500 ppm (as PbCl_2) was added (250 ppm had no effect). Corn grown from seed for 31 days in a loamy sand used in the 1976 work (pH 6) experienced a 42% decrease in plant weight after addition of 250 ppm Pb (125 ppm had no effect) (Miller et al., 1977).

Effects of Pb on horticultural crops have also been investigated. In a study using Brown earth soil, Khan and Frankland (1983) investigated the effects of Pb added as PbCl_2 , the less soluble PbO, or a combination, on radish weight. Root growth was reduced 24% by the addition of 500 ppm Pb as PbCl_2 or 1000 ppm (lowest concentration tested) as PbO (27%), to a soil having a pH of 5.4. John and Van Laerhoven (1972) investigated the effects of lead, added in various forms, to a silty clay loam soil (pH 3.8, % organic matter 17) on lettuce growth (30 days). Lead added at a rate 1000 ppm (lowest concentration tested) as PbCl_2 and $\text{Pb}(\text{NO}_3)_2$ reduced plant weight by 35 and 25%.

Lead is taken up passively by roots and translocation to shoots is limited (Wallace and Romney, 1977b). It is bound to the outside of roots, in the apoplast, and in cell walls and organelles of absorbing roots (Koepe, 1981). In the plant, lead may exist in naturally chelated form, or in pyro- or orthophosphate forms. The phytotoxicity of lead is relatively low compared with other trace elements. It affects mitochondrial respiration and photosynthesis by disturbing electron transfer reactions (Miles et al., 1972).

Toxicity to Wildlife Acute oral doses of 5–108 mg lead/kg bw reduced rat survival (Eisler, 1988b), and rats fed diets with 5 ppm lead had shortened life spans (Schroeder et al., 1965). An acute LD₅₀ based on a single oral dose of 12 mg tetraethyllead/kg body weight was reported by Branica and Konrad (1980). Rats fed 0.5, 5, 25, or 250 ppm inorganic lead in diets over two generations exhibited no substantial developmental effects (Kimmel et al., 1980). In another study, Azar et al. (1973) fed rats a diet containing 0, 10, 50, 100, 1000, or 2000 ppm lead acetate for three generations. While the number of litters and young/litter was not affected by any dose level, growth was reduced and kidney histopathologies were observed among offspring in the 1000 and 2000 ppm treatments. Frequency of pregnancy was reduced in mice ingesting 3 mg/kg body weight tetraethyllead daily, and daily ingestion of 1.5 mg/kg tetraethyllead chloride resulted in a reduction in the success of implanted ova (Clark, 1979).

Anemia and other hematological effects were induced among pigeons orally dosed with 6.25 mg lead/kg bw/day (Anders et al., 1982). Kendall and Scanlon (1981) exposed ring doves to drinking water containing 0 or 100 ppm lead and observed no effects on time to produce eggs, egg production, or fertility. However, testes weight and sperm count was decreased among lead-exposed males. Grandjean (1976) correlated eggshell thickness and eggshell lead levels in European kestrels (*Falco tinnunculus*), suggesting that lead may cause eggshell thinning. Among American kestrels (*Falco sparverius*) fed diets containing 0, 10, or 50 ppm lead, no adverse effects survival, egg-laying, initiation of incubation, egg fertility, or eggshell thickness were observed (Pattee, 1984).

Table 5. Toxicity of Lead to Aquatic Organisms.

Concentration (mg/L)		Effect
100 mg hardness	200 mg hardness	
570.201	1377.968	Midge (<i>Tanytarsus dissimilis</i>) LC50
244.399	590.623	Goldfish (<i>Carassius auratus</i>) LC50
159.829	386.249	Guppy (<i>Poecilia reticulata</i>) LC50
71.706	202.114	Fathead minnow (<i>Pimephales promelas</i>) LC50
105.421	212.455	Bluegill (<i>Lepomis macrochirus</i>) LC50
13.610	75.668	Rainbow trout (<i>Salmo gairdneri</i>) LC50
11.659	28.176	Brook trout (<i>Salvelinus fontinalis</i>) LC50
2.514	6.076	Snail (<i>Aplexa hypnorum</i>) LC50
0.9087	1.8441	Cladoceran (<i>Daphnia magna</i>) EC50
0.3874	0.9362	Rainbow trout (<i>Salmo gairdneri</i>) CV
0.3446	0.8328	Amphipod (<i>Gammarus pseudolimnaeus</i>) LC50
0.2363	0.5709	Brook trout (<i>Salvelinus fontinalis</i>) CV
0.1134	0.5696	Cladoceran (<i>Daphnia magna</i>) CV
0.0562	0.2821	Cladoceran (<i>Daphnia magna</i>) CV
0.0491	0.2464	Cladoceran (<i>Daphnia magna</i>) CV
0.0954	0.2307	Rainbow trout (<i>Salmo gairdneri</i>) CV
0.0167	0.0405	Snail (<i>Lymnaea palustris</i>) CV
0.082	0.197	NAWQC acute value
0.0032	0.0077	NAWQC chronic value

Lithium

The concentration of lithium (Li) found in the earth's crust is 30ppm. Metallic lithium does not occur in nature, it occurs as salts and complexes. Lithium is not considered a heavy metal or an essential element (Oehme, 1979).

Toxicity in Water to Aquatic Life The striped bass 96 hr LC₅₀ in a static test of lithium was >105 mg/L (Dwyer et al., 1992). Survival of the striped bass increased as the hardness of the water was increased. Recent studies conducted at Oak Ridge National Laboratory have revealed that the toxicity of lithium decreases as the concentration of sodium increases (Kszos, 1996). Survival of *Ceriodaphnia dubia* exposed to lithium concentrations ranging from 1-4 mg/L increased as sodium concentrations were increased. The feeding rate for *Elimia clavaeformis* was reduced by 25% at 0.11 mg/L, the growth of *Pimephales promelas* was reduced by 25% at 0.42 mg/L, and the reproduction of *Ceriodaphnia dubia* was reduced by 25% at 0.46 mg/L in 7 day tests. Studies of three species of fish by Hamilton (1994) showed lithium to be more toxic to fry than juveniles (Table 6). Lithium was found to have an EC₅₀ (50% immobilization response) for tubificid worms (*Tubifex tubifex*) of 44.77 mg/L at the 24 hr, 11.22 mg/L at the 48 hr, and 9.34 mg/L at the 96 hr (Khangarot, 1991).

Lithium as LiCl gradually decreased cell growth of the alga, *Chlamydomonas reinhardtii* between 13.9 and 138.8 mg/L over a 6 day period (Gamboa et al., 1985). LiCl placed in the alga media caused loss of cell mobility and production of large amounts of extracellular mucus. This toxicity is due to the free cation.

Studies on the uptake of lithium by aquatic organisms and of chronic aquatic toxicity were not found in literature. The mode of action of lithium is unclear. However, lithium may interfere with or substitute for sodium, potassium, calcium, and magnesium (Klemfuss and Greene, 1991). There are no NAWQ criteria for lithium.

Toxicity in Soil to Plants Toxicity of lithium has been tested with a limited number of plants. Lithium at 500 ppm (Li₂C₂O₄; lowest concentration tested) resulted in a 66% reduction in shoot weight of barley seedlings after 10 growth in a loam soil (pH 6) (Wallace, 1979). In the same soil, cotton leaf and stem weights were reduced 33 and 56% after 16 days by the addition of 50 ppm Li as LiNO₃, while 25 ppm had no effect. Bush bean leaf weight was reduced 32% after 10 days by the addition of 25 ppm Li as LiCl, while 10 ppm had no effect (Wallace et al., 1977c). Aldrich et al., (1951) recorded an undefined phytotoxic effect on sweet orange seedlings grown in a surface soil for 6 months with 2 ppm Li as LiSO₄ (lowest concentration tested).

The soluble Li in soils is easily taken up by plants. It appears to share the K⁺ transport carrier and is mainly found in leaf tissues. Toxicity symptoms include damage to root tips and necrosis of interveinal leaf tissue (Aldrich et al., 1951).

Table 6. Toxicity of Lithium to Aquatic Organisms.

Concentration (mg/L)	Effect
186	Razorback Sucker(2.0g-juvenile)LC50
138.8	Algae(<i>Chlamydomonas reinhardtii</i>)75% growth inhibition
65	Bonytail(2.6g-juvenile)LC50

Table 6 (continued)

Concentration (mg/L)	Effect
62	Bonytail(1.1g-juvenile)LC50
53	Razorback Sucker(0.9g-juvenile)LC50
44.77	Tubificid worm(<i>Tubifex tubifex</i>)24hr EC50
41	Colorado Squawfish(1.7g-juvenile)LC50
28	Colorado Squawfish(0.4-1.1g-juvenile)LC50
25	Razorback Sucker(swimup fry)LC50
22	Bonytail(swimup fry)LC50
17	Colorado Squawfish(swimup fry)LC50
13.9	Algae(<i>Chlamydomonas reinhardtii</i>)25% growth inhibition
11.22	Tubificid worm(<i>Tubifex tubifex</i>)48hr EC50
9.34	Tubificid worm(<i>Tubifex tubifex</i>)96hr EC50
0.46 ^c	Water flea(<i>Ceriodaphnia dubia</i>)7d reproduction IC25 ^a
0.42 ^c	Fathead minnow(<i>Pimephales promelas</i>)7d growth IC25 ^a
0.11 ^b	Freshwater snail(<i>Elimia clavaeformis</i>)7d feeding IC25 ^a

^aConcentration causing 25% reduction in test endpoints compared to control

^bNominal concentration

^cMeasured concentration

Manganese

Manganese (Mn) makes up about 0.10% of the earth's crust and is the 12th most abundant element (NAS, 1980). Manganese oxides and peroxides are used in industry as oxidizers, and the metal is used for manufacturing metal alloys to increase hardness and corrosion resistance. In living systems, manganese is an essential element that is found most often in the +2 valence state. There is evidence that manganese occurs in surface waters both in suspension in the quadrivalent state and in the trivalent state in a relatively stable, soluble complex (APHA, 1989).

Toxicity in Water to Aquatic Life Acute and chronic toxicity tests using fathead minnows and *Daphnia magna* were conducted in relatively hard water. Acute toxicity values for manganese ranged from 19.4 mg/L for *D. magna* to 33.80 mg/L for fathead minnow (Kimball, n.d.). Manganese toxicity was increased by the presence of food during the *D. magna* acute toxicity tests. Chronic toxicity values ranged from <1.10 mg/L for *D. magna* to 1.77 mg/L for fathead minnows. Biesinger and Christensen (1972) reported an LC50 of 9.80 mg/L for *D. magna* without food added. The CV of 4.10 mg/L based on a 3-week toxicity test resulted in 16% reproductive impairment of *D. magna*.

Toxicity of manganese to aquatic plants was not reported. Bioconcentration factors and toxicities of body burdens were also not determined for manganese. There are no NAWQ criteria for manganese.

Toxicity in Sediment to Benthic Organisms Very little sediment toxicity information is available for manganese. The Ontario Ministry of the Environment has estimated that most benthic organisms in that region will not be adversely affected by concentrations of 460 mg/kg, which is consistent with the Great Lakes pre-colonial sediments background level of 400 mg/kg. A concentration of 1,110 mg/kg manganese is estimated to be toxic to most benthic organisms (Persaud et al., 1990).

Mercury

Mercury (Hg) has no known biological function and is potentially toxic to fish and wildlife. It is a mutagen, teratogen, and carcinogen that adversely affects the central nervous, renal, and reproductive systems of wildlife (Eisler, 1987). Inorganic mercury compounds in aquatic systems are readily converted to organomercury by microbial action (Berlin, 1979) with organomercury compounds being more toxic than inorganic mercury compounds. Biota bioconcentrate mercury compounds which can be further biomagnified through food chains (Wren, 1986).

Toxicity in Water to Aquatic Life Mercury in ambient waters commonly occurs as mercury (II) and methylmercury (EPA, 1985-Hg). Elemental mercury is oxidized to mercury (II) under natural conditions, and mercury (II) can be methylated by both aerobic and anaerobic bacteria. Mercury (II) can also be methylated in the slime coat, liver, and intestines of fish, but methylation apparently does not occur in other tissues or in plants. Numerous factors such as alkalinity, ascorbic acid, chloride, dissolved oxygen, hardness, organic complexing agents, pH, sediment, and temperature probably affect the acute and chronic toxicity and bioaccumulation of the various forms of mercury. Biesinger and Christensen (1972) reported a 48-hr LC50 of 0.005 mg/L without food added for *Daphnia magna*. The 3-week CV for the toxicity of mercury to *D. magna* is 0.0034 mg/L which resulted in 16% reproductive impairment. Acute toxicity values for lead range from 0.00222 mg/L for the cladoceran, *Daphnia pulex* to 2.00 mg/L for the mayfly, *Ephemerella subvaria*. Chronic toxicity values of 0.00111 and 0.00024 mg/L were reported for *Daphnia magna* and fathead minnow. The NAWQ criteria for Hg^{++} is 0.00244 mg/L and the final chronic value is 0.00130 mg/L (Table 7).

Toxicity in Sediment to Benthic Organisms Sediments from the Little Grizzly Creek system in California, which had 0.8 to 3.5 (mean 1.5) mg/kg mercury and an organic carbon content of approximately 1%, caused greater than 90% mortality in *Daphnia magna* and *Hexagenia limbata* (mayfly larva) (Maleug et al., 1984). A Michigan lake sediment in the same study, with an organic carbon content of 2.2% and mercury concentration of 0.29 mg/kg, caused 100% mortality in *D. magna* and 40% mortality in *H. limbata*. However, sediments from the Phillips Chain of Lakes in Wisconsin, with mercury concentrations from 0.8 to 9.4 mg/kg, resulted in less than 20% mortality in both species. These sediments had a high organic carbon content of approximately 15% (studies cited in Long and Morgan, 1991).

Sediments from Waukegan Harbor, Illinois, with a mercury concentration of 0.1 mg/kg resulted in 34% mortality to *Hyaella azteca*. A study of benthic macroinvertebrate communities in Illinois rivers conducted by the Illinois Environmental Protection Agency found that the lowest number of benthic macroinvertebrate taxa occurred at a site with 1.6 mg/kg mercury, while the highest number of taxa occurred at a site with 0.3 mg/kg mercury (studies cited in Long and Morgan, 1991). Long et al., (1995) reported ER-L and ER-M values 0.15 and 0.71 mg/kg. Biological effects were observed in only 42% of the documented studies with concentrations greater than the ER-M.

Toxicity in Soil to Plants Mercury in soil is strongly associated with organic matter, and to a lesser extent, clay and Fe and Mn oxides. In general, little Hg is found in soil solution available to plants. Mercury and its compounds taken up by roots are translocated to only a limited extent in plants. Organic forms of Hg may be translocated to a greater degree than inorganic forms in some plants (Huckabee and Blaylock, 1973). Gay (1975) reports that pea plants form methylmercury as an intermediate product from Hg added to the soil in organic and inorganic forms. There was no primary reference data describing toxicity of Hg to plants grown in soil. Klope (1979) report unspecified toxic effects on plants grown in a surface soil with the addition of 0.3 ppm Hg and this has been chosen as the benchmark concentration for all mercury species (inorganic and organic) in soil.

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Toxicity to Worms Mercury is known to interfere with Cu metabolism (Beeby, 1991). Abbasi and Soni (1983) assessed the effect of Hg(II), added as HgCl₂ to a mixture of soil and animal dung, on survival and reproduction of *Octochaetus pattoni*. Survival and cocoon production were reduced 65 and 40% 0.5 ppm Hg, the lowest concentration tested.

The effect of methyl mercury on survival and segment regeneration of *Eisenia foetida* was investigated by Beyer et al. (1985). Methyl mercury chloride was added to an undefined potting soil in which the earthworms were cultured for 84 days. A concentration of 12.5 ppm Hg reduced survival by 21% and the ability to regenerate excised segments by 69% (2.5 ppm had no effect).

Toxicity to Wildlife Daily doses of 0.1–0.5 mg/kg bw/day and dietary concentrations of 1.0–5.0 ppm are lethal to sensitive mammals (Eisler, 1987). Central nervous system toxicity, weight loss, and mortality were observed among rats fed a diet containing 250 ppm methyl mercury (MeHg) for 2 weeks (Verschuuren et al., 1976a). Rats consuming 2.5 ppm MeHg in the diet for 2 years displayed reduced growth, increased kidney weight, and altered kidney histochemistry (Verschuuren et al., 1976b). To study effects on reproduction, Verschuuren et al. (1976c) fed rats a diet containing 0, 0.1, 0.5, and 2.5 ppm MeHg for three generations. While no effects were observed among rats fed 0.1 or 0.5 ppm MeHg, offspring viability was reduced among rats in the 2.5 ppm treatment. Among mink, 93-day consumption of diets containing 1.8 to 15.0 ppm MeHg produced mortality, ataxia, anorexia, and paralysis (Wobeser et al., 1976), with the highest exposures showing the greatest effects.

