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**Remedial Investigation Report for J-Field,
Aberdeen Proving Ground, Maryland**

Volume 3: Ecological Risk Assessment

**Environmental Assessment Division
Argonne National Laboratory**

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Remedial Investigation Report for J-Field, Aberdeen Proving Ground, Maryland

Volume 3: Ecological Risk Assessment

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FOREWORD

This document presents the results of an ecological risk assessment (ERA) conducted at J-Field in the Edgewood Area of Aberdeen Proving Ground (APG), a U.S. Army installation located in Harford County, Maryland. The ERA was carried out for the U.S. Army under the direction of the Environmental Conservation and Restoration Division, Directorate of Safety, Health, and Environment at APG, pursuant to the requirements outlined under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. This report comprises Volume 3 of a three-part series of documents that were prepared to describe the comprehensive evaluation of the site conditions, nature and extent of contamination, and risks to human health and the environment. Volume 1 of this series, prepared by Argonne National Laboratory, provides the results of the remedial investigation. Volume 2, prepared by ICF Kaiser Engineers, provides the results of the human health risk assessment. More information on the APG, including J-Field, may be obtained by visiting the APG Web site at www.apg.army.mil.

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NOTATION

The following is a list of abbreviations and acronyms, chemicals, and units of measure used in this document. Some acronyms used only in tables and equations are defined in those tables and equations.

ABBREVIATIONS AND ACRONYMS

ADD	applied daily dose
AEC	U.S. Army Environmental Center
ANCOVA	analysis of covariance
ANL	Argonne National Laboratory
ANOVA	analysis of variance
AOC	area of concern
APG	Aberdeen Proving Ground
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criterion (or Criteria)
BRA	baseline risk assessment
BTAG	Biological Technical Assistance Group (EPA)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COE	U.S. Army Corps of Engineers
COEC	contaminant of ecological concern
DOE	U.S. Department of Energy
DW	dry weight
EC ₅₀	concentration (of a substance) that causes effects in 50% of tested organisms
EEQ	ecological effects quotient
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ESR	earthworm survival rate
FFA	Federal Facility Agreement
FS	feasibility study
FSP	Field Sampling Plan
HE	high explosive
LC ₅₀	concentration (of a substance) that is lethal to 50% of tested organisms
LD ₅₀	dose that is lethal to 50% of tested organisms

MBP	Mustard Burning Pit
NAS	National Academy of Sciences
NCP	National Contingency Plan
NOAEL	no-observed-adverse-effects level
NPL	National Priorities List
NWI	National Wetland Inventory
PAOC	potential area of concern
PB	Prototype Building
PCEOC	potential contaminant of ecological concern
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
RCP	Riot Control Burning Pit
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RI	remedial investigation
RME	reasonable maximum exposure
RPDG	Robins Point Demolition Ground
RPTS	Robins Point Tower Site
SBDG	South Beach Demolition Ground
SBT	South Beach Trench
SE	standard error
SER	seed emergence rate
SIR	substrate-induced respiration
TAL	Target Analyte List
TBP	Toxic Burning Pits
TCL	Target Compound List
UCL	upper confidence limit
UM	University of Maryland
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USGS	U.S. Geological Survey
WHO	World Health Organization
WPP	White Phosphorus Burning Pits
XRF	x-ray fluorescence

CHEMICAL SYMBOLS AND ABBREVIATIONS

CHCl ₃	chloroform
C/N	carbon/nitrogen ratio
CN	chloroacetophenone
CO ₂	carbon dioxide
CS	<i>o</i> -chlorobenzylidene malonitrile
DANC	decontaminating agent, noncorrosive
11DCE	1,1-dichloroethene
12DCE	1,2-dichloroethene
DIMP	diisopropyl methylphosphonate
FDA	fluorescein diacetate
Hg	mercury
KCl	potassium chloride
NH ₄ -N	ammonium-nitrate
NO ₃ /NO ₂ -N	nitrate-nitrogen
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pNP	p-nitrophenyl
SVOC	semivolatile organic compound
111TCE	1,1,1-trichloroethane
112TCE	1,1,2-trichloroethane
TCLEA	1,1,2,2-tetrachloroethane
TCLEE	tetrachloroethene
TRCLE	trichloroethene
TTC	2,3,5-triphenyl tetrazolium chloride
VOC	volatile organic compound
VX	methyl phosphonothioc acid

UNITS OF MEASURE

atm	atmosphere(s)
°C	degree(s) Celsius
cm	centimeter(s)
cm ²	square centimeter(s)
cpm	count(s) per minute

d	day(s)
°F	degree(s) Fahrenheit
ft	foot (feet)
ft ²	square foot (feet)
g	gram(s)
ha	hectare(s)
in.	inch(es)
kg	kilogram(s)
L	liter(s)
lb	pound(s)
m	meter(s)
m ²	square meter(s)
m ³	cubic meter(s)
mg	milligram(s)
mi	mile(s)
min	minute(s)
mL	milliliter(s)
mm	millimeter(s)
mm ²	square millimeter(s)
mol	mole(s)
μg	microgram(s)
μm	micrometer(s)
ng	nanogram(s)
nm	nanometer(s)
pCi	picocurie(s)
ppb	parts per billion
ppm	parts per million
s	second(s)
yr	year(s)

REMEDIAL INVESTIGATION REPORT FOR J-FIELD, ABERDEEN PROVING GROUND, MARYLAND

VOLUME 3: ECOLOGICAL RISK ASSESSMENT

by

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SUMMARY

S.1 INTRODUCTION

The J-Field site is located within the Edgewood Area of the U.S. Army Aberdeen Proving Ground (APG) in Harford County, Maryland. Activities at J-Field since World War II have included the testing and destruction of chemical agents and munitions. The testing of lethal chemical agents ceased in 1969. Chemicals disposed of at the J-Field site have included nerve agents (such as methyl phosphonothioc acid [VX]), blister agents, riot control agents, white phosphorus, chlorinated solvents, and drummed chemical wastes generated by research laboratories, process laboratories, pilot plants, and machine and maintenance shops.