The LD₅₀ for MeHg for *Coturnix* quail ranges from 14.4 to 33.7 mg/kg bw (Eisler, 1987). Growth was decreased and mortality increased among leghorn cockerels fed diets containing 6 to 18 ppm MeHg (Fimreite, 1970). Ring-necked pheasants fed diets of MeHg-treated grains displayed reduced egg production and hatchability and laid more shell-less eggs than controls (Fimreite, 1971). Heinz (1979) fed mallard ducks a diet containing 0.5 ppm MeHg for three generations. While MeHg consumption did not affect adult weights or weight change during the reproductive season, MeHg-exposed females laid fewer eggs (with more eggs outside the nest box), produced fewer young, and displayed slightly thinner eggshells. Young of MeHg-treated adults were less responsive to maternal calls and hyper-responsive to fright stimuli.

Table 7. Toxicity of Mercury to Aquatic Organisms.

Concentration (mg/L)	Effect
2	Mayfly (<i>Ephemerella subvaria</i>) LC50
2	Stonefly (<i>Acroneuria lycorias</i>) LC50
2	Caddisfly (<i>Hydropsyche betteni</i>) LC50
1	Mozambique tilapia (<i>Tilapia mossambica</i>) LC50
0.5	Tubificid worm (<i>Spirosperma nikolskyi</i>) LC50
0.37	Snail (<i>Aplexa hypnorum</i>) LC50
0.33	Tubificid worm (<i>Spirosperma ferox</i>) LC50
0.275	Rainbow trout (<i>Oncorhynchus mykiss</i>) LC50
0.25	Tubificid worm (<i>Quistadrilus multisetosus</i>) LC50
0.24	Tubificid worm (<i>Rhyacodrilus montana</i>) LC50
0.24	Coho salmon (<i>Oncorhynchus kisutch</i>) LC50
0.18	Tubificid worm (<i>Limnodrilus hoffmeisteri</i>) LC50
0.18	mosquitofish (<i>Gambusia affinis</i>) LC50
0.16	bluegill (<i>Lepomis macrochirus</i>) LC50
0.159	fathead minnow (<i>Pimephales promelas</i>) LC50
0.14	Tubificid worm (<i>Stylodrilus heringianus</i>) LC50
0.14	Tubificid worm (<i>Tubifex tubifex</i>) LC50
0.1	Tubificid worm (<i>Varichaeta pacifica</i>) LC50
0.08	Tubificid worm (<i>Branchiura sowerbyi</i>) LC50
0.05	Crayfish (<i>Orconectes limosus</i>) LC50
0.03	guppy (<i>Poecilia reticulata</i>) LC50
0.02	Crayfish (<i>Faxonella clypeatus</i>) LC50
0.00316	Cladoceran (<i>Daphnia magna</i>) EC50
0.00243	acute NAWQC (Hg^{++})
0.00222	Cladoceran (<i>Daphnia pulex</i>) EC50
0.0013	final chronic value (Hg^{++})
0.00111	Cladoceran (<i>Daphnia magna</i>) CV
0.00024	fathead minnow (<i>Pimephales promelas</i>) CV

Molybdenum

Molybdenum occurs in nature as molybdenum(IV) or molybdenum(VI), always in combination with other elements, particularly sulfur and oxygen. Molybdenum is an essential micronutrient, being used in molybdoflavoproteins (e.g., xanthine oxidase) in a large number of biochemical systems in plants and animals (Dixon and Webb 1964, Schroeder et al. 1970). Molybdenum is concentrated in coal and petroleum products and is used in industrial processes. Elevated concentrations (above ~10 mg/kg) in soil are typically the result of industrial contamination.

Molybdenum interferes with copper absorption by mammals, resulting in toxicity by copper deficiency. Because the degree of interference depends on the ratio of copper to molybdenum, the concentrations at which molybdenum is toxic depend on the concentrations of copper in the diet.

Elevated dietary molybdenum concentrations cause reduced growth and reproduction by mammals. Anemia, bone deformities, liver and kidney histopathology, and male sterility have been reported (Chappell et al. 1979) at a dietary concentration of 100 mg/kg. In a three-generation study of mice, Schroeder and Mitchener (1971) reported slight reductions of breeding success and survival of pups from birth to weaning when the mice were given molybdenum at 10 mg/L in drinking water.

At high dietary concentrations, molybdenum causes reduced weight gain and decreased egg production in birds (Eisler 1989). A reduction in egg production, accompanied by embryolethal molybdenum concentrations in the eggs, was noted in domestic chickens at a dietary concentration of 500 mg/kg, and egg production was reduced by 50% at a dietary concentration of 1000 mg/kg (Friberg et al. 1975).

Nickel

Nickel is a naturally occurring element that may exist in various mineral forms. It forms 0.008% of the earth's crust (NAS, 1980). Soil and sediment are the primary receptacles for nickel, but mobilization may occur depending on physico-chemical characteristics of the soil (ATSDR, 1988; USAF, 1990). Nickel is used in a wide variety of applications including metallurgical processes and electrical components, such as batteries (ATSDR, 1988; USAF, 1990). There is some evidence that nickel may be an essential trace element for mammals. Nickel occurs in nature in the nonionic and divalent states; other valence states occur very infrequently (Mastromatteo, 1986).

Toxicity in Water to Aquatic Life Although nickel can exist in several oxidation states, the divalent cation state predominates and is generally considered the most toxic form (EPA 1986-Ni). As with many metals the toxicity of nickel increases as hardness decreases. Fish and invertebrates have approximately the same range of sensitivity. Acute toxicities of nickel to aquatic life, normalized to 100 and 200 mg/L of hardness, are presented in Table 8. Acute toxicities, normalized to 100 mg/L, range from 0.0106 to 0.502 mg/L and acute toxicities, normalized to 200 mg/L range from 0.283 to 0.746 mg/L. The chronic toxicity of nickel to aquatic life, normalized to 100 mg/L, range from 2.5 to 139.7 mg/L and the chronic toxicities, normalized to 200 mg/L, range from 5.7 to 77.7 mg/L. In general, invertebrates are more sensitive to nickel than fish. Biesinger and Christensen (1972) reported 48-hr LC50 values of 0.510 and 1.120 mg/L for the acute toxicity test of *Daphnia magna* without and with. The 3-week CV of 0.030 mg/L caused 16% reproductive impairment in *D. magna*. Nickel bioconcentration factors range from 0.8 for fish muscle to 193 for a cladoceran.

Toxicity in Sediment to Benthic Organisms No information is available from spiked sediment toxicity tests for nickel; data are only from field studies (Long and Morgan, 1991). In sediments of Lake Union, Washington, 88 mg/kg resulted in 95% mortality of *Hyaella azteca* (Long and Morgan, 1991). Sediments with between 22 and 63 (mean of 40) mg/kg nickel from the Little Grizzly Creek system in California caused greater than 90% mortality in *Daphnia magna* and *Hexagenia limbata* (Maleug et al., 1984). This lake had an organic carbon content of 1%. A Michigan lake sediment in the same study, with an organic carbon content of 2.2% and a nickel concentration of 150 mg/kg, caused 100% mortality in *D. magna* and 40% mortality in *H. limbata*. However, sediments from the Phillips Chain of Lakes in Wisconsin, with a high organic carbon content of approximately 15% and nickel concentrations from 140 to 350 mg/kg, resulted in less than 20% mortality in both species (studies cited in Long and Morgan, 1991).

Long et al., (1995) reported ER-L and ER-M values 20.9 and 51.6 mg/kg. A relatively low percentage (17%) of these documented studies indicated an incidence of biological effects at concentrations greater than the ER-M.

Toxicity in Soil to Plants Nickel is not generally considered to be an essential element for plants. However, it may be required by nodulated legumes for internal N transport as part of the urease enzyme (Aller et al., 1990). It is generally adsorbed as the Ni(II) ion and translocated in xylem and phloem with an organic chelate (Hutchinson, 1981). Nickel is fairly uniformly distributed between roots and shoots (Wallace and Romney, 1977a). Symptoms of Ni toxicity are generally Fe-deficiency induced chlorosis and foliar necrosis (Khalid and Tinsley, 1980). Excess nickel affects nutrient absorption by roots, root development, and metabolism, and it inhibits photosynthesis and transpiration. Nickel can replace Co and other heavy metals located at active sites in metallo-enzymes and disrupt their functioning.

A limited number of studies have evaluated the effects of Ni on oak, rye grass, corn, cotton, and beans. Dixon (1988) measured a 30% weight reduction of red oak seedlings grown for 16 weeks in a sandy loam soil (pH 6, % organic matter 1.5) with addition of 50 ppm Ni (NiCl_2) (no effect at 20 ppm Ni). Oats grown from seed for 110 d in the presence of 50 ppm Ni (as NiCl_2) in soil (pH 6.1, % organic matter 1.4) had reductions of 38 and 63% in grain and straw weight (Halstead et al., 1969). In a second soil (pH 5.7, % organic matter 4.1) only straw weight was reduced (45%) by addition of 100 ppm Ni (50 ppm had no effect). Traynor and Knezek (1973) measured a 21% reduction in corn plant weight with the addition of 294 ppm Ni (as NiCl_2) to a sandy soil (pH 5, % organic matter 2) in which the plants had been grown for 5 weeks from seed. Addition of 220 ppm had no effect.

Wallace et al., (1977b) report the results of experiments on the effects of Ni (as NiSO_4) on seedlings of a variety of plants grown in a loam soil at several pH's. Corn grown in soil at pH 4.2, 5.6, and 7.5 experienced 74, 80, and 50% reductions in shoot weight after 14 days growth with the addition of 250 ppm Ni. Ni at 100 ppm had no effect. At pH 5.8, bush beans grown for 16 days had a 64% reduction in shoot weight with the addition of 100 ppm (lowest concentration tested). At pH 7.5, a 36% reduction in plant weight occurred with 250 ppm Ni, while 100 ppm had no effect. After 28 days growth in a loam soil at pH 5.8, bush bean leaf weight was reduced 45% by the addition of 100 ppm Ni, while 25 ppm had no effect. For barley under these same growth conditions, 25 ppm Ni (lowest concentration tested) reduced shoot weight 88%.

A limited number of studies have evaluated the effects of Ni on oak, rye grass, corn, cotton, and beans. Dixon (1988) measured a 30% weight reduction of red oak seedlings grown for 16 weeks in a sandy loam soil (pH 6, % organic matter 1.5) with addition of 50 ppm Ni (NiCl_2) (no effect at 20 ppm Ni).

Rye grass shoot weight was reduced 66% with the addition of 180 ppm Ni (as NiSO_4) to a loam soil (pH 4.7) in which the plants had been grown for 4 weeks from seed (90 ppm had no effect) (Khalid and Tinsley, 1980). Oats grown from seed for 110 d in the presence of 50 ppm Ni (as NiCl_2) in soil (pH 6.1, % organic matter 1.4) had reductions of 38 and 63% in grain and straw weight (Halstead et al., 1969). In a second soil (pH 5.7, % organic matter 4.1) only straw weight was reduced (45%) by addition of 100 ppm Ni (50 ppm had no effect). Traynor and Knezek (1973) measured a 21% reduction in corn plant weight with the addition of 294 ppm Ni (as NiCl_2) to a sandy soil (pH 5, % organic matter 2) in which the plants had been grown for 5 weeks from seed. Addition of 220 ppm had no effect.

Wallace et al., (1977d) report the results of experiments on the effects of Ni (as NiSO_4) on seedlings of a variety of plants grown in a loam soil at several pH's. Corn grown in soil at pH 4.2, 5.6, and 7.5 experienced 74, 80, and 50% reductions in shoot weight after 14 days growth with the addition of 250 ppm Ni. Ni at 100 ppm had no effect. At pH 5.8, bush beans grown for 16 days had a 64% reduction in shoot weight with the addition of 100 ppm (lowest concentration tested). At pH 7.5, a 36% reduction in plant weight occurred with 250 ppm Ni, while 100 ppm had no effect. After 28 days growth in a loam soil at pH 5.8, bush bean leaf weight was reduced 45% by the addition of 100 ppm Ni, while 25 ppm had no effect. For barley under these same growth conditions, 25 ppm Ni (lowest concentration tested) reduced shoot weight 88%.

Two-week old cotton seedlings grown for 35 d in soil (pH 6.8) to which 100 ppm Ni was added (lowest concentration tested) experienced reductions in leaf and stem weights of approximately 45 to 60% (Rehab and Wallace, 1978).

Nickel is not generally considered to be an essential element for plants. However, it may be required by nodulated legumes for internal N transport as part of the urease enzyme (Aller et al., 1990). It is generally adsorbed as the Ni(II) ion and translocated in xylem and phloem with an organic chelate (Hutchinson, 1981). Nickel is fairly uniformly distributed between roots and shoots (Wallace and Romney, 1977b). Symptoms of Ni toxicity are generally Fe-deficiency induced chlorosis and foliar necrosis (Khalid and Tinsley, 1980). Excess nickel affects nutrient absorption by roots, root development, and metabolism, and it inhibits photosynthesis and transpiration. Nickel can replace Co and other heavy metals located at active sites in metallo-enzymes and disrupt their functioning.

Toxicity to Wildlife The absorption of nickel is dependent on its physico-chemical form, with water soluble forms being more readily absorbed. Soluble nickel compounds tend to be more toxic than insoluble compounds (Goyer, 1991). The metabolism of nickel involves conversion to various chemical forms and binding to various ligands (ATSDR, 1988). Nickel is excreted in the urine and feces with relative amounts for each route being dependent on the route of exposure and chemical form. Most nickel enters the body via food and water consumption.

Oral LD_{50} values for rats range from 67 mg nickel/kg (nickel sulfate hexahydrate) to >9000 mg nickel/kg (nickel powder) (ATSDR, 1988). The Food and Drug Research Laboratories, Inc. (1984) reported an acute oral LD_{50} of 175 mg/kg for female rats exposed to nickel dioxide hexahydrate; acute oral LD_{50} s for 11 other nickel compounds ranged from 275 to >9000 mg/kg. Toxic effects of oral exposure to nickel usually involve the kidneys with some evidence from animal studies showing a possible developmental/reproductive toxicity effect (ATSDR, 1988; Goyer, 1991).

Inorganic nickel compounds are well-tolerated when taken orally by rodents in doses up to 500 mg/kg (Mastromatteo, 1986). Rats continually fed a 250 ppm nickel diet for 16 months suffered no deleterious effects and were considered in excellent condition (Phatak and Patwardhan, 1952).

Progressive accumulation of nickel was not observed in the tissues assayed. In a three-generation study of rats, Ambrose et al. (1976) reported a no-observed-adverse-effects level (NOAEL) and lowest-observed-adverse-effects level (LOAEL) of 5 mg/kg/day and 50 mg/kg/day, respectively. Doses of 24.15 mg/kg-day administered as nickel sulfate in the diet had no adverse effects on reproduction of the rats. Growth in dogs was depressed by dietary concentrations of 2500 ppm nickel sulfate hexahydrate; in the rats, growth was depressed at dietary concentrations >1000 ppm (Ambrose et al., 1976).

Weber and Reid (1968) fed a basal diet of up to 1300 ppm nickel sulfate or nickel acetate to domestic chicks for 4 weeks. Growth of chicks was significantly depressed at 700 ppm nickel and above. Doses of 21.4 mg/kg-day administered as nickel sulfate in the diet had no adverse effects on weight gain after 4 weeks. Mallard ducklings on diets with ≥ 800 ppm nickel would be adversely affected (Cain and Pafford, 1981).

Table 8. Toxicity of Nickel to Aquatic Organisms.