This ecological risk assessment (ERA) for J-Field was conducted as part of a remedial investigation (RI) initiated by APG. This RI is composed of two distinct, but highly integrated, components: (1) a characterization investigation that identified the nature and the extent of contamination at the site and (2) a baseline risk assessment (BRA) that evaluated risks from site contamination to human health and the environment. The BRA consisted of two separate risk assessments — a human health risk assessment, which evaluated potential risks of site contamination to human health, and the present ERA, which evaluated potential risks to ecological resources at the site. The RI report consists of three volumes. Volume 1 presents the results of the J-Field characterization investigation, Volume 2 presents the results of the human health risk assessment, and Volume 3 presents the results of the ERA.

For the RI, the J-Field site was divided on the basis of known APG activities into eight geographic areas or features designated as areas of concern (AOCs): the Toxic Burning Pits (TBP), the White Phosphorus Burning Pits (WPP), the Riot Control Burning Pit (RCP), the Robins Point Demolition Ground (RPDG), the Robins Point Tower Site (RPTS), the South Beach Demolition Ground (SBDG), the South Beach Trench (SBT), and the Prototype Building (PB). In addition to the eight AOCs, a number of other areas at J-Field were identified as potential areas of concern (PAOCs). These PAOCs included suspected storage areas, burning areas, and trenches, as well as crater areas and ruins associated with some of the AOCs or located elsewhere within the J-Field site.

The ERA used both the site-specific data collected as part of the RI contaminant characterization investigation and data collected for ERA-specific studies.

S.2 ECOLOGICAL RISK ASSESSMENT APPROACH

The ERA was designed to (1) determine whether past site activities and current levels of contamination have adversely affected the ecological resources at the site, (2) determine whether conditions at the site pose potential adverse risks to ecological resources, and (3) identify areas of J-Field where remediation may be warranted from an ecological standpoint.

The approach used in this ERA meets the requirements for a quantitative-level risk assessment and follows U.S. Environmental Protection Agency (EPA) guidance for conducting environmental evaluations and ERAs under the Comprehensive Environmental, Response, Compensation, and Liability Act. This level of risk assessment is the most scientifically rigorous and constitutes the most complete weight-of-evidence approach (by media and habitat) to determine the potential for ecological risk. The ERA targeted multiple ecosystem components, including aquatic and terrestrial vegetation, soil and aquatic invertebrates, fish, and terrestrial wildlife. The assessment also evaluated multiple levels of ecosystem organization, including individuals, populations, and communities.

The ERA consisted of three steps. Step 1 included a screening assessment that compared maximum contaminant concentrations to screening ecotoxicity values. Activities conducted during this step included qualitative and quantitative biotic surveys (e.g., to identify ecological receptors and pathways); qualitative evaluations of contaminant release, fate, and transport; and identification of potential contaminants of ecological concern (PCOECs), including those identified during the RI characterization investigation. Step 2 included exposure and effects assessments. Exposure assessment included dose modeling and tissue residue analysis, while the effects assessment included toxicity tests and field and laboratory studies. This step also involved the development of contaminant uptake models for selected ecological receptors, such as birds of prey, waterfowl, and large mammals. In Step 3, the results of the Step 1 and 2 activities were integrated in a weight-of-evidence risk evaluation to characterize the risk to ecological resources from the current levels of contamination at J-Field. Potential risks to ecological receptors were characterized for each AOC and for wide-ranging species that may visit multiple AOCs and PAOCs.

S.3 CONTAMINANTS OF ECOLOGICAL CONCERN

A final list of PCOECs was developed for each AOC by comparing media concentrations with chemical-specific factors, including background concentrations, regulatory standards, and

ecological screening values. The detection frequency, capacity to bioconcentrate, importance as a micro- or macronutrient, and known toxicity were also considered in this screening process.

The first step in the process involved comparing maximum reported concentrations of contaminants, by medium and AOC, to reported background concentrations and ecological screening values. The ecological screening values represent medium-specific contaminant concentrations considered protective of biota. The screening values were obtained from many sources, including regulatory values, EPA reports, other agency reports, and the open scientific literature. The regulatory values were primarily EPA ambient water quality criteria (AWQC) for the protection of aquatic biota. At each AOC, contaminants present at concentrations exceeding screening concentrations were retained as the final PCOECs for that AOC. Contaminants present at concentrations exceeding background levels but for which no screening values are available were also retained for further evaluation. Contaminants below background levels but either exceeding screening values or for which screening values were unavailable were retained as final PCOECs for the AOC. The final PCOECs included 19 metals and 42 volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). Metals were the most commonly encountered PCOECs, occurring at all the AOCs and in all media. The greatest number of PCOECs were identified for the TBP AOC.

S.4 ECOLOGICAL RECEPTORS AND EXPOSURE SCENARIOS

The evaluation of ecological risks required the identification of exposure pathways to ecological resources and the selection of representative ecological receptors to be evaluated at each AOC. During the initial phases of the ERA, a series of ecological conceptual models that incorporated known or expected contaminant fate and transport pathways was developed for each AOC to determine the potential exposure routes to ecological resources. Characterization data from Volume 1 of the RI, aerial photographs, U.S. Geological Survey topographic maps, previous investigations at J-Field, and preliminary field surveys of ecological habitats at the site were used to develop these models. The models were then used to identify ecosystem components that could be exposed at each AOC.

Uptake modeling was used to quantitatively evaluate the selected exposure pathways and ecological receptors. Exposure pathways included the incidental ingestion of contaminated soil or sediment, ingestion of contaminated drinking water, food-chain transfer and uptake of contaminants, root uptake for vegetation, and dermal absorption for terrestrial invertebrates and aquatic biota. Contaminant uptake through the food chain was the principal exposure route for most terrestrial wildlife. These exposure routes were then modeled to predict applied daily doses (ADDs) of contaminants for individual receptors.

S.5 ASSESSMENT METHODS

The investigations under Step 2 of the ERA fell into two general categories: exposure assessment and effects assessment. Exposure assessment characterized the co-occurrence of the ecological receptors with the distribution of contaminants by using one of two approaches: direct measurements of contaminant concentrations in biological tissues or modeling of contaminant uptake and ADD estimation. Effects assessment, which involved field studies and laboratory toxicity testing of site media, identified and quantified actual adverse effects occurring at the AOCs under existing environmental conditions.

S.5.1 Exposure Assessment

In the exposure assessment, terrestrial vegetation (common reed), terrestrial invertebrates (grasshoppers and crickets), fish (golden shiners and banded killifish), amphibians (frogs), and small mammals (white-footed mice) were collected from different AOCs and habitats at J-Field and analyzed for metals, SVOCs, pesticides, and polychlorinated biphenyls (PCBs). The measured tissue concentrations provided insight into contaminant uptake by biota at the site and were used in uptake models.

Because collecting many wildlife species for tissue analysis was not practical or feasible, contaminant uptake was modeled for various avian and mammalian species. ADDs were estimated by AOC for each COEC and selected ecological receptor. Mathematical equations were developed to model contaminant uptake along all appropriate exposure pathways to selected receptors. The greatest number of exposure routes modeled for any particular receptor was eight (for the red fox). The ADDs were modeled by using exposure point concentrations of contaminants in each medium and species-specific exposure factors, such as body weight, home range, and diet composition. Exposure point concentrations were determined from the characterization data presented in Volume 1 of the RI. Exposure factors were obtained from the EPA *Wildlife Exposure Factors Handbook* or the scientific literature, or were estimated by using empirically derived allometric equations.

S.5.2 Effects Assessment

The effects assessment characterized actual effects on vegetation, soil biota, terrestrial vertebrates, and aquatic biota by using several approaches and targeting a variety of ecological receptors, including vegetation, terrestrial vertebrates, fish, and aquatic invertebrates. In addition, many of the methods targeted soil invertebrates and biologically mediated soil processes related to nutrient cycling. Table S.1 summarizes the assessment methods, including the target ecological receptors and the assessment levels.

TABLE S.1 General Assessment Endpoints, Ecological Receptors, Assessment Levels, and Measurement Endpoints for the J-Field Ecological Risk Assessment

Assessment Endpoint	Ecological Receptor	Assessment Level	Measurement Endpoint
Protection of the plant community from ecological changes related to contaminant exposure	Vegetation	Individual	Seed germination, growth, survival, tissue concentrations
		Population and community	Species diversity, total biomass
Protection of the soil invertebrate community and soil nutrient processes from ecological changes related to contaminant exposure	Soil invertebrates	Individual	Earthworm survival, tissue concentrations
		Population and community	Species diversity, trophic dominance, biomass, abundance
		Biological processes	Soil respiration, microbial enzyme activities
Protection of the terrestrial vertebrate community from ecological changes related to contaminant exposure	Terrestrial vertebrates	Individual	Modeling dose estimates, tissue concentrations
		Population and community	Species diversity, reproductive success, abundance
Protection of the aquatic community from ecological changes related to contaminant exposure	Aquatic biota	Individual	Acute and chronic toxicity, tissue concentrations
		Population and community	Species diversity

S.6 EXPOSURE ASSESSMENT RESULTS

S.6.1 Tissue Residues

The results of the tissue analyses generally indicated low levels of contaminant uptake by biota at J-Field. Metals were by far the dominant category of PCOECs to be detected in biological tissues collected from any AOC. Sixteen metals were detected in plant tissues collected from the TBP and RCP AOCs. Several of these metals are considered essential plant nutrients (such as calcium, manganese, and potassium), and their presence was not unexpected. Eight metals were present at concentrations of <10 mg/kg; the highest mean concentration was detected for magnesium (423 mg/kg). Only two SVOCs were detected in plant tissues: 2-methylphenol and

bis(2-ethylhexyl)phthalate. The latter compound was also detected in laboratory blanks and likely reflects laboratory contamination rather than a true tissue concentration. The only other compound detected in plant tissues was the pesticide beta-BHC, which was detected in two samples from the TBP AOC at a mean concentration of 1.7 µg/kg. For comparison, beta-BHC has been detected in soils at the TBP AOC at concentrations of 4.46 and 28.2 µg/kg.