Concentration (mg/L)		Effect
100 mg/L hardness	200 mg/L hardness	
77.7	139.7	banded killifish (<i>Fundulus diaphanus</i>) LC50
72.7	130.7	stonefly (<i>Acroneuria lycorias</i>) LC50
54.3	97.6	caddisfly LC50
38.3	68.9	goldfish (<i>Carassius auratus</i>) LC50
38.1	68.5	damselfly LC50
25.3	45.6	Worm (<i>Nais</i> sp.) LC50
24.1	43.2	rainbow trout (<i>Oncorhynchus mykiss</i>) LC50
23.4	42	amphipod (<i>Gammarus</i> sp.) LC50
23.3	41.8	white perch (<i>Morone americana</i>) LC50
23	41.3	snail (<i>Amnicola</i> sp.) LC50
21.9	39.4	American eel (<i>Anguilla rostrata</i>) LC50
19.4	31.4	bluegill (<i>Lepomis macrochirus</i>) LC50
17.6	31.7	common carp (<i>Cyprinus carpio</i>) LC50
17.4	31.2	guppy (<i>Poecilia reticulata</i>) LC50
14.3	25.3	fathead minnow (<i>Pimephales promelas</i>) LC50
13.6	24.4	pumpkinseed (<i>Lepomis gibbosus</i>) LC50
12.2	25.2	striped bass (<i>Morone saxatilis</i>) LC50
8.33	15	Mayfly (<i>Ephemera subvaria</i>) LC50
7.75	13.9	rock bass (<i>Ambloplites rupestris</i>) LC50
3.67	6.6	<i>Daphnia pulicaria</i> EC50
2.5	5.7	<i>Daphnia magna</i> EC50

Table 8 (continued)

Concentration (mg/L)		Effect
100 mg/L hardness	200 mg/L hardness	
1.42	2.55	acute NAWQC
0.502	0.746	fathead minnow (<i>Pimephales promelas</i>) CV
0.231	0.415	Caddisfly (<i>Clistoronia magnifica</i>) CV
0.162	0.291	rainbow trout (<i>Oncorhynchus mykiss</i>) CV
0.158	0.283	chronic NAWQC
0.0809	0.398	<i>Daphnia magna</i> CV
0.0106		<i>Ceriodaphnia dubia</i> CV ^b

^a Seven day test at 117 mg/L hardness from Kszos et al. (1992).

Selenium

Selenium (Se) has a combination of attributes which make it an unusual pollutant (EPA 1987). These attributes include, but are not limited to, the following: it is an essential trace nutrient; it can occur in three oxidation states and be reduced or oxidized by various organisms; it is a metalloid with physicochemical properties similar to sulfur, which may reduce the toxicity of selenium or be replaced by selenium in biologically important compounds; it can reduce the toxicity of several heavy metals and have varying effects on cadmium and mercury toxicity; both water and food are important exposure pathways for aquatic biota; and there are substantial natural and anthropogenic releases to water. The two oxidation states (Se(IV) and Se(VI)) for which the most toxicity data exist are discussed separately. Plants have the ability to convert inorganic selenium to organic selenium compounds, thereby increasing their biological availability (Lo and Sandi, 1980).

Toxicity in Water to Aquatic Life Acute toxicity values for Se(IV) are available for 23 freshwater fish and invertebrate species in 22 genera and range from 0.304 mg/L for the amphipod *Hyalella azteca* to 203.0 mg/L for the leech *Nephelopsis obscura*. Both the two most sensitive and resistant species were invertebrates. The species mean acute values were (0.8555 mg/L) for *Daphnia magna* and (1.601 mg/L) for the fathead minnow. Chronic values for Se(IV) ranged from > 0.047 mg/L for the rainbow trout *Salmo gairdneri* to 0.6928 mg/L for *Daphnia pulex*. The fathead minnow and *Daphnia magna* had chronic values of 0.1127 and 0.09165 mg/L, respectively. Uptake of Se(IV) by fish takes about 100 days to reach steady-state and bioconcentration factors from 2 to 452 have been reported.

Acute toxicity values for Se(VI) are available for 12 freshwater animal species and range from 0.06538 mg/L for the amphipod *Gammarus pseudolimnaeus* to 442.0 mg/L for the leech *Nephelopsis obscura*. The species mean acute values were (1.450 mg/L) for *Daphnia magna* and (5.5 mg/L) for the fathead minnow. Chronic values for Se(VI) ranged from 0.5655 mg/L for the fathead minnow to 0.002891 mg/L for the rainbow trout *Salmo gairdneri*. *Daphnia magna* had a chronic value of 0.001999 mg/L. Se(VI) bioaccumulation factors for the fathead minnow ranged from 21 to 52.

Selenium toxicity values for nine species of freshwater algae ranged from 0.5 to 30.0 mg/L. The species of selenium are not differentiated in the water quality criteria. The acute and chronic NAWQ criteria for the protection of aquatic organisms are 0.26 and 0.035 mg/L, respectively.

Toxicity in Soil to Plants Selenium is not proven to be essential for plant growth. It is absorbed by plants as selenite (IV), selenate (VI) or in organic form and the selenate may be the more toxic. It is believed that selenate is taken up actively while selenite uptake is largely passive (Peterson et al., 1981). Selenium is translocated to all parts of the plant, including the seed, in low molecular weight compounds (Broyer et al., 1972). Toxicity symptoms include chlorosis, stunting and yellowing of the leaves. The mechanism of toxicity is thought to be indiscriminate replacement of S by Se in proteins and nucleic acids with disruptions in metabolism (Trelease et al., 1960). Wan et al., (1988) measured 30 to 85% reductions in shoot weight of alfalfa grown in soils containing 1.5 ppm Se. Shoot weights of alfalfa (Soltanpour and Workman 1980) and sorghum (Carlson et al. 1991) were reduced approximately 25-90% and 55% by 2 and 1 ppm Se in various soils. The benchmark for Se in soil is 1 ppm.

Wan et al., (1988) investigated the effects of Se(VI), as Na_2SeO_4 , on alfalfa grown from seed to 0.25 bloom stage in three soils. In the sandy loam soil (pH 6.7, % organic matter 13) and in the two clay loam soils (pH 5.6, % organic matter 15; pH 6.9, % organic matter 13), shoot weight was reduced 83, 33, and 56% by the addition of 1.5 ppm Se(VI), while 0.5 ppm had no effect. The effect of Se(VI) (Na_2SeO_4) on alfalfa grown from seed to bloom was examined in five silty clay loam soils, ranging in pH from 6.9 to 7.8, by Soltanpour and Workman (1980). Shoot weight was reduced by 2 ppm in 4 of the 5 soils (91, 74, 23, and 27% reductions), with the greatest reductions in soils with the lowest organic matter content (% organic matter 3.1, 3.7, 5, and 6.5, respectively).

Carlson et al., (1991a) investigated the effects of Se(VI) (as Na_2SeO_4) and Se (IV) (as Na_2SeO_3) on sorgrass (*Sorghum*) grown from seed for 42 days in several soils. In a loamy sand soil (% organic matter 19) at pH 5.5 and 6.0, there were 59 and 53% reductions in shoot weight with the addition of 1 ppm Se(VI), (lowest concentration tested). No reductions were observed with additions of up to 4 ppm Se(IV). In a sandy soil at pH 4.9, 1 ppm Se(VI) and 2 ppm Se(IV) caused 64 and 61% reductions in shoot weight. In this same sandy soil limed to pH 6.5, Se(IV) had no effect up to 4 ppm and Se(VI) reduced shoot weight 66% at 1 ppm.

Selenium is not proven to be essential for plant growth. It is absorbed by plants as selenite (IV), selenate (VI) or in organic form and the selenate may be the more toxic. It is believed that selenate is taken up actively while selenite uptake is largely passive (Peterson et al., 1981). Selenium is translocated to all parts of the plant, including the seed, in low molecular weight compounds (Broyer et al., 1972). Toxicity symptoms include chlorosis, stunting and yellowing of the leaves. The mechanism of toxicity is thought to be indiscriminate replacement of S by Se in proteins and nucleic acids with disruptions in metabolism (Trelease et al., 1960).

Toxicity to Wildlife While selenium is an essential nutrient that interacts with Vitamin E and maintains muscle integrity, it has a very narrow tolerance range; in humans, while 0.04-0.1 ppm is required in diet, 4 ppm may produce toxic effects (Eisler, 1985b). In mammals, chronic selenium poisoning is induced by diets containing 1-44 ppm selenium (Harr, 1978). Symptoms include liver cirrhosis, lameness, loss of hair, emaciation, reduced conception, and increased fetal resorption. Plants convert inorganic selenium to organic selenium compounds, thereby increasing their biological availability (Lo and Sandi, 1980).

To evaluate the effects of selenium on reproduction, Schroeder and Mitchner (1971) exposed mice to 3 ppm selenate in drinking water for three generations. This dosage level increased juvenile

mortality, number of runts, and resulted in reproductive failure by the third generation. In another study, exposure to 3 ppm selenate or selenite in water for a lifetime had no effect on mouse longevity and no tumorigenicity was observed (Schroeder and Mitchner, 1972).

Selenium is both embryotoxic and teratogenic to birds, with organic selenium (selenomethionine) being more toxic than inorganic selenium (Hoffman and Heinz, 1988). Mallard ducks were fed diets containing 1, 5, 10, 25, or 100 ppm selenite (Heinz et al., 1987) or 1, 2, 4, 8, or 16 ppm selenomethionine (Heinz et al., 1989) for about 10 weeks. Exposure to 1, 5, or 10 ppm selenite or 1, 2, or 4 ppm selenomethionine in the diet had no effect on survival, growth, or reproductive success of adults. The diet containing 100 ppm selenite killed 11 of 12 adults. While only one adult receiving the 25 ppm diet died, time to laying, interval between eggs was increased, and duckling survivorship was reduced in this treatment (Heinz et al., 1987). Diets containing 8 and 16 ppm selenomethionine resulted in 6.8% and 67.9% malformed embryos, respectively. In addition, duckling survival was significantly reduced (Heinz et al., 1989).

The most visible incident of environmental selenium toxicity occurred at the Kesterson National Wildlife Refuge in California. Agricultural wastewater containing approximately 0.3 ppm selenium was used for marsh management at the refuge (Ohlendorf et al., 1986). Mean selenium concentrations in plants, invertebrates, and fish at the site were 22–175 ppm (dry weight). As a result, reproductive success among water birds was poor, and the incidence of embryo mortality and developmental abnormalities was dramatically increased. Raccoons on the refuge were found to bioaccumulate selenium (Clark et al., 1989). While peak births at the refuge was 2 months later than reported at other locations, no adverse effects on raccoon reproduction were observed.

Metabolism of selenium may be significantly modified through interactions with heavy metals, and selenium may provide some protection from adverse effects associated with various metals, including cadmium and mercury (Eisler, 1985). Arsenite inhibits methylation of selenium but increases fecal excretion of selenite (Venugopal and Luckey, 1978).

Table 9. Toxicity of Selenium to Aquatic Organisms.

Concentration mg/L Selenium (IV)	Effect
203	Leech (<i>Nepheopsis obscura</i>) LC50
42.5	Midge (<i>Tanytarsus dissimilis</i>) LC50
35	Common carp (<i>Cyprinus carpio</i>) LC50
34.91	Snail (<i>Aplexa hypnorum</i>) LC50
30.18	White sucker (<i>Cotostomus commersoni</i>) LC50
28.5	Bluegill (<i>Lepomis macrochirus</i>) LC50
26.1	Goldfish (<i>Carassius auratus</i>) LC50
25.93	Midge (<i>Chironomus plumosus</i>) LC50
24.1	Snail (<i>Physa</i>) LC50
13.6	Channel catfish (<i>Ictalurus punctatus</i>) LC50
12.6	Mosquitofish (<i>Gambusia affinis</i>) LC50

Table 9 (continued)

Concentration mg/L Selenium (IV)	Effect
11.7	Yellow perch (<i>Perca flavescens</i>) LC50
10.49	Rainbow trout (<i>Salmo gairdneri</i>) LC50
10.2	Brook trout (<i>Salvelinus fontinalis</i>) LC50
6.5	Flagfish (<i>Jordonella floridae</i>) LC50
3.87	Cladoceran (<i>Daphnia pulex</i>) EC50
2.704	Amphipod (<i>Gammarus pseudolimnaeus</i>) LC50
1.783	Striped bass (<i>Morone saxatilis</i>) LC50
1.7	Hydra (<i>Hydra</i>) LC50
1.601	Fathead minnow (<i>Pimephales promelas</i>) LC50
0.8558	Cladoceran (<i>Daphnia magna</i>) EC50
0.6928	Cladoceran (<i>Daphnia pulex</i>) CV
<0.6036	Cladoceran (<i>Ceriodaphnia affinis</i>) EC50
0.304	Amphipod (<i>Hyaella azteca</i>) LC50
0.1615	Cladoceran (<i>Daphnia magna</i>) CV
0.1127	Fathead minnow (<i>Pimephales promelas</i>) CV
>0.047	Rainbow trout (<i>Salmo gairdneri</i>) CV
0.09165	Cladoceran (<i>Daphnia magna</i>) CV
0.883	Rainbow trout (<i>Salmo gairdneri</i>) CV
442.0	Leech (<i>Nepheleopsis obscura</i>) LC50
193.0	Snail (<i>Aplexa hypnorum</i>) LC50
66.0	Channel catfish (<i>Ictalurus punctatus</i>) LC50
63.0	Bluegill (<i>Lepomis macrochirus</i>) LC50
47.0	Rainbow trout (<i>Salmo gairdneri</i>) LC50
20.0	Midge (<i>Paratanytarsus parthenogeneticus</i>) LC50
7.30	Hydra (<i>Hydra</i>) LC50
5.50	Fathead minnow (<i>Pimephales promelas</i>) LC50
1.450	Cladoceran (<i>Daphnia magna</i>) EC50
0.760	Amphipod (<i>Hyaella azteca</i>) LC50
0.6752	Sheepshead minnow (<i>Cyprinodon variegatus</i>) CV
0.5655	Fathead minnow (<i>Pimephales promelas</i>) CV
0.246	Cladoceran (<i>Daphnia pulicaria</i>) EC50

Table 9 (continued)

Concentration mg/L Selenium (IV)	Effect
0.2117	Mysid (<i>Mysidopsis bahia</i>) CV
0.06538	Amphipod (<i>Gammarus pseudolimnaeus</i>) LC50
0.002891	Rainbow trout (<i>Salmo gairdneri</i>) CV
0.001999	Cladoceran (<i>Daphnia magna</i>) CV

Silver

Silver (Ag), a basic element, occurs naturally in the environment as a soft, silver colored metal (ATSDR, 1989). It also occurs in a powdery white or dark gray to black compound. Silver is found at an average of 0.1 ppm in the earth's crust and about 0.3 ppm in soils. Silver metals and silver compounds are used in the production of surgical prostheses, fungicides, coinage, jewelry, and dental fillings (Fisher and Bohe, 1984). The accumulation of silver in marine algae appears to result from adsorption rather than uptake; bioconcentration factors of 13,000 - 66,000 have been reported (Fisher et al., 1984; ATSDR, 1989).

Toxicity in Water to Aquatic Life Toxicity of silver to freshwater fish and invertebrates is dependent upon water hardness and chloride content, with silver being more toxic in soft and low chloride water (EPA 1980-Ag). Toxicity of silver is dependent upon the form of the element. In tests with fathead minnow, free silver ion is the form of silver most acutely toxic to fish, with a 96-h LC_{50} of 0.016 mg/L, followed by silver thiosulfate complex (280-360 mg/L), and silver sulfide (>240 mg/L).

Acute toxicity data are available for four invertebrate species (U.S. EPA, 1980), with acute values ranging from 0.00025 mg/L for *Daphnia magna* to 4.5 mg/L for the scud *Gammarus pseudolimnaeus*, both of which were tested in Lake Superior water. Most of the acute toxicity data for fish are for the rainbow trout and fathead minnow. Acute values range from 0.0000039 mg/L for fathead minnow in soft water to 0.28 mg/L for rainbow trout in hard water (U.S. EPA, 1980).

Chronic values for rainbow trout listed in U.S. EPA (1980) are between 0.00004 and 0.00027 mg/L. One of these studies was an 18-month study to evaluate the effects on silver nitrate in soft water on survival and growth of rainbow trout was conducted by Davies et al., (1978). The exposure was initiated with eyed embryos which hatched after 26 days. The "no-effect" concentration was between 0.00009 and 0.00017 mg/L, based on mortality data. However, this concentration does not reflect possible effects of silver on spawning behavior or reproduction. From 3.5 months of exposure to the end of the experiment, significant decreases in growth occurred in fish exposed to 0.00069 mg/L Ag. Egg and sac-fry mortality was 52% in the 0.00069 mg/L concentration.