No SVOCs or PCBs were measured in insect tissues collected from the TBP, RCP, and PB AOCs; the only pesticide detected was dieldrin, which was found in one sample from the TBP AOC. Seven metals were detected in insect tissues; mean concentrations ranged from 1.3 mg/kg for lead to 1,090 mg/kg for magnesium. The pesticides heptachlor, 4,4'-DDD, and 4,4'-DDE were the only organic compounds detected in fish tissues collected from the TBP AOC; heptachlor was detected in only one of four samples. Seven metals were also detected in fish tissues; mean concentrations ranged from 0.72 mg/kg for lead to 2,060 mg/kg for manganese.

Amphibians were collected for tissue analysis from craters at the TBP, WPP, SBDG, RPDG, and RPTS AOCs and from the Ruins Site and Area D PAOCs. The pesticide p,p'-DDE was detected in frogs from all sampled locations (except the WPP and RPTS) at mean concentrations of 2.86–9.0 µg/kg. Three explosives compounds were detected in one of seven frogs collected from a crater at the RPDG AOC, but not from any other sampled locations. These compounds were 2,4,6-trinitrotoluene and two dinitrotoluene compounds; they were detected at mean concentrations of 5.0–10.0 µg/kg. Only four metals were detected in frogs: arsenic, barium, chromium, and lead. Maximum concentrations ranged from 13 mg/kg for barium to 86 mg/kg for lead. Barium was detected in the greatest number of specimens (five), while arsenic was detected in only one specimen.

Mice were collected from the TBP, RCP, and RPDG AOCs for tissue analysis. PCBs were detected in samples from all three locations, but in only a few individuals (4 out of 33) at mean concentrations of 27–38 µg/kg. Five metals were also detected in mice: arsenic, barium, cadmium, chromium, and lead. These metals were detected in all samples from all locations; however, whole-body metal levels did not statistically differ from, or were statistically lower than, levels reported in mice collected from a reference site.

S.6.2 Applied Daily Dose

Uptake modeling was conducted to estimate either tissue concentrations or ADDs for various receptors. Measured or modeled tissue concentrations for vegetation and insects were used in modeling contaminant uptake to higher-trophic-level receptors. Although measured tissue concentrations were available for vegetation and insects, not all the PCOECs were included for tissue analysis. Thus, tissue concentrations of most contaminants had to be estimated by modeling. Higher-trophic-level receptors for which ADDs were estimated included the mallard, great blue heron,

American robin, tree swallow, American kestrel, red-tailed hawk, muskrat, white-footed mouse, eastern cottontail, white-tailed deer, and red fox. Contaminant uptake by these receptors was modeled for each AOC by using those receptors known or considered likely to occur at the AOC. The modeled ADD values were then used to estimate risks from contaminant exposure at each AOC.

S.7 EFFECTS ASSESSMENT RESULTS

S.7.1 Toxic Burning Pits Area of Concern

The effects assessment conducted at the TBP AOC included quantitative and qualitative surveys of terrestrial and aquatic invertebrate and vertebrate biota and wetland and upland vegetation; quantitative evaluations of soil invertebrate physiological parameters, such as enzyme activity and respiration rates; and quantitative evaluations of biologically mediated soil processes, such as litter decomposition and nitrogen mineralization. Toxicity tests of site soils, sediments, and surface waters were also conducted with a variety of invertebrate, vertebrate, and plant test organisms.

Surveys of the aquatic invertebrate community at the TBP AOC marsh and pond showed the presence of a diverse community. Overall, the benthic fauna in the pond and marsh were representative of communities expected to occur in such habitats. The lowest diversity was reported for the site nearest the Pushout Area. Several genera were collected from taxonomic groups that include species known to be intolerant of poor water quality. Two species dominated the fish community: the golden shiner and the blue-spotted sunfish. The shiner was present in very large numbers. None of the fish collected exhibited any external evidence (such as lesions, ulcers, fin rot, exophthalmus) of contaminant effects or other environmental stressors.

The vertebrate surveys indicated a diverse bird community inhabiting or using the site; more than 100 species were identified. No individuals exhibited any obvious external abnormalities. Two nest boxes were placed at the site; one was used by eastern bluebirds for nesting, with eight young fledged. Mammals collected from the site included the white-footed mouse, meadow vole, and short-tailed shrew; none of the specimens exhibited any external abnormalities (such as lesions or tumors).

Toxicity testing of aquatic media showed no acute toxicity for surface water from either the pond or the marsh. However, tests indicated chronic toxicity for surface water from the marsh. This toxicity was restricted to surface water collected from the marsh immediately next to the Pushout Area. No chronic toxicity was detected for surface water from the pond. Sediments from the Pushout Area-marsh boundary exhibited toxic effects on some test organisms. In contrast, no toxicity was detected for sediments collected from the pond. Testing of groundwater from the surficial aquifer

at the TBP AOC showed both acute and chronic toxicity for a variety of test organisms, including zooplankton, vascular plants, amphibians, and larval fish.