Toxicity of silver is dependent upon the form of the element. In tests with fathead minnow, free silver ion is the form of silver most acutely toxic to fish, with a 96-h LC_{50} of 0.016 mg/L. The 96-h LC_{50} for silver thiosulfate complex is between 280 and 360 mg/L, and the 96-h LC_{50} for silver sulfide is >240 mg/L. Results of exposing fathead minnow embryos and larvae to silver sulfide at 11 mg/L (total silver) resulted in no significant effects on average wet weight or total length of larvae after 30 days of continuous exposure. Exposures of silver thiosulfate complex at total silver concentrations

greater than 35 mg/L caused significant effects in survival and total length. Concentrations of 140 mg/L total silver resulted in a significant reduction in egg hatch (LeBlanc et al., 1984).

Toxicity in Sediment to Benthic Organisms Effects were not observed in association with silver concentrations less than approximately 0.6 mg/kg (Long and Morgan, 1991). No data were available for freshwater systems. At concentrations of 2.1 to 2.6 mg/kg in marine systems, there was an absence of *Macoma balthica* in Fraser River sediments, low arthropod abundance and low species richness in southern California benthos, and increased burrowing time of *M. balthica* exposed to Strait of Georgia sediments (studies cited in Long and Morgan, 1991).

The ER-L and ER-M values are 1.0 mg/kg and 3.7 mg/kg, respectively. A high percentage (92.8%) of the documented studies in Long et al., (1995) indicated occurrence of biological effects at concentrations greater than the ER-M.

Table 10. Toxicity of Silver to Aquatic Organisms.

Concentration (mg/L)		Effect
100 mg hardness	200 mg hardness	
15.9	52.4	scud (<i>Gammarus pseudolimnaeus</i>) LC50
15.2	50.1	rotifer (<i>Philodina acuticornis</i>) LC50
11.3	37.3	midge (<i>Tanytarsus dissimilis</i>) LC50
0.309	1.020	bluegill (<i>Lepomis macrochirus</i>) LC50
0.046	0.113	rainbow trout (<i>Oncorhynchus mykiss</i>) LC50
0.0339	0.1118	flagfish (<i>Jordanella floridae</i>) LC50
0.0271	0.0765	fathead minnow (<i>Pimephales promelas</i>) LC50
0.011	0.036	mottled sculpin (<i>Cottus bairdi</i>) LC50
0.0106	0.0350	speckled dace (<i>Rhinichthys osculus</i>) LC50
0.00791	0.00791	cladoceran (<i>Daphnia magna</i>) CV
0.00683	0.03484	cladoceran (<i>Daphnia magna</i>) EC50
0.0041	0.0134	NAWQC acute value
0.0012	0.0012	rainbow trout (<i>Oncorhynchus mykiss</i>) CV

^a Acute effect levels were converted based on a 100 mg/L water hardness. Slopes used for the conversion were associated with individual species, where specified in the Criteria document. Otherwise, 1.72 was used. Chronic values were not converted based on water hardness, since no correlation was evident. A chronic NAWQC has not been determined.

^b Acute effect levels were converted based on a 200 mg/L water hardness.

Strontium

Strontium (Sr) is usually found in the basic mineral form of strontianite (SrCO_3), but often tested in the form of strontium chloride (SrCl_2). The mean level of strontium found in the earth's crust is 450ppm (Oehme, 1979).

Toxicity in Water to Aquatic Organisms The strontium 96 hr LC₅₀ for striped bass (*Morone saxatilis*) was >92.8 mg/L (Dwyer, et al., 1992). Survival of the striped bass increased with increased hardness in the strontium test.

According to Biesinger and Christensen (1972), the acute toxicity test (48 hr) for the effects of strontium on *Daphnia magna* had an LC₅₀ of 125 mg/L. The strontium chronic toxicity test (3 week) on *Daphnia magna* had an LC₅₀ of 86 mg/L. More recent studies of the toxicity of strontium on *Daphnia magna* reported by Khangarot et al., (1989) were similar to the previous data with strontium having a 24 hr EC₅₀ of 162.93 mg/L and a 48 hr EC₅₀ of 94 mg/L. Acute toxicity tests were performed to obtain the toxic effects of strontium on *Tubifex tubifex* worms. The study revealed EC₅₀'s of 540 mg/L for the 24 hr, 320 mg/L for the 48 hr, and 240.8 mg/L for the 96 hr test. Strontium was reported as having a secondary acute value of 6.1 mg/L and a secondary chronic value of 0.62 mg/L (Suter and Mabrey, 1994).

Specific data pertaining to the bioaccumulation of strontium was not found in the literature, however, strontium has been known to substitute for calcium in the bony tissues of fishes (Snyder et al., 1992). The body burdens of strontium on aquatic organisms and the mode of action of strontium are unknown. There are no NAWQ criteria available for strontium.

Table 11. Toxicity of Strontium to Aquatic Organisms.

Concentration (mg/L)	Effect
540	<i>Tubifex tubifex</i> (24 hr)EC50 ^a
320	<i>Tubifex tubifex</i> (48 hr)EC50 ^a
240.8	<i>Tubifex tubifex</i> (96hr)EC50 ^a
162.93	<i>Daphnia magna</i> (24 hr)EC50 50% immobilization ^b
125	<i>Daphnia magna</i> (48 hr)LC50 ^c
94	<i>Daphnia magna</i> (48 hr)EC50 50% immobilization ^b
86	<i>Daphnia magna</i> (3wk)LC50 ^c
60	<i>Daphnia magna</i> (3wk)50% reproductive impairment ^c
42	<i>Daphnia magna</i> (3wk)16% reproductive impairment ^c

^aKhangarot(1991)

^bKhangarot and Ray(1989)

^cBiesinger and Christensen(1972)

Thallium

Thallium (Tl) is a widely distributed metal, occurring at concentrations of approximately 1 ppm in the earth's crust (Kazantzis, 1979). Principal systems affected by thallium exposure include nervous and digestive; renal damage and hair loss have also been observed.

Toxicity in Soil to Plants There was no primary reference data showing toxicity of Tl to plants grown in soil. Kloeke (1979) reported unspecified toxic effects on plants grown in a surface soil with

the addition of 1 ppm Tl. Thallium is not essential for plant growth. When soluble forms are available, Tl is readily taken up by plants and translocated to aerial parts, probably because of its similarity to K. Toxic effects on plants include impairment of chlorophyll synthesis and seed germination, reduced transpiration due to interference in stomatal processes, growth reduction, stunting of roots, and leaf chlorosis (Adriano, 1986).

Toxicity to Wildlife Thallium sulfate, which has been widely used as a rodenticide, has an acute oral LD_{50} of 16 mg/kg (Ware, 1978). In chronic studies, rats tolerated a dose of 10 mg Tl acetate/kg, while 30 mg/kg was lethal to males by 15 weeks. All rats fed a daily dose of 0.45 mg Tl/kg died after 4 months (Kazantzis, 1979). Rats exposed to 10 ppm Tl in drinking water for 2 mo accumulated Tl in testis and exhibited signs of testicular toxicity including reduced sperm motility (Formigli et al., 1986).

Bean and Hudson (1976) orally dosed 3 golden eagles with 60 and 120 mg Tl_2SO_4 /kg bw; the bird receiving 60 mg Tl_2SO_4 /kg survived while the two dosed with 120 mg Tl_2SO_4 /kg died, suggesting an LD_{50} between the doses. Oral LD_{50} 's for quail, geese, and ducks are 12, 15, and 30 mg/kg respectively (Shaw, 1933). No long-term studies of thallium toxicity to birds are currently available.

Uranium

Uranium (U) is a silvery white metal consisting of three semistable radioactive isotopes; U238, U235, and U234 (Brobst and Pratt, 1973). Uranium makes up approximately 2 ppm of the earth's crust. Uranium is a radioactive element used in the manufacture of nuclear weapons, ammunition, and in some industrial uses, however, it also has a chemical toxicity unrelated to its radioactivity (Oehme, 1979).

Toxicity in Water to Aquatic Life Relatively little aquatic toxicity data is available for uranium. The only standard data are LC_{50} s for fathead minnow with values for various uranium salts ranging from 2.8 to 135 mg/L (Cushman et al., 1977). Toxic concentrations from nonstandard and poorly documented tests fall within this range.

Vanadium

Vanadium (V) is a metallic element that occurs in six oxidation states and numerous inorganic compounds. The toxicity of vanadium depends on its physico-chemical state, particularly on its valence state and solubility. Based on acute toxicity, pentavalent NH_4VO_3 has been reported to be more than twice as toxic as trivalent VCl_3 and more than 6 times as toxic as divalent VI_2 . Pentavalent V_2O_5 has been reported to be more than 5 times as toxic as trivalent V_2O_3 (Roshchin 1967).

Toxicity to Wildlife In animals, acutely toxic oral doses cause vasoconstriction, diffuse desquamative enteritis, congestion and fatty degeneration of the liver, congestion and focal hemorrhages in the lungs and adrenal cortex (Gosselin et al., 1984). Minimal effects seen after subchronic oral exposures to animals include diarrhea, altered renal function, and decreases in erythrocyte counts, hemoglobin, and hematocrit (Domingo et al., 1985; Zaporowska and Wasilewski, 1990).

A vanadyl sulfate concentration of 0.005 mg/mL in drinking water, plus a vanadium level of 0.0032 mg/g in the diet (4.1 mg V/kg total) of mice, was reported to cause no adverse effects over

a lifetime exposure period (Schroeder and Balassa, 1967). In similar lifetime studies, rats and mice exhibited no adverse effects when exposed to 5 ppm vanadium (as vanadyl sulfate) in drinking water (Schroeder et al., 1970; Schroeder and Mitchner, 1975b). The estimated dose levels were 0.7 mg V/kg/day for rats and 0.9 mg V/kg/day for mice. Vanadium pentoxide in the diet of rats at levels of 10 and 100 ppm for their entire lifetime resulted in no significant toxicological effects except for a reduction in hair cystine content (Stokinger, 1981).

White and Dieter (1978) observed no mortality among mallard ducks fed diets containing 1, 10, or 100 ppm vanadyl sulfate for 12 weeks. Altered lipid metabolism was observed among birds fed 100 ppm vanadium; no other effects were observed. Among chickens, 200 to 400 ppm $\text{Ca}_2(\text{VO}_4)_2$ in the diet produced 100% mortality; weight gain decreased among chicks fed 20 to 40 ppm $\text{Ca}_2(\text{VO}_4)_2$ (Romoser et al., 1961).

Zinc

Zinc (Zn) is an essential trace element in all organisms; it assures the stability of biological molecules and structures such as DNA, membranes, and ribosomes (Eisler, 1993). It is used commercially primarily in galvanized metals and metal alloys, but zinc compounds also have wide applications as chemical intermediates, catalysts, pigments, vulcanization activators and accelerators in the rubber industry, UV stabilizers, and supplements in animal feeds and fertilizers. Zinc compounds are also used in rayon manufacture, smoke bombs, soldering fluxes, mordants for printing and dyeing, wood preservatives, mildew inhibitors, deodorants, antiseptics, and astringents (Lloyd, 1984; ATSDR, 1989). Zinc phosphide is used as a rodenticide. Zinc makes up about 0.002% of the earth's crust (NAS, 1980) and occurs in many forms in natural waters and aquatic sediments.

In freshwater with pH >4 and <7, the dominant forms of dissolved zinc are the free ion (aquo ion complex) (98%) and zinc sulfate (2%) (Campbell and Stokes, 1985), whereas at pH 9.0, the dominant forms are the monohydroxide ion (78%), zinc carbonate (16%), and the free ion (6%) (EPA, 1987-Zn). Zinc occurs in nature as a sulfide, oxide, or carbonate (Eisler, 1993). It is divalent in solution. Zinc interacts with many chemicals, and it may diminish the toxic effects of cadmium and protect against lead toxicosis in terrestrial animals (Eisler, 1993). Background concentrations seldom exceed 0.040 mg/L in water or 200 mg/kg in soil or sediment (Eisler, 1993).

Although it is essential for normal growth and reproduction (Prasad, 1979; Stahl et al., 1989) and important to central nervous system function (Eisler, 1993), the primary toxic effect of zinc is on zinc-dependent enzymes that regulate RNA and DNA. It is most harmful to aquatic life in conditions of low pH, low alkalinity, low dissolved oxygen, and elevated temperature. Zinc is relatively nontoxic in mammals, but excessive intake can cause a variety of effects. It is not known to be carcinogenic by normal exposure routes (Eisler, 1993).

Toxicity in Water to Aquatic Life Zinc toxicity, which is relatively well defined, increases as either hardness decreases or temperature increases (EPA, 1987-Zn). The aqueous toxicity of zinc is summarized in Table 12. Although freshwater plants are often more sensitive to zinc than freshwater animals, the range of toxicity values was much greater: growth of the algae *Selenastrum capricornutum* was inhibited by 0.030 mg/L whereas several other species of green algae had 96-hour EC_{50} s that exceeded 200.0 mg/L. Zinc bioaccumulated in freshwater animal tissue from 51 to 1130 times the water concentration. Toxicities of body burdens were not determined.

Toxicity in Sediment to Benthic Organisms A concentration of 127 mg/kg caused 34% mortality to *Hyalella azteca* in Waukegan Harbor, Illinois. A concentration of 320 mg/kg in Lake Union, Washington, caused 95% mortality to *H. azteca*. In Torch Lake, Michigan, there was significant mortality of *Daphnia magna* and *Hexagenia limbata* associated with concentrations of 310 mg/kg. At 2 rivers in Illinois, the highest number of benthic macroinvertebrate taxa was associated with concentrations of 96 and 182 mg/kg zinc, while the lowest number of taxa was associated with concentrations of 107 and 327 mg/kg, respectively (studies cited in Long and Morgan, 1991). Long et al., (1995) reported ER-L and ER-M values of 150 and 410 mg/kg for zinc.

Toxicity to Wildlife Gastrointestinal absorption of zinc is variable (20–80%) and depends on the chemical compound as well as on zinc levels in the body and on dietary concentrations of other nutrients (EPA, 1984). Information on pulmonary absorption is limited and complicated by the potential for gastrointestinal absorption due to mucociliary clearance from the respiratory tract and subsequent swallowing. Pulmonary inflammation and changes in lung function have been observed in inhalation studies on animals (Amur et al., 1982; Lam et al., 1985; Drinker and Drinker, 1928). Zinc is present in all tissues with the highest concentrations in the prostate, kidney, liver, heart, and pancreas. Zinc is a vital component of many metalloenzymes such as carbonic anhydrase, which regulates CO₂ exchange (Stokinger, 1981).

In animals, gastrointestinal and hepatic lesions (Allen et al., 1983; Brink et al., 1959), pancreatic lesions (Maita et al., 1981; Drinker et al., 1927), anemia (ATSDR, 1989; Fox and Jacobs, 1986; Maita et al., 1981), and diffuse nephrosis (Maita et al., 1981; Allen et al., 1983) have been observed following subchronic oral exposures. Anemia and pancreatitis were the major adverse effects observed in chronic animal studies (Aughey et al., 1977; Drinker et al., 1927; Walters and Roe, 1965; Sutton and Nelson, 1937). Teratogenic effects have not been seen in animals exposed to zinc; however, high oral doses can affect reproduction and fetal growth (Ketcheson et al., 1969; Schlicker and Cox, 1967, 1968; Sutton and Nelson, 1937).

Livestock and small mammals are tolerant of extended dietary loadings >100 times the minimum recommended daily zinc requirement (Eisler, 1993). No adverse effects on general health or reproduction were observed in dairy cows fed 1310 mg zinc/kg food (Miller et al., 1989). A diet of 4000–5000 mg zinc/kg food for 18 days resulted in fetotoxicity and poor reproduction in rats (NAS, 1979). Acute oral LD₅₀ doses of 350–800 mg zinc/kg body weight have been reported for rats (Eisler, 1993). Wlostowski et al. (1988) recommended 30 mg zinc/kg in the diet of bank voles.

Dogs on diets with up to 1000 mg zinc/kg of food for up to one year showed no measurable signs of damage (NAS, 1979). Horses ingesting >90 mg zinc/kg body weight daily in the vicinity of a lead-zinc smelter exhibited decreased growth and death (NAS, 1979). No effects were observed in mice fed <682 mg zinc/kg food (<109 mg zinc/kg body weight daily) for 13 weeks, but at 6820 mg zinc/kg food adverse effects on growth and survival were documented (Maita et al., 1981). In a 37-day study involving rats, doses of 97 mg/kg-day administered as zinc carbonate in the diet had no adverse effects on the reproductivity of rats (Kinnamon, 1963). European ferrets (*Mustela putorius furo*) fed up to 500 mg zinc/kg for up to 197 days all survived with no significant histopathologies, but those fed 1500 or 3000 mg/kg diet died within 21 days (Straube et al., 1980; Reece et al., 1986). Reproduction ceased entirely in female rats ingesting a diet with 500 mg zinc/kg/day (Sutton and Nelson, 1937), possibly a result of zinc-induced anemia.

Mallards (*Anas platyrhynchos*) fed diets containing >3000 mg zinc/kg for 30 or 60 days suffered leg paralysis, decreased food consumption, and high mortality (Gasaway and Buss, 1972; NAS, 1979). Egg production in Japanese quail (*Coturnix coturnix japonica*) hens fed 15,000 mg zinc (as ZnO)/kg feed for 7 days decreased to near zero within 3 days (Hussein et al., 1988). Seven percent

of 14-day old quail fed 600 mg zinc (as zinc phosphide)/kg feed over 5 days died, 53% of those fed 990 mg/kg died, and 93% of those fed 1634 mg/kg died (Hill and Camardese, 1986). Domestic chicken pullets and hens on a diet with 20,000 mg zinc/kg feed for 5 days were lighter weight by day 5 and produced significantly fewer eggs for 4 weeks following treatment (Palafox and Ho-A, 1980). Eggs collected 14–28 days post-treatment had reduced fertility and hatchability. However, normal growth, egg production, fertility, and hatchability was observed 4–12 weeks post-treatment. Acute oral LD₅₀ values for zinc phosphide, a rodenticide, were between 16 and 47 mg/kg body weight in ring-necked pheasants (*Phasianus colchicus*), golden eagles (*Aquila chrysaetos*), mallards, and horned larks (*Eremophila alpestris*) (Hudson et al., 1984), but much of the biocidal action is attributed to the phosphide rather than the zinc (Eisler, 1993).

Diets containing 28, 48, 228, or 2028 mg zinc/kg for 12–44 weeks had no effect on overall egg production by domestic chickens although zinc levels were elevated in hens on the highest zinc diet (Stahl et al., 1990). All day-old chicks fed diets containing 16,000 mg zinc/kg feed for 5 weeks and 80% of those fed 8000 mg/kg died; those on a 4000 mg zinc/kg diet showed no significant reductions in growth or survival (Oh et al., 1979). In a 60-day study, doses of 170 mg/kg-day administered as zinc carbonate in the diet caused increased mortality and altered blood chemistry in mallards (Gasaway and Buss, 1972).

In chickens, adverse effects associated with zinc deficiency have been observed at <38 mg zinc/kg dry weight feed (Blamberg et al., 1960; Westmoreland and Hoekstra, 1969; Stahl et al., 1989), but concentrations of 93–120 mg/kg are suggested as adequate in the diet (Blamberg et al., 1960; Westmoreland and Hoekstra, 1969). Greater than 178 mg/kg dry weight feed is considered excessive (Stahl et al., 1989), and dietary concentrations >2000 mg/kg dry weight feed are considered toxic (NAS, 1979; Oh et al., 1979; Stahl et al., 1990). Turkey poults tolerated zinc levels up to 2000 ppm in starter diets for 21 days with no deleterious effects, but levels ≥4000 ppm resulted in marked growth depression (Vohra and Kratzer, 1968). No mortality was observed in poults on a diet containing 10,000 ppm zinc (Vohra and Kratzer, 1968), but increased mortality has been observed for chickens on diets with 3000 ppm zinc (Roberson and Schaible, 1960).

Table 12. Toxicity of Zinc to Aquatic Organisms.

Concentration (mg/L)		Effect
100 mg hardness	200 mg hardness	
160	288.0	damselfly (<i>Argia sp.</i>) LC50
35.6	64.1	amphipod (<i>Crangonyx pseudogracilis</i>) LC50
33.8	60.8	pumpkinseed (<i>Lepomis gibbosus</i>) LC50
33.1	59.6	Worm (<i>Nais sp.</i>) LC50
31.9	57.3	banded killifish (<i>Fundulus diaphanus</i>) LC50
30.3	54.4	snail (<i>Amnicola sp.</i>) LC50
24.5	44.1	American eel (<i>Anquilla rostrata</i>) LC50
24.2	43.5	white perch (<i>Morone americana</i>) LC50
20.9	37.6	isopod (<i>Asellus communis</i>) LC50
18.9	58.8	guppy (<i>Poecilla reticulata</i>) LC50

Table 12 (continued)

Concentration (mg/L)		Effect
100 mg hardness	200 mg hardness	
18.4	33.2	goldfish (<i>Carassius auratus</i>) LC50
17.5	31.4	Worm (<i>Lumbriculus variegatus</i>) LC50
14.6	26.2	amphipod (<i>Gammarus</i> sp.) LC50
14.1	25.4	Caddisfly (<i>Clistoronia magnifica</i>) CV
13.0	23.4	common carp (<i>Cyprinus carpio</i>) LC50
11.8	21.3	northern squawfish (<i>Ptychochallus oregonensis</i>)
10.8	19.4	golden shiner (<i>Notemigonus crysoleucas</i>) LC50
10.3	18.6	isopod (<i>Asellus bicrenata</i>) LC50
9.41	16.92	white sucker (<i>Catostomus commersoni</i>) LC50
8.82	15.86	Asiatic clam (<i>Corbicula fluminea</i> ?) LC50
8.75	12.91	bluegill (<i>Lepomis macrochirus</i>) LC50
7.81	14.05	southern platyfish (<i>Xiphophorus maculatus</i>) LC50
6.81	12.12	fathead minnow (<i>Pimephales promelas</i>) LC50
5.87	10.57	isopod (<i>Lirceus alabamae</i>) LC50
3.91	7.04	Atlantic salmon (<i>Salmo salar</i>) LC50
3.70	6.53	brook trout (<i>Salvelinus fontinalis</i>) LC50
3.07	5.53	bryozoan (<i>Lophopodella carteri</i>) LC50
3.01	5.41	flagfish (<i>Jordanella floridae</i>) LC50
2.93	5.27	coho salmon (<i>Oncorhynchus kisutch</i>) LC50
2.89	5.20	bryozoan (<i>Plumatella emarginata</i>) LC52
2.84	5.11	snail (<i>Hellsoma campanulatum</i>) LC 50
2.70	4.86	sockeye salmon (<i>Oncorhynchus nerka</i>) LC50
2.35	4.23	bryozoan (<i>Pectinatella magnifica</i>) LC50
2.27	4.09	Tubificid worm (<i>Limnodrilus hoffmeisteri</i>) LC50
2.08	3.75	snail (<i>Physa gyrina</i>) LC50
2.07	3.95	snail (<i>Physa heterostrophia</i>) LC50
1.62	2.85	brook trout (<i>Salvelinus fontinalis</i>) CV
1.42	2.56	Mozambique tilapia (<i>Tilapia mossambica</i>) LC50
1.37	2.52	rainbow trout (<i>Oncorhynchus mykiss</i>) CV

Table 12 (continued)

Concentration (mg/L)		Effect
100 mg hardness	200 mg hardness	
1.26	2.32	rainbow trout (<i>Oncorhynchus mykiss</i>) LC50
1.25	3.88	guppy (<i>Poecilia reticulata</i>) CV
1.20	2.16	chinook salmon (<i>Oncorhynchus tshawytscha</i>) cv
0.848	2.025	cladoceran (<i>Daphnia magna</i>) EC50
0.803	1.445	chinook salmon (<i>Oncorhynchus tshawytsche</i>) LC50
0.598	1.075	Sockeye salmon (<i>Oncorhynchus nerka</i>) CV
0.455	0.819	cladoceran (<i>Daphnia pulex</i>) EC50
0.410	0.737	longfin dace (<i>Agosia chrysogaster</i>) LC50
0.313	0.564	cladoceran (<i>Ceriodaphnia dubia</i>) EC50
0.218	0.342	striped bass (<i>Morone saxatilis</i>) LC50
0.203	0.361	fathead minnow (<i>Pimephales promelas</i>) CV
0.120	0.211	acute NAWQC
0.110	0.191	chronic NAWQC
0.0928	0.1670	Cladoceran (<i>Daphnia magna</i>) CV
0.0912	0.1641	cladoceran (<i>Ceriodaphnia reticulata</i>) EC50
0.0900	0.0900	cutthroat trout (<i>Salmo clarki</i>) LC50
0.0730	0.1313	flagfish (<i>Jordanella floridae</i>) CV

^a Effect levels were converted based on a 100 mg/L water hardness. Slopes used for the conversion were associated with individual species, where specified in the Criteria document. Otherwise, 0.8473 was the slope for both the acute and chronic test conversions.

^b The cutthroat trout acute test did not specify the hardness of the water.

^c Effect levels were converted based on a 200 mg/L water hardness.

Acenaphthene

Acenaphthene is a polycyclic aromatic hydrocarbon (PAH) compound (EPA-Acen, 1993). Acenaphthene may occur naturally in coal tar or as a by product of various oil and coal tar manufacturing processes (Verschuere, 1983). It is also used in the production of dyes, plastics, insecticides and fungicides. The fate of acenaphthene in aquatic systems primarily depends on sorption and biodegradation and is hardly affected by oxidation, hydrolysis, or volatilization (EPA, 1980).

Toxicity in Sediment to Benthic Organisms In studies used to calculate the NOAA ER-L, effects were usually observed in association with concentrations of 0.15 mg/kg or greater (Long and Morgan, 1991). The AET for Puget Sound sediments, derived from the Microtox[®] bioassay, the

benthic community composition, oyster larvae bioassay, and *Rhepoxynius abronius* amphipod bioassay, were 0.5, 0.5, 0.5, and 0.63 mg/kg, respectively, in a 1986 study and 0.5, 0.73, 0.5, and 2.0 mg/kg, respectively, in a 1988 study (Long and Morgan, 1991). According to EPA (1993) benthic organisms represent both the most sensitive and most resistant organisms to acenaphthene in freshwater. The freshwater snail, *Aplexa hypnorum*, was the most resistant having an LC50 >2.04 mg/L and the stonefly, *Peltoperla maria*, was the most sensitive with an LC50 of 0.24 mg/L of acenaphthene. Long et al., (1995) reported ER-L and ER-M values of 16 and 500 mg/kg. The acute and chronic NAWQ criteria for acenaphthene in freshwater are 0.080 and 0.023 mg/L (Suter and Mabrey, 1994).

Anthracene

Anthracene is a member of the polycyclic aromatic hydrocarbons (PAHs) produced by incomplete combustion. Exposure may come from natural (coal tar, volcanoes, and forest fires) or anthropogenic (combustion of fossil fuels, wood burning stoves, furnaces, and power plants) sources.

Toxicity in Sediment to Benthic Invertebrates Long and Morgan (1991) reported an ER-L value of 0.085 mg/kg and an ER-M value of 0.96 mg/kg for the toxicity of anthracene. The ER-L degree of confidence is low because there is no consistency in the effects observed at lower concentrations. The AET for Puget Sound sediments, derived from the Microtox[®] bioassay, the benthic community composition, oyster larvae bioassay, and *Rhepoxynius abronius* amphipod bioassay, were 0.96, 1.3, 0.96, and 1.9 mg/kg, respectively, in a 1986 study and 0.96, 4.4, 0.96, and 13.0 mg/kg, respectively, in a 1988 study (Long and Morgan, 1991). Long et al., (1995) reported ER-L and ER-M values of 85.3 and 1100 mg/kg. There are no SQC or NAWQ criteria for anthracene, however, the SQB value derived using equilibrium partitioning, based on the Tier II SCV, and assuming 1% organic carbon is 0.0003 mg/kg. (Hull and Suter, 1994). The freshwater SCV for anthracene is 0.0000013 mg/L (Suter and Mabrey, 1994). The SQB derived from the LCV for fish is 0.023672 mg/kg.

Benzo(a)anthracene

Benzo(a)anthracene (B(a)A) is a polycyclic aromatic hydrocarbon (PAH) compound. B(a)A is found in smoke and soot from the burning of gasoline, garbage, or any animal or plant material (ATSDR, 1990). It is also found in coal tar pitch that industries use to join electrical parts or in creosote, used to preserve wood. B(a)A is a known animal carcinogen (ATSDR, 1990)

Toxicity in Sediment to Benthic Organisms In bioassays of the lower Columbia River sediments, no toxicity to *Hyalella azteca* was observed at concentrations of 2.2 mg/kg. However, these data were not used in the calculation of the ER-L (Long and Morgan, 1991). In the studies used to calculate the ER-L, no effects were observed at concentrations below 0.06 mg/kg. The overall AET from these data was 0.55 mg/kg, although AET values in the data base ranged from 1.3 to 5.1 mg/kg for Puget Sound to 0.06 to 1.1 mg/kg for San Francisco Bay. Long et al., (1995) reported ER-L and ER-M values of 261 and 1600 mg/kg. There are no SQC for benzo(a)anthracene, however, the SQB derived using equilibrium partitioning and assuming 1% organic carbon is 0.108 mg/kg and is based on the Tier II SCV (Hull and Suter, 1994). The freshwater SCV is 0.000027 mg/L (Suter and Mabrey, 1994). The SQB derived from the LCV for Daphnids is 2.59 mg/kg.

Benzo(a)pyrene

Benzo(a)pyrene (BaP) is a polycyclic aromatic hydrocarbon (PAH) consisting of 5 fused benzene rings. Despite their high lipid solubility, most PAH's show little tendency to biomagnify in food chains, probably because they are rapidly metabolized in most biota (Eisler, 1987). PAH's are ubiquitous in nature, produced by forest fires, microbial synthesis, and anthropogenic activities. PAH's are teratogenic, mutagenic, and carcinogenic, with the higher molecular weight compounds being less toxic than lighter compounds (Eisler, 1987).

Toxicity in Sediment to Benthic Organisms A study was found relating effects data in freshwater sediment to concentrations of benzo(a)pyrene: 220 mg/kg resulted in 95% mortality of *Hyallela azteca*. In the studies documented in Long et al. (1995), 63% indicated biological effects at concentrations between the ER-L (430 mg/kg) and ER-M (1600 mg/kg), and 80% of the studies at concentrations above the ER-M indicated biological effects. The freshwater SCV for benzo(a)pyrene is 0.000014 mg/L (Suter and Mabrey, 1994). There are no SQC for benzo(a)pyrene, however, the SQB derived using equilibrium partitioning and assuming 1% organic carbon is 0.14 mg/kg and is based on the Tier II SCV (Hull and Suter, 1994). The SQB derived from the LCV for Daphnids is 3.0 mg/kg.

Bis(2-ethylhexyl)phthalate

Bis(2-ethylhexyl)phthalate (BEHP) or di(2-ethylhexyl)phthalate is a colorless oily liquid that is extensively used as a plasticizer in a wide variety of industrial, domestic and medical products. The wide-spread uses of bis(2-ethylhexyl)phthalate have made the compound, along with other phthalic acid esters, ubiquitous in the environment. It has been detected in ground water, surface water, drinking water, air, soil, plants, fish and animals (Sittig, 1985; Sandmeyer and Kirwin, 1978). While bioaccumulation factors for bis(2-ethylhexyl)phthalate at lower trophic levels are high, because it is rapidly metabolized, levels in higher trophic levels are generally lower than those observed at lower trophic levels (Peakall, 1975).

Toxicity in Sediment to Benthic Organisms There were no specific data found relating to the toxicity of BEHP to benthic organisms. There are no SQC available, however, the SQB derived using equilibrium partitioning, based on the Tier II SCV, and assuming 1% organic carbon is $8.9\text{E}+05$ mg/kg. (Hull and Suter, 1994). The freshwater SCV for BEHP is 0.0322 mg/L (Suter and Mabrey, 1994). The SQB derived from the LCV for Daphnids is 82,626.861 mg/kg.

Chlordane, Total

Chlordane is a persistent organochlorine insecticide used primarily in non-agricultural areas. Because chlordane has a high biological potency and is long-lived in the environment, it presents a potential hazard to fish and wildlife. In the mid 1970's, approximately 50% of all chlordane used in the United States was for structural termite protection and approximately 30% was used for agricultural pest control (Parrish et. al., 1976). Since 1983, chlordane in the United States has only been used for the control of underground termites. Because chlordane is highly toxic to earthworms, that may be the greatest long-term hazard for the environment (WHO, 1984).