Total macroinvertebrate numbers, bacterial and fungal biomasses, and nematode numbers were significantly reduced in soils from the TBP AOC, particularly the Pushout Area, relative to numbers measured in soils from on-site and off-site reference locations. The trophic structure of the nematode community at the Pushout Area also differed from that observed at the reference site, indicating an adverse ecological effect.

The activity of several bacterial and fungal nutrient-acquiring enzymes was significantly lower in the Pushout Area than in the reference site, and enzyme activity was significantly and negatively correlated with the total metal content of the soil. Substrate-induced respiration (SIR) and soil nitrogen dynamics were also lower in the disturbed Pushout Area relative to the reference site.

Soils from the AOC had lethal and sublethal effects on earthworms and vegetation. Testing with soils from the southern main pit and the Pushout Area resulted in nearly 100% mortality of earthworms, and significant weight loss by earthworms occurred in soil mixtures containing >25% soil from the site. Toxicity testing on vegetation showed seedling emergence rates (SERs) of $\leq 2.5\%$ for soils from the Pushout Area and the southern main pit. The SERs were <75% from other areas of the AOC. A SER of 100% was measured for soil from the VX pit, but all the seedlings died during the 14-day exposure.

S.7.2 White Phosphorus Pits Area of Concern

The effects assessment conducted at the WPP AOC included quantitative and qualitative surveys of terrestrial invertebrate and vertebrate biota and wetland and upland vegetation; quantitative evaluations of soil microbial respiration rates and soil invertebrate-mediated processes, such as litter decomposition and nitrogen mineralization; and toxicity tests of site soils, sediments, and surface waters with a variety of invertebrate, vertebrate, and plant test organisms.

Surveys of the aquatic invertebrate community at the pond at the northwestern suspect burning area indicated the presence of a variety of aquatic invertebrate taxa, including zooplankton, amphipods, and aquatic insect larvae of several species. Although no fish were collected from the pond, their absence is probably due to factors other than contamination. The pond is very small and isolated and has no connections to the nearby bay or other surface water bodies that support fish populations that could colonize the pond. In addition, because of its small size, the pond may become dry during very hot and dry summers.

Qualitative observations of birds at the WPP AOC indicated that a variety of species occur in the immediate vicinity of the site, and waterfowl may use the site on occasion. No individuals of

any species exhibited any obvious external abnormalities. Eastern bluebirds used a nest box placed at the site, and four young were fledged. Five amphibian species and two reptilian species were found at the AOC. Reproducing adults of one amphibian species were observed at the pond in the northwestern suspect burning area, as were larvae of two other species. These observations suggested that successful reproduction occurs in the surface waters at the AOC, at least for some species.

The survey results indicated that the total abundance of invertebrates at the site was not adversely affected by current site conditions. Also, little indication was found of adverse effects on the abundance of nematodes or community trophic structure, microbial biomass nitrogen, litter decomposition rates, or SIR rates. However, no net mineralization was measured at the pit area, which suggests altered soil nitrogen dynamics.

Toxicity testing of aquatic media found no acute or chronic toxicity for surface water or sediment from the pond or marsh. Soil toxicity was indicated for soils from the north pit and from the presumed Pushout Area located west of the main pits. Seedling emergence rates of 70% were measured for soil samples from both locations, while SERs ranged from 93 to 100% for other samples and the control sample. Seedling growth, measured as dry weight at the end of the test period, was <50% of that measured for the negative control sample. Seedling survival was 100% for all locations.

S.7.3 Riot Control Pit Area of Concern

The effects assessment conducted at the RCP AOC included quantitative evaluations of the abundance of soil invertebrates and community composition; qualitative surveys of wetland and upland vegetation; qualitative surveys of aquatic and terrestrial invertebrates and vertebrates; quantitative evaluations of soil invertebrate physiological parameters, such as enzyme activity and respiration rates, and soil invertebrate-mediated processes, such as litter decomposition and nitrogen mineralization; and toxicity tests for site soils, sediments, and surface waters. A variety of invertebrate, vertebrate, and plant test organisms were used in the testing.

The RCP AOC contained only ephemeral surface waters, primarily ponded water in the pit. The aquatic community present consisted exclusively of aquatic invertebrates. Because of the ephemeral nature of the aquatic habitat, no fish were found at the AOC. Amphibian larvae were observed at the RCP AOC, which suggested that local amphibian populations use the AOC for reproduction. Small mammal trapping collected juvenile and adult white-footed mice; none of the specimens exhibited any external abnormalities (lesions or tumors). Qualitative surveys of birds at nearby Rickett's Point revealed a variety of species in the area; a pair of tree swallows used a nest box placed at the RCP AOC to fledge four young.

The surveys did not indicate any adverse effects on the activity of epigeic invertebrates at the AOC. However, significant differences in nematode abundance and trophic structure were observed between the pit and the local background site (i.e., area north of the pit). The pit site also exhibited a soil microbial biomass nitrogen concentration that was 50% lower than the concentration measured at the local background location.

Nutrient-acquiring enzyme activity, active and total fungal and bacterial biomasses, and SIR did not appear to be adversely affected by conditions at the AOC, although the total fungal biomass and nitrogen mineralization rates were reduced in soils collected from the pit compared with soils from the reference site. Litter decomposition was significantly slower at the pit locations than at the local background site.