Toxicity in Sediment to Benthic Organisms Survival of the amphipod, *Hyallela azteca*, was unaffected at chlordane concentrations <0.0115 mg/L (Cardwell et al., 1977). Survival was reduced to zero at 0.0205 mg/L of chlordane. There are no SQC for chlordane, however, the SQB derived

using equilibrium partitioning, based on the NAWQ criteria, and assuming 1% organic carbon is 0.437 mg/kg. (Hull and Suter, 1994). The acute and chronic NAWQ criteria for the toxicity of chlordane in freshwater are 0.0024 and 0.00017 mg/L (Suter and Mabrey, 1994). The SQB derived from the LCV for NDI is 2.80173 mg/kg.

Chrysene

Chrysene is a polycyclic aromatic hydrocarbon (PAH) compound and like all other PAH compounds it is derived from both natural and man-made sources. The major sources of chrysene released into the environment are from the incomplete combustion of carbonaceous material, residential heating and open burning (ATSDR, 1990). Chrysene is known to accumulate in aquatic biota, however, detected concentrations are low because many organisms metabolize and excrete PAH compounds rapidly (ATSDR, 1990).

Toxicity in Sediment to Benthic Organisms In freshwater systems, a concentration of 4.1 mg/kg was not toxic to *Hyalella azteca* in the Columbia River but a concentration of 170 mg/kg in Lake Union, Washington, resulted in 95% mortality to *Hyalella azteca*. In the studies used to calculate the ER-L, effects were almost always observed at concentrations exceeding 0.9 mg/kg, although the lowest Puget Sound and San Francisco Bay AET values were 1.4 and 1.7 mg/kg, respectively (studies cited in Long and Morgan, 1991). Long et al., (1995) reported ER-L and ER-M values of 384 and 2800 mg/kg. There are no SQC or SQB values available for chrysene.

Dichloroethene

Dichloroethylenes are clear, colorless liquids and consist of three isomers: 1,1-dichloroethylene (1,1-DCE), cis-1,2-DCE, and trans 1,2-DCE (EPA 1980d). DCE is the isomer most widely used in industry and, consequently, in aquatic toxicity tests. DCE is used in the production of copolymers, such as Saran, which are used in the packaging industry and as coatings for steel pipes, and the interior of fuel storage tanks. 1,1-DCE is not known to occur in nature and is expected to be short-lived in water because of its volatilization to the atmosphere.

Toxicity in Water to Aquatic Life Acute toxicity values for 1,1-DCE are available for 3 freshwater animal species and range from 11.6 mg/L for the cladoceran *Daphnia magna* to 169.0 mg/L for the fathead minnow. The species mean acute values, based on two tests for each species, were (30.3 mg/L) for *D. magna* and (108.0 mg/L) for the fathead minnow. The lowest acute toxicity of DCE observed for the bluegill *Lepomis macrochirus* was 73.9 mg/L. This is also the only test in which 1,2-DCE was used. In the one available chronic test 1,1-DCE had a chronic value for the fathead minnow of >2.8 mg/L.

In the one available toxicity test using freshwater algae *Selenastrum capricornutum* had a 96-hr EC50 of >798.0 mg/L. Bioconcentration factors were not available for any isomer. However, the K_{ow} for DCE (5.37) indicates that it should not accumulate significantly. There are no NAWQ criteria for the DCE isomers.

DDT, Total

DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane) is an organochlorine insecticide that was banned from use in the United States in 1972. DDT, and its metabolites, DDE and DDD, are highly

persistent man-made chemicals and are not known to occur naturally in the environment (ATSDR, 1992). The half-life of DDT in soil is reported to range from 2 to 15 years (ATSDR, 1993). DDT and its metabolites are also highly lipophilic and have a high bioaccumulation potential. A bioconcentration factor for rainbow trout is reported to be 12000 (ATSDR, 1993). DDTs are transported from one medium to another by solubilization, adsorption, bioaccumulation, or volatilization (ATSDR, 1992).

4,4'-DDD

Toxicity in Sediment to Benthic Organisms No data regarding effects of 4,4'-DDD on benthic invertebrates were found from freshwater systems. Although marine data are available from all approaches, the degree of confidence in the ER-L and ER-M from Long and Morgan (1991) is low. The SQB for 4,4'-DDD derived using equilibrium partitioning and assuming 1% organic carbon is 0.063 mg/kg and is based on the Tier II Values (Hull and Suter, 1994). The freshwater SCV for DDD p,p is 0.00001 mg/L (Suter and Mabrey, 1994). The SQB derived from the LCV for fish is 10.66318 mg/kg.

4,4' - DDE

Toxicity in Sediment to Benthic Organisms Long et al., (1995) reported ER-L and ER-M values of 2.2 and 27 mg/kg. There are no SQC, SQB, or NAWQ criteria for DDE.

4,4' - DDT

Toxicity in Sediment to Benthic Organisms Long et al., (1995) reported ER-L and ER-M values of 1.58 mg/kg and 46.1 mg/kg for total DDT. There are no SQC for DDT, however, the SQB derived using the equilibrium partitioning and assuming 1% carbon is 0.745 mg/kg and is based on the NAWQ criteria (Hull and Suter, 1994). The freshwater NAWQ criteria for DDT is 0.0011 mg/L (Suter and Mabrey, 1994). The SQB derived from the LCV for plants is 5.58626 mg/kg.

Dibenz(a,h)anthracene

Dibenz(a,h)anthracene (DB(a,h)A) is a polycyclic aromatic hydrocarbon (PAH) compound. Like all other PAH compounds, it is a product of combustion and its major fate is most likely sorption and biodegradation (ATSDR, 1990). The half-life of (DB(a,h)A) in soil is estimated at 750 days.

Toxicity in Sediment to Benthic Organisms In studies used to calculate the ER-L, effects in sediments were observed at concentrations as low as 0.042 mg/kg in marine systems (Long and Morgan, 1991). The safe sediment level based upon equilibrium partitioning and the acute NAWQ criteria is 240 mg/kg (Long and Morgan, 1991). Long et al., (1995) reported ER-L and ER-M values of 63.4 and 260 mg/kg. There are no SQC or SQB for dibenz(a,h)anthracene.

Dieldrin/Aldrin

Dieldrin and aldrin are organochlorine pesticides that, prior to the 1970's, had been widely used in agriculture to control soil pests and as seed treatments (WHO 1989). Dieldrin was also widely

used to control tsetse flies and other tropical disease vectors. Since the early 1970's, however, the use of both compounds has been banned or severely restricted in the U.S. and many other countries (WHO, 1989). Aldrin is readily metabolized to dieldrin by both plants and animals, therefore, most environmental residues consist of dieldrin (WHO, 1989). Both compounds are contact and stomach poisons. In addition they are lipophilic and bioaccumulate in biota; bioconcentration factors of 170 and 10,000 have been reported for earthworms and fish (species not stated), respectively (WHO, 1989)

Toxicity in Sediment to Benthic Organisms Hoke and Ankley (1991, cited in EPA-Dieldrin, 1993) studied the effects of dieldrin-spiked sediment from three freshwater sites in Minnesota on the freshwater amphipod, *Hyalella azteca*. LC50's based on various total organic carbon (TOC) concentrations of 1.7, 2.9, and 8.7% were reported for *H. azteca* at 18.2, 35.0, and 386.0 mg/kg of dieldrin. Tests from two sites in Minnesota of the freshwater midge, *Chironomus tentans* at TOC concentrations of 1.5 and 2.0% had LC50's at 1.53 and 0.53 mg/kg of dieldrin. The SQC for Dieldrin/Aldrin derived using equilibrium partitioning and assuming 1% organic carbon is 0.11 mg/kg (EPA-Dieldrin, 1993).

Endrin

Endrin is a cyclodiene organochlorine insecticide, avicide, piscicide, and rodenticide. It has been used on various agricultural crops, including cotton, tobacco, sugar cane, rice and ornamentals. The use of endrin increased over the years until it was restricted and then banned in 1984 because of its toxicity to non-target organisms, bioaccumulation, and persistence (EPA-Endrin, 1993). The acute toxicity of endrin in freshwater ranges from 0.0008 to 0.352 mg/L with little variation between the acute and chronic toxicity of endrin to aquatic organisms (EPA-Endrin, 1993).

Toxicity in Sediment to Benthic Invertebrates Over 100 standard acute toxicity tests were reported by EPA (1993) with overall genus mean acute values (GMAV's) ranging from 0.00015 to 0.165 mg/L of endrin. Benthic organisms represented the most sensitive and most resistant of the freshwater species. The mayfly, *Hexagenia bilineata* (LC50 = 0.063 mg/L) and the oligochaete, *Lumbriculus variegatus* (LC50 >0.165 mg/L) were among the most endrin tolerant organisms. Various test for the toxicity of endrin to the amphipod, *Hyalella azteca* ranged from concentrations of 0.0044 to 0.006 mg/kg. EPA-Endrin (1993) reported LC50's of 4.8, 6.0, 5.1, 7.7, 19.6, 21.7, 10.3, and 9.8 mg/kg at TOC concentrations of 6.1, 11.2, 3.0, 3.0, 11.0, 11.0, 11.0, and 11.0% for the toxicity of dieldrin on the amphipod, *H. azteca*. The SQC for endrin derived using equilibrium partitioning and assuming 1% carbon is 0.042 mg/kg (EPA-Endrin, 1993).

Fluoranthene

Fluoranthene is a member of the polycyclic aromatic hydrocarbon (PAH) group of organic compounds. Sources of fluoranthene include crude oil, coal tar and motor oil or it may be produced by plants, algae and bacteria (Verschueren, 1983; as cited in EPA-Fluoranthene, 1993). Gradual increases in fossil fuel consumption in the United States will lead to increases in emissions of PAH's to the environment. The impact of PAH's is of environmental concern because they are known carcinogens and/or mutagens. Although fluoranthene bioaccumulates in aquatic biota, the associated health or ecological risks are unknown (EPA-Flu, 1993).

Toxicity in Sediment to Benthic Organisms In Lake Union, Washington, sediment with a concentration of 570 mg/kg caused 95% mortality to *Hyalella azteca*. Columbia River, Washington,

sediment with 2.1 mg/kg fluoranthene was not toxic to *Hyalella azteca*. The lowest AET for Puget Sound and San Francisco Bay were 1.7 and 2.0 mg/kg, respectively. The confidence in the ER-L is high (Long and Morgan, 1991). The EPA freshwater SQC assuming 1% organic carbon is 6.2 mg/kg (EPA, 1993-Fluoranthene).

A freshwater sediment with approximately 0.5% organic carbon was spiked with fluoranthene to generate an EC₅₀ for *Hyalella azteca* and *Chironomus tentans*, using organism immobility as the endpoint (Suedel et al., 1993). The EC₅₀ values were between 2.3 and 7.4 mg/kg for *H. azteca* and between 3.0 and 8.7 mg/kg for *C. tentans*. The SQC for fluoranthene derived using equilibrium partitioning and assuming 1% organic carbon is 6.2 mg/kg (EPA-Fluoranthene, 1994).

Fluorene

Fluorene is a polycyclic aromatic hydrocarbon (PAH) compound. Like all other PAH compounds, fluorene is the result of the combustion of fossil fuels and remains persistent in the environment (Eisler, 1987). Fluorene compounds may be introduced into aquatic environments by sewage effluents, surface runoff, or petroleum spills. PAH compounds reach soil by direct deposition or by deposition on vegetation.

Toxicity in Sediment to Benthic Organisms In Lake Union, Washington, sediment with a concentration of 40 mg/kg fluorene caused 95% mortality in *Hyalella azteca*. The SQC calculated using equilibrium partitioning and the acute NAWQ criteria and 1% organic carbon yields a value of 7.0 mg/kg (Long and Morgan, 1991). Long et al. (1995) reported ER-L and ER-M values of 19 and 540 mg/kg for fluorene.

Naphthalene

Naphthalene is a white solid substance used in the manufacture of dyes, resins and in mothballs. It is released to the air from the burning of coal and oil and from the use of mothballs containing naphthalene. Naphthalene may also be released into the air by coal tar production and wood preservation. In water and soil, naphthalene is either destroyed by bacteria or evaporated into the air within a few hours or days (ATSDR, 1989). Naphthalene breaks down readily in the environment and is easily metabolized by various organisms (ATSDR, 1989).

Toxicity in Sediment to Benthic Organisms In Lake Union, Washington, sediments with 40 mg/kg naphthalene caused 95% mortality in *Hyalella azteca*. Effects were almost always observed at concentrations greater than 0.50 mg/kg in marine systems (Long and Morgan, 1991). The Puget Sound AET was 2.1 mg/kg. Long et al. (1995) reported ER-L and ER-M values of 160 and 2100 mg/kg. The SQB value is 0.407 mg/kg and is derived from equilibrium partitioning and assuming 1% organic carbon (Hull and Suter, 1994). The freshwater SCV is 0.0234 mg/L (Suter and Mabrey, 1994). The SQB derived from the LCV for fish is 10.77 mg/kg.

PAH, Total

Polycyclic aromatic hydrocarbons (PAH) are composed of two or more fused aromatic rings containing only carbon and hydrogen atoms (Hodgson, 1984). Anthropogenic combustion of fossil fuels is thought to be the primary source of PAH in the aquatic environment. Some PAH's are among the most potent carcinogens known to exist (Eisler, 1987). Prior to 1900, the production and

degradation of PAH's was balanced, however, the recent increase in industrial development and increased emphasis of fossil fuels as energy sources has disrupted that balance. PAH's reaching the sediment may be adsorbed or assimilated by plant leaves before entering the animal food chain. The fate of PAH's that accumulate in sediments is thought to be biotransformation and biodegradation by benthic organisms (EPA, 1980; Eisler, 1987). Long et al., (1995) reported ER-L and ER-M values of 4022 and 44792 mg/kg for total PAH.

PCB's

Polychlorinated biphenyls (PCB's) are a family of man-made chemicals consisting of 209 individual compounds with varying toxicity (ATSDR, 1989). Aroclor is the trade name for PCB's made by Monsanto. Because of their insulating and nonflammable properties, PCB's were widely used in industrial applications such as coolants and lubricants in transformers, capacitors, and electrical equipment (ATSDR, 1989). The United States stopped manufacturing PCB's in 1977 due to evidence that they accumulated in the environment. Although PCB's are no longer manufactured or used in the United States, they remain present and will continue to become a widespread environmental contaminant. The biodegradation of PCB's in soil is slow, especially in soils with high organic carbon content (ATSDR, 1993).

Toxicity to Wildlife Mink are one of the most susceptible mammals; dietary levels as low as 0.1 ppm fresh weight have caused death and reproductive toxicity (Eisler, 1986). Diets containing 20 ppm Aroclor 1242 were lethal to mink in a 247-day experiment.

PCB-Total

Toxicity in Sediment to Benthic Organisms Freshwater data indicated little or no concordance between toxicity and PCB concentrations. Relatively poor relationships were observed between the incidence of effects and the concentrations of total PCBs in marine sediments. For example, there is a relatively low (51%) incidence of biological effects at concentrations greater than the ER-M ("probable-effects range") (Long et al., 1995). Co-occurrence analyses and AET are highly variable and are predominantly for marine and estuarine systems. Co-occurrence analyses indicated that concentrations of PCBs ranging from 0.038 to 0.276 mg/kg were highly toxic (43-79% mortality) to the amphipod *Rhepoxynius abronius*. Long and Morgan (1991) reported LC₅₀ and/or EC₅₀ PCB concentrations of 0.26 mg/kg for toxicity tests on the amphipod. AET of approximately 1 mg/kg, were associated with reduction of the benthic community composition in Puget Sound. However, some inconsistency in effects is expected given the variance in composition of PCB mixtures. Long et al., (1995) reported ER-L and ER-M values of 22.7 and 180 mg/kg. There are no SQC for total PCB, however, the SQB derived from equilibrium partitioning, based on NAWQ criterion, and assuming 1% organic carbon is 20.52 mg/kg. (Hull and Suter, 1994). The acute NAWQ criterion for total PCB is 0.002 mg/L (Suter and Mabrey, 1994).

Toxicity to Wildlife Most exposures to PCBs are oral. Absorption of PCBs following oral exposure is often >90% (ATSDR, 1989). PCBs are preferentially stored in adipose tissues in animals. They may cross the placenta or be transferred to offspring through milk. PCBs with higher chlorine content (the last 2 digits of the Aroclor designation indicate the percent Cl content of the compound) tend to persist in the environment longer than those with lower Cl content, and PCBs are known to bioaccumulate and biomagnify to toxic concentrations in animals (Eisler, 1986; ATSDR, 1989). Chronic exposures are of particular concern. PCBs with high K_{ow} values and high numbers of chlorines in adjacent positions are generally the most toxic. Although relatively insoluble in

water, PCBs are generally freely soluble in nonpolar organic solvents and in biological lipids (EPA, 1980).