Toxicity testing of aquatic media showed little or no acute or chronic toxicity for surface water or sediment; chronic surface water testing showed reduced growth in *Selenastrum*. Soils from the AOC did not have a lethal effect on earthworms, although earthworms tested with soil from the pit exhibited a 6% mean weight loss on completion of the tests. Soil toxicity testing on vegetation showed a 0% SER in soils from north of the pit. The SERs for all other tested locations ranged from 78 to 87%. Seedling height and weight were measured for plants grown in soil from north of the pit, and no adverse effects were identified.

S.7.4 South Beach Trench Area of Concern

The effects assessment conducted at the SBT AOC were less intensive than those conducted at some of the other AOCs because of the small size of and limited wildlife habitat at the SBT AOC. The effects assessment included quantitative surveys of soil-dwelling and epigeic invertebrates; qualitative surveys of amphibians; quantitative evaluations of nutrient-acquiring enzyme activity and soil respiration rates; and toxicity tests of site soils, sediments, and surface waters. Several types of invertebrate, vertebrate, and plant toxicity tests were used.

The aquatic habitat at the site consists of ponded water in the trench; because of the ephemeral nature of this habitat, no fish and only a limited aquatic invertebrate community were expected to occur at the site. Thus, no surveys for fish or invertebrates were conducted, although zooplankton, amphipods, and dipteran larvae were observed in the trench.

No significant differences in the abundance of soil-dwelling macroinvertebrates, epigeic macroinvertebrates, or soil nematodes were found between the AOC and the reference site; however, active and total fungal and bacterial biomasses and the abundance of soil protozoa were higher at the AOC than at the reference site. No differences in the activity of nutrient-acquiring enzymes or in soil respiration rates were detected between the AOC and the reference site. The biomass of terrestrial vegetation was less in the trench than at other locations in the AOC.

No toxicity to bacteria, floating vascular plants, zooplankton, amphipods, fish, or amphibians was indicated for surface water or sediment collected from the trench. The growth of green algae chronically exposed to surface water was inhibited. Vegetation testing indicated some soil toxicity, but only for soils collected directly from the trench. The SERs at these locations were 61 and 73%, while the SERs were >80% at all other locations and 91% for control soils.

Only the southern leopard frog was found during surveys for amphibians at this AOC. Few amphibians were expected at this AOC because of the temporal nature of its aquatic habitats. A bird nest box was placed at the site to evaluate nesting success, but no birds used it. The lack of use of the nest box may have been due to factors other than the effects of contaminants.

S.7.5 South Beach Demolition Ground

The effects assessment conducted at the SBDG AOC was very limited because the site is now located offshore in Chesapeake Bay. The assessment focused primarily on the large detonation crater located onshore north of the RPDG AOC. The assessment included surveys for fish and amphibians and acute and chronic toxicity testing of surface water and sediment from the crater.

Although the pond water present in the crater appeared to be permanent, no fish were collected from this habitat. The absence of fish was not unexpected, given the small size and isolated nature of the pond (no immigration routes from areas with fish). Although no aquatic invertebrate surveys were conducted at the pond, a variety of taxa were observed in this habitat, including zooplankton, amphipods, and dipteran larvae. Amphibian surveys found frog larvae and adults, and adult red-spotted newts and spotted salamanders. The presence of both adult and larval frogs indicated that frogs used the pond for reproduction. Adult newts and salamanders are typically forest-floor-dwelling species that migrate to fishless ponds to reproduce, and their presence in the detonation crater suggested the use of this habitat for reproduction. Several turtles were also observed using the pond, but the species were not identified. No water toxicity was indicated for surface water at the pond. In contrast, chronic sediment toxicity tests showed significantly lower survival and growth in the amphipod *Hyaella*.

S.7.6 Robins Point Demolition Ground Area of Concern

The effects assessment conducted at the RPDG AOC included quantitative surveys of the abundance of soil invertebrates and bacterial and fungal biomasses; qualitative surveys of amphibians and birds; quantitative evaluations of nutrient-acquiring enzyme activity and soil respiration rates; evaluations of bird nesting success using nest boxes; and soil, surface water, and sediment toxicity testing with a variety of plant and animal test species.

Because of the ephemeral nature of the surface water habitats, no surveys for fish or aquatic invertebrates were conducted at the RPDG AOC. However, several aquatic invertebrate taxa were observed at the site during other activities. The taxa inhabiting the temporary aquatic habitats at this AOC are probably similar to those inhabiting similar ephemeral habitats throughout J-Field (e.g., zooplankton, amphipods, and dipteran larvae).

No significant differences between the AOC and reference site in the abundance of soil-dwelling macroinvertebrates and nematodes or in total bacterial biomass were evident. The activity of epigeic macroinvertebrates and total fungal biomass were greater at the AOC than at the reference site. In contrast, active bacterial and fungal biomasses were greatly reduced at the AOC. Active biomass is affected by current conditions and probably reflects short-term responses to climate and season, whereas total biomass is a measure of long-term production and is probably a better indicator of contaminant effects.

Substrate-induced respiration rates and the activities of some nutrient-acquiring enzymes were significantly reduced at the RPDG AOC relative to those at the reference site. The activities of the other two enzymes measured at the RPDG AOC were similar to those measured at the reference site. Soil toxicity was indicated at two locations in the clear area, with SERs at <60%.