PCB-1254

Toxicity in Sediment to Benthic Organisms The log K_{oc} for Aroclor 1254 is 5.93. There are no SQC for PCB-1254, however, the SQB derived from equilibrium partitioning and assuming 1% organic carbon is 0.17 mg/kg (Hull and Suter, 1994). The freshwater SCV is 0.00002 mg/kg (Suter and Mabrey, 1994). The SQB derived from the LCV for plants is 0.85 mg/kg.

Toxicity to Wildlife Sixty percent of mice fed diets containing 1,000 ppm Aroclor 1254 for 14 days died within 15 days, but none of the mice fed diets with only 250 ppm Aroclor for 14 days died (Sanders et al., 1974). These diets translate to doses of 130 and 32.5 mg/kg/day, respectively (ATSDR, 1989). White-footed mice fed 10 ppm Aroclor 1254 for 18 months had fewer offspring produced and a longer time between litters than control mice (Linzey, 1987).

Feeding studies suggest a total intake of 500-2,000 mg/kg of Aroclor 1254 obtained through the diet over 1 to 7 weeks is lethal in rats (Hudson et al., 1984). Male rats consuming diets containing 0-100 ppm Aroclor 1254 for 104 weeks suffered dose-related reduced survival (NCI, 1978); however, there was no effect on similarly treated female rats. Dietary concentrations of ≥ 20 ppm Aroclor 1254 reduced litter sizes in one- and two-generation reproduction studies with rats; concentrations < 5 ppm had no effect (Linder et al., 1974).

The LC_{50} for chronic exposures is 6.65 ppm Aroclor 1254 for mink over a 8 month period (Ringer et al., 1981). Diets containing 5 ppm Aroclor 1242 caused complete reproductive failure (Bleavins et al., 1980). Exposure for 160 days to 3.57 ppm Aroclor 1254 resulted in 100% mortality of adult mink (Platonow and Karstad, 1973).

A chronic study was conducted over 4.5 months exposing mink to 1, 5 and 15 ppm Aroclor 1254 in the diet. There was a significant reduction in the number of offspring born alive at the 5 and 15 mg/kg exposures (Aulerich and Ringer 1977). Mink fed carp containing 1.5 ppm Aroclor 1254 for 6 months produced no offspring that survived to 24 hours (Hornshaw et al., 1983). No effects were observed in mink fed 0.64 ppm Aroclor 1254 for 160 days (Platonow and Karstad, 1973). Exposure of mink for 6 months to 1 ppm Aroclor 1254 resulted in no significant difference from controls in number of offspring, or offspring mortality (Wren et al., 1987). Therefore, the 1 ppm dose was considered to be a chronic NOAEL.

A dietary dose of 25 ppm Aroclor 1254 fed for at least a month before egg-laying in mallard ducks had no detrimental effect on reproductive success (Custer and Heinz, 1980). Dietary exposure of 5 ppm Aroclor 1254 for 39 weeks to laying hens and roosters resulted in reduced egg production, although hatchability of fertile eggs was not affected (Platonow and Reinhart, 1973). Screech owls fed 3 ppm Aroclor 1248 through two breeding seasons did not have significantly different reproductive success, relative to controls (McLane and Hughes, 1980). Exposure of pheasants to 12.5 mg/bird/week (1.8 mg/kg/d) of Aroclor 1254 for 17 weeks resulted in significantly reduced egg hatchability (Dahlgren et al., 1972). Because this study considered exposure throughout a critical life stage (reproduction), the 12.5 mg/bird/week dose was considered to be a chronic LOAEL.

PCB-1260

Toxicity in Sediment to Benthic Organisms The log K_{oc} for Aroclor 1260 is 7.02. There are no SQC for PCB-1260, however, the SQB derived from the equilibrium partitioning and assuming 1% organic carbon is 1099 mg/kg (Hull and Suter, 1994). The freshwater SCV is 0.0105 mg/L (Suter and Mabrey, 1994). The SQB derived from the LCV for fish is 136.127 mg/kg.

Table 13. Concentrations of PCB causing toxic effects in lipids and whole bodies of fish.
Concentrations are the geometric means of body burdens at the LOEC and NOEC.

Species	PCB form	mg/kg lipid wet weight	mg/kg wet weight	LOEC Effect	Source
channel catfish	1242	<213 ¹	<14.3 <11.9 ¹³	growth	Hansen et al. 1976
fathead minnow	1242	NE ²	>390 ³	100% mortality	Nebeker et al. 1974
fathead minnow	1248	370 ⁴	ca 26 ⁴	growth (F2)	DeFoe et al. 1978
lake trout	1254	22 ⁶	0.7	survival	Berlin et al. 1981
coho salmon	1254	NE ²	<645	100% mortality	Mayer et al. 1977
fathead minnow	1254	NE ²	126 ⁹	repro	Nebeker et al. 1974
brook trout	1254	NE ²	94 ¹¹	mortality	Mauck et al. 1978
fathead minnow	1260	NE ²	<350 ¹²	weight	DeFoe et al. 1978

¹ The < sign signifies that the value corresponds to a LOEC, not a CV.

² Not estimated due to lack of lipid content data.

³ 390mg/kg is the residue that was associated with no mortality and extremely variable spawning. Mortality occurred at higher exposures, but residues were not measured.

⁴ These values are approximate due to extraction of the LOEC, NOEC, and lipid content from figures.

⁶ The residue is normalized for lipid content based on an estimate of R. Hesselberg, one of the authors of the paper. His estimate of 3 % lipid is from another study, but is from fish of the same species and about the same age.

⁹ Value for males; the female value is higher

¹¹ The residue for effects on weight was not presented in the paper but is probably < 71 mg/kg.

¹² 350 mg/kg was the body residue at 250 days exposure. The 66 days exposure was associated with an 8% decrease in weight.

¹³ Concentration in edible carcass; all others are whole fish

Phenanthrene

Phenanthrene is a polycyclic aromatic hydrocarbon (PAH) compound. It is produced by fractional distillation of high-boiling coal-tar oil and purification of the crystalline solid (Hawley, 1981; cited in EPA-Phenanthrene, 1993). Phenanthrene may be used in the manufacturing of dye, drugs, and explosives. The fate of phenanthrene in sediment is highly influenced by sorption and biodegradation. Phenanthrene has the ability to bioaccumulate in aquatic biota. The acute toxicity

of phenanthrene in freshwater ranges from 0.096 to >1.150 mg/L and 0.0219 to 0.6 mg/L for saltwater organisms.

Toxicity in Sediment to Benthic Organisms In Lake Union, Washington, sediments with 410 mg/kg phenanthrene caused 95% mortality among *Hyaella azteca*. Columbia River, Washington, sediments with 0.58 mg/kg phenanthrene were not toxic to the same species (studies cited in Long and Morgan, 1991). The EPA SQC for phenanthrene is 1.8 mg/kg assuming 1% organic carbon (EPA-Phen, 1993). Long et al., (1995) reported ER-L and ER-M values of 240 and 1500 mg/kg. The SQC for phenanthrene derived using equilibrium partitioning and assuming 1% organic carbon is 1.8 mg/kg (EPA-Phen, 1993).

Pyrene

Pyrene is an polycyclic aromatic hydrocarbon (PAH) compound. The PAH are of environmental concern because they are known carcinogens and/or mutagens. Like all other PAH compounds, pyrene is a product of combustion and it's major fate is most likely biodegradation (ATSDR, 1990).

Toxicity in Sediment to Benthic Organisms In Lake Union, Washington, sediments with 750 mg/kg pyrene caused 95% mortality among *Hyaella azteca*. A concentration of 2.5 mg/kg in Columbia River, Washington, sediments was not toxic to the same species (studies cited in Long and Morgan, 1991). The EPA interim SQC based on equilibrium partitioning and 1% organic carbon is 13.1 mg/kg (Long and Morgan, 1991). Long et al., (1995) reported ER-L and ER-M values of 665 and 2600 mg/kg.

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G.13.4 FINDINGS OF THE VEGETATION ASSESSMENT AT SELECTED SITES IN BEAR CREEK VALLEY

1. INTRODUCTION

Vegetation at fourteen sites in Bear Creek valley was visually assessed for mortality and indicators of plant stress. The surveys were conducted on November 1, 2, 9, 10, and 17, 1995. The assessments were conducted at a coarse level consisting solely of visual observations during site walk-through surveys.

Vegetation at the sites was assessed primarily for (1) groupings of dead trees or shrubs, (2) patches of dead ground cover vegetation, (3) twig or bud die-back, and (4) atypical growth form. Signs of plant stress in leaves or in many short-lived herbaceous species (e.g., chlorosis; premature senescence, and other leaf damage) could not be assessed because most of the vegetation was entering dormancy and/or had begun senescence. The aboveground parts of most of the perennial grasses and herbaceous species were dead or in the process of annual die-back. The trees and shrubs had ceased chlorophyll production and most had dropped some or all of their leaves. The first widespread killing frost of the year occurred on November 3 when the temperature was 310°, although some of the survey sites may have been affected by scattered frost that occurred on October 22. Frost has occurred on several nights since November 3.

Ten of the sites are situated over contaminant plumes in the shallow groundwater. Four of the sites are in the upstream or other areas outside of the groundwater contaminant plume area and were used as reference sites. The sites are as follows:

Groundwater Plume Area	Reference Sites
Mainstem Bear Creek in West End Management Zone	
North Tributary (NT)1 downstream of Bear Creek Rd.	NT1 upstream of Bear Creek Rd.
NT2 at and downstream of Haul Rd.	NT2 upstream of Haul Rd.
NT3 in Boneyard Burnyard	NT3 upstream of Haul Rd.
NT7 between Haul Rd. and Bear Creek Rd	
NT8 from Burial Ground fence to Bear Creek and the West branch of NT8 upstream of Haul Rd.	
.South Spring (SS) 2	
SS3	
SS 4	
SS 5	SS6

Although several sites outside of the groundwater contaminant plume area were assessed as reference sites, a direct comparison between sites within and outside of the zone of groundwater contamination is not possible because of the differences in vegetation communities, disturbance histories, and

external influences. Vegetation sampling sites in the Bear Creek floodplain and riparian zone that were visited in October for a different task are briefly discussed.

2. SURVEY FINDINGS

2.1 North Tributary (NT) 1—Downstream of Bear Creek Road

This site was surveyed on November 1, 1995. It is located in and around Bear Creek North Tributary 1 between Bear Creek Road and the NT1-Bear Creek confluence. This reach of the stream and the surrounding land has been highly disturbed as a result of construction of the West End Management Zone. Most of the adjacent land has been cleared, graded, and filled. A small patch of a relatively undisturbed forest community, dominated by red oak and white oaks (*Quercus rubra*, *Q. alba*) exists on a slope to the northwest of the stream bottom. However, most of the stream bottom and riparian zone, and adjacent uplands have been impacted by construction. Obvious impacts to the stream and adjacent areas include clearing and alteration of the stream bottom and riparian vegetation, stream siltation, and elimination of upland forest. A steep fill bank covered with stone rip-rap abuts the stream bottom in the section just downstream of the Bear Creek Road culvert. It appears that there may have been clearing of most of the vegetation around the stream in this section; however, it is not known if this was done sometime in the past or as a part of the West End Management Zone construction. The stream is heavily silted from soil eroded from the developed site.

Common species in the stream bottom include box elder (*Acer negundo*), microstegium (*Eulalia viminea*), Japanese honeysuckle (*Lonicera japonica*), kudzu, elderberry (*Sambucus canadensis*), blackberry (*Rubus* sp.), poison ivy (*Toxicodendron radicans*), privet (*Ligustrum vulgare*), rose (*Rosa* sp.), saplings of tulip poplar (*Liriodendron tulipifera*), green ash (*Fraxinus pennsylvanica*), and red maple (*Acer rubrum*), and an unidentified grass. (The unidentified grass is probably Kentucky fescue (*Festuca arundinacea*), a commonly planted grass.) Microstegium, Japanese honeysuckle, privet, kudzu, and fescue are all exotic species that are commonly found on disturbed or altered sites.

There are several dead or partially dead trees in the upstream reach of this section of NT1. Some of the dead trees are covered with kudzu. Kudzu vines grow rapidly and will blanket, and eventually kill by shading, most other vegetation species including mature canopy trees. At least some of the tree mortality may be attributed to kudzu growth. There are several dead trees, a couple of them fallen, in the stream bottomland immediately downstream of the kudzu area. Death cannot be attributed to kudzu since the vines have not yet spread to this area. Other possible explanations for tree death include bottomland siltation (which would deprive tree roots of oxygen) and physical damage to the trees from construction activities. In the same area as the dead trees, the ground cover and shrub layer is dominated by grasses, privet, blackberry, rose, and green ash and box elder saplings, none of which show obvious signs of stress or damage.

In the downstream reach of the survey site NT1 is directed through a culvert that ends at the main stem of Bear Creek. Within the last year beaver have built a dam in Bear Creek just downstream of the incoming NT1 culvert, which has resulted in higher water levels in the downstream reach of NT1. There are at least six dead or stressed trees in the flooded portion of NT1. There are no dead or visibly stressed trees in the uplands and bottomland that is immediately adjacent to the flooded area. The lack of mortality or signs of stress in adjacent vegetation suggests that the cause of tree death and plant stress is the extended inundation of the root zone.

2.2 North Tributary—Upstream of Bear Creek Road

The site survey was conducted on November 1, 1995. This site encompasses the bottomland of NT1 in the upstream reach extending from the spring at the base of Pine Ridge to the Bear Creek Road culvert. This reach of NT1 is outside of the groundwater plume area. It is not directly comparable to the downstream reach because of the differences in the vegetation community and the levels of disturbance.

NT1 begins at springs and seeps at the base of Pine Ridge. It flows through a relatively undisturbed forested catchment, crosses a power line right-of-way (ROW), then flows through a forested bottomland prior to entering the culvert under Bear Creek Road and entering the West End Management Zone (Sect. 2.1).

Immediately upstream of the ROW, NT1 forms a small pond and scrub-shrub wetland. Species in and around the pond include red maple, sweetgum (*Liquidambar styraciflua*), loblolly pine (*Pinus taeda*), black willow (*Salix nigra*), cattail (*Typha latifolia*), blackberry, lespedeza (*Lespedeza sericea*), Japanese honeysuckle, and sedges (*Carex* spp. and *Scirpus* spp.). There are several dead trees and tree stumps in the pond. The apparent cause of tree mortality is long-term inundation. Trees outside of the inundated area show no obvious signs of stress or mortality.

In the ROW, NT1 has been directed through a culvert and has been partially channelized. No dead trees or shrubs, patches of dead vegetation or obvious signs of plant stress were observed in the ROW. There are patches of bare soil in the ROW, but the lack of vegetation can probably be attributed to low soil fertility and organic matter content.

Downstream of the ROW NT1 flows through an undisturbed oak-dominated upland and then enters a forested wetland. The dominant species are red oak, white oak, chestnut oak (*Q. prinus*), sycamore, ironwood (*Carpinus caroliniana*), sweetgum, tulip poplar, green ash, red maple, flowering dogwood (*Cornus florida*), microstegium, leafy bulrush (*Scirpus polyphylos*), sedges, jewelweed (*Impatiens capensis*), cardinal flower (*Lobelia cardinalis*), and Christmas fern (*Polystichum acrostichoides*). No dead or visibly stressed vegetation was observed in this area, with the exception of one small area in the forested wetland adjacent to the Bear Creek Road right-of-way. In this location there are two dead red maples and four dead green ash. These species are adapted to wet soil conditions thus it is unlikely that they died as a result of the wetland conditions. The dead trees are surrounded by apparently healthy saplings of red maple and sweetgum and mature trees of other species, which suggests that the condition(s) that lead to tree mortality is no longer present.

2.3 North Tributary 2—From the Vicinity of the Haul Road to the Bear Creek Confluence

This site was surveyed on November 9, 1995. The site extends from the power line ROW to the NT2-Bear Creek confluence. From approximately 50 feet upstream of the Haul Road downstream to the Bear Creek confluence the site is in the groundwater contaminant plume area. The areas immediately adjacent to the Haul Road on both the upstream and downstream sides have been altered by road construction.

On the immediate upstream side of the Haul Road, for a distance of approximately 30 to 40 feet, the native vegetation has been cleared for road and ROW construction. The stream and adjacent riparian zone is frequently inundated or saturated because the drainage is slowed by the road bank and culvert. There are at least six dead or partially dead trees in and adjacent to this expanded area of saturation and inundation. At least four of the dead trees might have been oaks, most of which, in

this area, do not grow well on wet sites. The shrub and ground cover layer in the same area is dominated by smooth alder (*Alnus serrulata*), sweetgum and sycamore saplings, fescue, bulrush (*Scirpus* sp.), microstegium, Japanese honeysuckle, aster (*Aster* sp.), seedbox (*Ludwigia* sp.), leafy bulrush, smartweed (*Polygonum* sp.), and bugleweed (*Lycopus virginicus*). No plants in the shrub and ground cover layer had indicators of stress or premature death.

Altered hydrology (prolonged inundation and increased soil saturation) appears to be the cause of tree mortality in the area just upstream of the Haul Road. The evidence supporting this conclusion is: (1) the dead trees may be species that are not adapted to wet conditions; (2) they are surrounded by apparently healthy trees and shrubs, and; (3) there is no evidence of stress or mortality in shrubs and ground cover growing in the same area. Dead trees in the bottomlands immediately upstream of the Haul Road culverts are not an unusual sight in the Bear Creek valley and are known to occur in at least six locations (NT3, NT4, NT5, NT8, NT9, NT10). In all of these locations, the cause of tree mortality is probably the extended periods of saturation and inundation of the root zone resulting from retention of water upstream of the Haul Road culverts.

On the immediate downstream side of the Haul Road, NT2 is flanked by naturally revegetated banks. At the top of the banks, for a short linear distance along the stream, are areas which are level to slightly sloping that have been planted in grass and are routinely mowed. The stream then enters a level, wooded area that is dominated by mixed pine and hardwoods. Species on the revegetated stream banks and in the wooded area include black willow, sycamore, red maple, box elder, sweetgum, oaks, tulip poplar, spicebush (*Lindera benzoin*), microstegium, Japanese honeysuckle, blackberry, sedges, fescue, and goldenrod.

On the southeast side of the stream in the area flanked by the planted grass there are several dead and partially dead trees and a patch of dead ground cover vegetation. The dead ground cover is an approximately 10-ft wide patch of Japanese honeysuckle vines that extends from the edge of the stream to the edge of the grassy area at the top of the bank. The honeysuckle leaves are blackened, unlike those on adjacent honeysuckle vines which are dark green. The presence of leaves indicates that the impact is recent; however, the cause of mortality is unknown. The dead and partially dead trees are located at or near the bottom of the grassy bank a short distance downstream from the dead ground cover patch. There are two standing dead trees and two fallen dead trees. One of the partially dead trees is a tulip poplar that forks about halfway up the main trunk. One of the forks is living and the other is dead. In addition, there is an ash tree that has a misshapen crown and at least one dead branch. No other dead or stressed vegetation was observed in this site.

2.4 North Tributary 2—Upstream of the Haul Road

The NT2 catchment upstream of the immediate Haul Road vicinity is outside of the groundwater plume area. The vegetation community is an apparently healthy hardwood forest dominated by oaks, beech (*Fagus grandifolia*), tulip poplar, and elm (*Ulmus* sp.), with black cherry (*Prunus serotina*) and pawpaw (*Asimina triloba*) as minor species. There are several old dead trees scattered throughout the forested area, but all appear to be a naturally occurring part of the forest ecosystem.

2.5 North Tributary 3—Downstream of the Haul Road

This site was surveyed on November 2, 1995. The site comprises the stream bottom and riparian zone of North Tributary 3 in the reach from the Bear Creek Haul Road to the confluence with Bear Creek. It is in a groundwater contaminant plume area. This reach of NT3 is in a contaminated area

(the "Boneyard Burnyard") and was surveyed from the Oil Landfarm and landfill cap on the western side of the stream, outside of the yellow-&-magenta chain barrier. The distance from the chain barrier to the stream ranged from approximately 5 feet to 25 feet.

The stream may have been channelized. It flows through small wooded areas in the upstream and downstream ends of the survey area, but the largest section flows through an open area with grass-covered caps to the west and the lespedeza/grass-dominated Boneyard Burnyard to the east. The stream also forms a small ponded area in a utility ROW immediately downstream of the Haul Road culvert. The species in the upstream and downstream wooded areas include loblolly pine, box elder, red oak, white oak, beech, red maple, sweetgum, black willow, blackberry, rose, microstegium, Japanese honeysuckle, and sedges. The species growing in the ROW clearing and on the stream banks in the field area include immature black willow, smooth alder, monkey flower (*Mimulus* spp.), cattail, grasses, and sedges.

No dead or visibly stressed vegetation was observed in the stream riparian area and in the adjacent wooded upland areas. There were brown patches of dead grass and clover (both of which had been seeded) on the cap to the west of the stream. It is highly unlikely that there is a relationship between contamination in the shallow groundwater and these patches of dead vegetation because of the nature of the cap (i.e., designed for exclusion of groundwater from the surface). An odor of hydrogen sulfide was detected in an area along the side bank of the cap. It is not known if there is a relationship between the hydrogen sulfide and plant mortality.

2.6 North Tributary 3—Upstream of the Haul Road

The site survey was conducted on November 2, 1995. The upstream reach of NT3 is not in a groundwater contaminant plume area. However, it is not directly comparable as a reference site because of the differences in the vegetation community and levels of disturbance. NT3 upstream of the Haul Road flows through an undisturbed forested catchment. There are dead trees in the bottomland immediately upstream of the Haul Road, but mortality is believed to be the result of the increased levels of soil saturation and inundation caused by the placement of the Haul Road and culverts. With the exception of these dead trees near the culvert, no dead or visibly stressed vegetation was observed at this site.

2.7 North Tributary 7

This site, which is in a groundwater contaminant plume area, was surveyed on November 2, 1995. NT7 has been significantly altered by the past activities and more recent remedial activities in and around the Bear Creek burial grounds. It is located in a groundwater contaminant plume area. Upstream of the Haul Road, NT7 flows through the middle of the burial ground. It is flanked by concrete caps and lined with stone rip-rap, but is also flanked on one side by a tree-covered slope. It was not possible to observe this area closely because it is within the fenced, restricted access area of the burial ground; however, in a long-distance observation from the Haul Road, no patches of dead vegetation or any dead trees were evident.

In the stream reach between the Haul Road and the confluence with Bear Creek, NT7 has been channelized and lined with stone rip-rap. Planted sycamore and tulip poplar trees are on the top of the banks, but there is essentially no canopy and very little coverage in the shrub/sapling layer. The stream is flanked by a field with sparse growth of grass and herbaceous species to the east and, to the west, by a fescue-dominated vegetation strip that separates the stream from a gravel road and an area

of buildings. In addition to the planted sycamore and tulip poplar, species growing along the stream include fescue, lespedeza, Queen Anne's lace (*Daucus carota*), goldenrod (*Solidago* spp.), tick-trefoil (*Desmodium* sp.), wool grass (*Scirpus cyperinus*), blackberry, and saplings of black willow, box elder and red cedar (*Juniperus virginiana*). No dead or visibly stressed vegetation was observed at this site.

2.8 North Tributary 8

The NT8 site was surveyed on November 9, 1995. A walk-through survey of almost the entire length of NT 8 was conducted. NT8 has an east and west branch that both begin north of the Haul Road. Portions of the upstream branches are in a groundwater contaminant plume area.

The uppermost reach of the east branch is within the Bear Creek burial ground fence and was not surveyed. The east branch bottomland downstream of the fence supports an immature forested wetland community dominated by red maple, sweetgum, tulip poplar, ironwood, and microstegium. The wetland extends into the power line ROW which parallels the north side of the Haul Road. The vegetation in the ROW portion of the wetland has been recently mowed with a Bushhog; thus, it was not possible to determine species presence or to assess the vegetation for non-mowing related mortality or stress.

The bottomland of the west branch of NT8 is larger in size and, on the day of the survey, had a wetter substrate (e.g., standing water; saturated, anoxic soil) than the east branch bottomland. The upper reach of the west branch flows through an upland oak forest. However, approximately 2/3 to 3/4 of the bottomland area upstream of the Haul Road is a forested wetland. Species include green ash, red maple, sweetgum, and black willow in the canopy and sapling layer, and microstegium, sedges, cardinal flower, false nettle, smartweed, and rushes (*Juncus* sp.) in the herbaceous layer. In the bottomland area just upstream of the Haul Road culvert there are numerous dead trees, most of them small with only the main trunk and one or two branches remaining. Tree mortality may be attributable to the altered hydrology upstream of the Haul Road culvert.

The east and west branches flow through culverts under the Haul Road then flow through un upland mixed pine/hardwood forest. The streams join at seep marker 04-475, and the single channel continues through a loblolly pine plantation. The banks become progressively shallower and the stream enters a wetland. The wetland receives its primary water input from groundwater and supports a diverse and apparently healthy wetland plant community. Species include sycamore, green ash, smooth alder, spicebush, rice cut-grass (*Leersia oryzoides*), several species of sedge, soft rush (*Juncus effusus*) turtlehead (*Chelone glabra*), smartweed, leafy bulrush, bugleweed, cardinal flower, curly dock (*Rumex crispus*), and fowl manna grass (*Glyceria striata*). There are several dead trees and stumps. The possible cause of tree mortality is not clear. Altered hydrology and increased site saturation and inundation is a potential cause; however, unlike the bottomland areas upstream of the Haul Road, there is no downstream culvert or road bank that would serve to artificially detain water. No other potential causes for tree mortality were observed or evident.

2.9 The Mainstem of Bear Creek in the West End Management Zone

The Bear Creek main stem in the West End Management Zone was surveyed on November 1, 1995. This reach of Bear Creek is located in a groundwater contaminant plume area. It was not possible to access the stream or the banks of the stream in the upper reach because it was cordoned off with a yellow-and-magenta chain barrier. A brief walk-through of the downstream section revealed no patches of dead or stressed vegetation. Species identified during the survey include

sycamore, tulip poplar, Japanese honeysuckle, black cherry, elm, aster, black walnut (*Juglans nigra*), box elder, redbud (*Cercis canadensis*), blackberry, rose, and microstegium. A wetland survey of this area was conducted in the summer of 1994. The species identified during that survey included sweetgum, red maple, green ash, slippery elm, leathery bulrush, rice cut-grass, fowl manna grass, arrowleaf tearthumb (*Polygonum sagittata*), sensitive fern (*Onoclea sensibilis*), cardinal flower, hog peanut (*Amphicarpaea bracteata*), lance-leaved loosestrife (*Lysimachia lanceolata*), several species of sedge, and common reed (*Phragmites* sp.). No patches of dead or visibly stressed vegetation was observed during the wetland survey.

2.10 South Spring 4

The South Spring (SS) 4 area was surveyed on November 2, 1995. The spring is located at the base of Chestnut Ridge and immediately adjacent to the shoulder of Bear Creek Road. It is located in a groundwater contaminant plume area. There is a shallow stream channel that flows parallel and immediately adjacent to the road shoulder for a short distance before entering a culvert under the road and continuing toward Bear Creek. The stream zone is in a narrow area between the bottom of the steep wooded slope of the ridge and the road shoulder. It is well-shaded by tulip poplar, sycamore, beech, elm, ash, sweetgum, red maple, and sugar maple (*Acer saccharum*) in the canopy, and smooth alder and flowering dogwood (*Cornus florida*) in the shrub layer. There is a large beech and a large elm growing at the spring. Herbaceous species include microstegium, cardinal flower, aster, bugleweed, sedges, leafy bulrush, and Japanese honeysuckle. No dead or visibly stressed vegetation was observed at this site.

2.11 South Spring 5

The South Spring 5 area was surveyed on November 10, 1995. SS5 is located in a groundwater contaminant plume area. The spring forms a deep, steep-sided pool that drains directly into Bear Creek. There is no floating or rooted aquatic vegetation in the pool. During previous surveys and informal visits to this area conducted from 1992 through 1994, some during the spring and summer, at no time was aquatic vegetation observed in the SS5 pool. The lack of aquatic plants is probably due to natural conditions such as shading, pool depth, and water chemistry. For comparison, South Spring 6, which is not located near a groundwater contaminant plume and forms a similar but smaller pool on the edge of a utility ROW, also does not support aquatic vegetation.

SS5 is flanked by hardwood forest on the south and west sides. The spring area is adjacent to Bear Creek Road and Chestnut Ridge Road but is separated from these by a narrow hardwood forest buffer. Vegetation species include oak, tulip poplar, beech, ironwood, Japanese honeysuckle, Christmas fern, and cross vine (*Bignonia capreolata*). No dead or visibly stressed vegetation was observed at this site.

2.12 South Spring 2

South Spring 2 was surveyed on November 17, 1995. It is located in a groundwater contaminant plume area. The SS2 spring and stream area is bordered by an oak-hickory-dominated forested slope on the southwest side and a gravel access drive, that is partially overgrown with grass and low-growing herbaceous vegetation on the northeast side. Watercress (*Nasturtium officinale*) is growing at the spring and in the stream. On the side banks and in shallow, rocky places in the stream, the autumn remains of some grass and herbaceous species were identifiable. These include aster,

smartweed, soft rush, jewelweed, Japanese honeysuckle, and grasses. There were remains of several herbaceous species, but these were no longer identifiable due to the time of year. An elderberry is growing next to the spring; however, it is being shaded out by the surrounding trees. Ironwood saplings are growing along the edge of the stream. Near the spring there is one dead red cedar and a damaged oak. The red cedar probably died as the tree canopy filled in and shaded it. The damaged oak is split vertically on one side and is partially hollow, but the upper branches continue to produce leaves. Other than these two trees, no dead, damaged, or visibly stressed vegetation was observed.

2.13 South Spring 3

South Spring 3, which is located in a groundwater contaminant plume area, was surveyed on November 17, 1995. It is located a short distance from SS2 and drains to the SS2 stream channel, but it is located farther back in the woods than is SS2. The spring and stream area is surrounded by an oak-hickory forest community. The area through which the stream flows has an open canopy and includes a small wetland. Species include red maple, green ash, sweetgum, sycamore, black willow, and loblolly pine in the tree and sapling layer, and Christmas fern, aster, microstegium, rose, goldenrod, sedge, rush, and Japanese honeysuckle in the ground cover layer. With the exception of Christmas fern and some of the honeysuckle, most of the ground cover vegetation was dormant or senescent. No dead, damaged, or visibly stressed vegetation was observed during the survey.

2.14 Locations in the Floodplain and Riparian Zone of Bear Creek

Vegetation sampling in the Bear Creek floodplain and riparian zone was conducted in September and October, 1995. The sampling was done in support of the Bear Creek Valley Remedial Investigation/Feasibility Study. The samples were collected along transects identified in the Soil Sampling and Analysis Plan for the Bear Creek Valley Floodplain at the Y-12 Oak Ridge Plant, Oak Ridge, Tennessee (DOE/OR/01-1322&D1) and associated memoranda. The vegetation sampling sites included the following:

G023, G033, G034, G042, G073, G071, and G092.

Station G042 coincides with the NT8 wetland described above. The other sampling stations are in the Bear Creek floodplain or riparian zone.

The only large area of dead or damaged vegetation in the transect areas is the loblolly pines killed by the pine bark beetle. The dead trees in the wetland at the NT8 (G042) station are described earlier in this report. No other areas of dead or stressed vegetation in the transect areas were observed. However, the purpose of the vegetation sampling did not involve assessing the vegetation for mortality or stress, and it is possible that dead or stressed vegetation may have been overlooked.

3. SUMMARY

Vegetation at fourteen sites in the Bear Creek valley was assessed for mortality and indicators of plant stress. Ten of the sites are located in areas that overlay contaminant plumes in the shallow groundwater. Four of the sites occur outside of the plume area and were used as reference sites. In addition, several sites visited during vegetation sampling in October, 1995, are briefly discussed. The assessment survey was conducted on dates between November 1 and November 17, 1995, with many of the sites being visited after the first killing frost. Due to the time of year in which the surveys were

conducted, vegetation at the sites was assessed primarily for (1) groupings of dead trees, (2) patches of dead ground cover vegetation, (3) twig or bud die-back, and (4) atypical growth form.

Dead and dying vegetation and atypical growth form of trees was observed at several of the plume area sites and reference sites. In some locations, plant death and stress could be attributable to alterations in surface hydrology, the pine bark beetle, competition from kudzu, or natural plant succession, such as when the tree canopy closes over a shade-intolerant species. In other locations, there were no easily observable potential causes of vegetation mortality.

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