Qualitative surveys for amphibians found three frog species and two salamander species at the site. Salamander egg masses and successful hatching were observed at the AOC. Three reptile species were also incidentally observed at the site. More than 25 bird species were seen or heard during qualitative bird surveys at the site. Four nest boxes were established, and two were used by eastern bluebirds for nesting. Although eggs were found in both nest boxes, no fledglings were documented. Nest failure at one nest box was attributed to a fire that swept the site, while ant predation was postulated as the cause of the other nest failure.

Eleven white-footed mice were collected from the site for tissue analyses. Necropsies revealed no gross internal or external conditions that might indicate adverse effects of contaminants.

S.7.7 Robins Point Tower Site Area of Concern

Because of the absence of aquatic habitats at the RPTS AOC, no surveys of aquatic biota or toxicity testing of surface water and sediment were performed. The effects assessment included quantitative surveys of soil invertebrates and bacterial and fungal biomasses, quantitative evaluations of microbial enzyme activity and soil respiration rates, qualitative surveys of birds, evaluations of bird nesting success in nest boxes, and soil toxicity testing to evaluate SERs.

The abundance of soil nematodes at the RPTS AOC was almost 50% lower than the abundance measured at the reference site. In contrast, total and active fungal and bacterial biomasses

and soil protozoan abundance were greater at the AOC than at the reference site. No significant differences in microbial enzyme activity, soil respiration rates, or in the activity of epigeic macroinvertebrates were detected between the AOC and reference sites.

Soil toxicity was indicated by reduced SERs for 4 of 10 sample locations at the RPTS AOC. Three of these samples came from the central portion of the AOC, while the fourth sample came from the southwestern portion of the site. Thirty bird species were observed or heard at the site, and an active osprey nest was atop the old tower structure. Four nest boxes were placed at the AOC, but these received only limited use, and nesting did not occur in any nest box.

S.7.8 Prototype Building Area of Concern

Because aquatic habitats are not present at the PB AOC, the effects assessment focused on soil biota and soil toxicity. Soil macroinvertebrate abundance and activity, soil nematode abundance, and total fungal and bacterial biomasses were greater at the AOC than at the reference site. In contrast, active fungal and bacterial biomasses were less at the AOC. Protozoan ciliates and flagellates were less abundant at the AOC, while the abundance of amoebae did not differ between the AOC and reference sites.

Microbial enzyme activities did not differ between the AOC and the reference site for two enzymes, while dehydrogenase activity and SIR rates were significantly lower at the PB AOC than those measured at the reference site.

Soil toxicity was evaluated at eight locations at the PB AOC, and toxicity (as indicated by reduced SERs) was indicated for all locations. The SER for the PB AOC sample locations varied from 55 to 85% while the SER for the control soil was 91.1%.

S.7.9 Potential Areas of Concern

Only limited assessment was performed at the PAOCs, consisting principally of toxicity testing of surface water and sediment from craters, pits, and other depressions, and qualitative surveys of amphibian and bird populations. Soil biota and soil processes were not investigated at the PAOCs.

Few permanent aquatic habitats are associated with the PAOCs; most aquatic habitats are ephemeral surface waters that support limited fauna. Permanent habitats are present at Area A and the Ruins Site and consist of some ponds and trenches. Mosquito fish were collected from the swampy areas associated with Area A, but fish traps failed to collect any fish at the Ruins Site.

No acute toxicity was identified for surface water or sediment. However, chronic toxicity was indicated for surface water at the two craters sampled at the Ruins Site.

Three frog and two salamander species were found during quantitative surveys of the various crater and pit habitats associated with the PAOCs. More than 60 species of birds were observed or heard during qualitative surveys along Ford's Point Road near Areas A, B, and C. A pair of Carolina chickadees used a nest box placed near the Ruins Site, but no young were fledged. The cause of the nest failure is unknown, but it may have been due to a variety of factors (e.g., high summer temperature) unrelated to contaminant conditions in the area.

S.8 RISK ESTIMATION

S.8.1 Toxic Burning Pits Area of Concern

The results of the effects assessment show that 19 of 32 evaluated parameters were adversely affected at the TBP AOC. Adverse effects were indicated for 7 of the 17 aquatic parameters; these were related primarily to acute and chronic toxicity for sediment and surface water collected from along the marsh-Pushout Area boundary. Surface waters from these locations also exceeded AWQC concentrations for some contaminants. No risks were identified for aquatic biota for other locations of the marsh or the pond. The results of 12 of the 15 effects assessments evaluating terrestrial media, biota, and habitats indicated adverse ecological effects. The greatest impacts appeared to be associated with the Pushout Area and the main pits. The hazard quotient (HQ) risk estimates identified several contaminants as posing potentially high to extreme risks to wildlife. These risks were associated primarily with soil levels of aluminum, antimony, arsenic, lead, mercury, and zinc. On the basis of these results, the TBP AOC poses a high risk to ecological resources that are largely restricted to the AOC proper, but little or no risk to wide-ranging receptors that may visit the site for short periods.

S.8.2 White Phosphorus Pits Area of Concern

A total of 23 ecological parameters were evaluated as part of the effects assessment of the WPP AOC. The results showed that 3 of 23 ecological parameters were adversely affected at the WPP AOC; the reported effects were limited to soils. Uptake modeling primarily indicated moderate to extreme risks from aluminum to two of the nine wildlife species modeled and moderate risks from aluminum, lead, and zinc to two receptors. No or low risks to wildlife were indicated for the other PCOECs. On the basis of these results, the contaminated media at the WPP AOC pose an overall low risk to ecological receptors at the site, and any risks would be limited to biota that would use the pits and presumed Pushout Area.

S.8.3 Riot Control Pit Area of Concern

The effects assessment at the RCP AOC evaluated 25 ecological parameters for possible adverse impacts from site contamination. The results indicated that 8 of the parameters were adversely affected. A total of 12 aquatic parameters were evaluated at the RCP AOC by using media toxicity tests and surveys of invertebrates and fish. The only adverse effect indicated by the assessment was a reduction in the growth of green algae. A total of 13 terrestrial parameters were evaluated at the RCP AOC; the results showed that 7 of the 13 parameters were adversely affected by site conditions, which suggests a high risk for terrestrial resources at the AOC.

Little evidence exists to indicate that surface waters at the site pose a risk to aquatic biota, particularly given the very limited nature of the aquatic biota at the site. The principal risks at the site are related to soil contamination. Modeling results identified low to moderate risks to terrestrial wildlife from six contaminants: aluminum, cadmium, chromium, copper, lead, and zinc. Extreme risks were identified to two receptors from only aluminum. Although a strong potential for adverse risks from soil contamination was suggested by the number of measured adverse effects and the modeled risks, the magnitude of some of the impacts (slight reduction in earthworm weight) was relatively minor, while the observed reduction in plant biomass may have been due more to factors unrelated to contamination (loss of topsoil during initial excavations). In addition, the adverse effects identified at the site were limited to the immediate vicinity of the pit and were not widespread across the AOC. Thus, the overall level of ecological risk posed at the site is low. The risks are limited to terrestrial biota and soil processes and are restricted to the immediate vicinity of the pit.

S.8.4 South Beach Trench Area of Concern

A total of 24 ecological parameters were evaluated as part of the effects assessment at the SBT AOC. The results showed that 3 of the 24 parameters were adversely affected at the site. On the basis of this level of existing adverse effects, the contaminated media at the SBT AOC pose a low risk to ecological resources at the site. No risks to aquatic biota were identified; only 1 of the 13 parameters evaluated was adversely affected. Adverse effects were identified for only 2 of the 11 parameters evaluated in the terrestrial-based effects assessment. These effects included reduced SERs (but no evidence of complete emergence failure) in soils from the pit and reduced plant biomass within the pit. No adverse effects were identified from any locations outside the pit. Modeling results identified only a low risk from cadmium, lead, and zinc to one receptor, a low to moderate risk to three receptors from aluminum, and a moderate risk to vegetation from zinc.

On the basis of the weight of evidence, the SBT AOC poses little risk to ecological resources at the site. No adverse effects to ecological parameters were identified for surface water and sediment from the site. For soils, minor adverse effects were identified, and those were limited to soils directly within the trench.

S.8.5 South Beach Demolition Ground Area of Concern

The SBDG is currently located offshore of the J-Field site and could not be evaluated directly. Instead, the effects assessment focused on a crater located onshore, just north of the AOC. The assessment of the crater evaluated six parameters; however, adverse effects were indicated only for two of them: reduced growth and survival for an amphipod. The other toxicity tests indicated that zooplankton, amphibians, and vascular plants were not adversely affected by conditions. Also, a variety of aquatic invertebrates, including amphipods, were observed in the pond. Various amphibians were found to be using the crater, and the presence of larvae indicated that the pond was used for reproduction. Risk estimation indicated only a low risk from a single contaminant (iron) to aquatic biota, and no risks for terrestrial wildlife were identified from uptake modeling. On the basis of these results, the crater at the SBDG AOC does not pose a significant risk to ecological resources at J-Field.

S.8.6 Robins Point Demolition Ground Area of Concern

The effects assessment at the RPDG AOC included the evaluation of 22 parameters, 8 of which indicated adverse effects. Effects on aquatic biota were evaluated through 8 toxicity tests, and the results of 3 tests indicated surface water or sediment toxicity. Effects on terrestrial biota were evaluated for 14 parameters, 5 of which were found to be adversely affected. The adverse effects were primarily related to nutrient processes and nutrient cycling in soils and to surface water toxicity. No evidence was found of impacts on vegetation or wildlife using the site. Risk estimation based on the HQ identified moderate to extreme risks to aquatic biota from three contaminants, while moderate risks were identified to two terrestrial receptors from a single contaminant. On the basis of the effects assessment results and the HQ estimates, the RPDG AOC poses a low to moderate risk to ecological resources. The risks are associated primarily with the soils and seasonally occurring ponded surface water in the clear area. However, because of the nature and magnitude of the observed adverse effects and the limited availability of quality habitat in the clear area of the AOC, the ecological significance of the predicted risks is expected to be minor.

S.8.7 Robins Point Tower Site Area of Concern

Of the 11 parameters evaluated at the site, 3 showed adverse effects: (1) the soil nematode community, (2) vegetation biomass, and (3) soil toxicity (reduced seedling germination) at several locations. The magnitude of the effects was low. Four surface water and three soil PCOECs were identified as posing potential risks to biota, but only aluminum was identified to pose more than a moderate risk to terrestrial biota. Risks identified for the other PCOECs were low or moderate and limited to only one or two receptors. Iron was indicated to pose a potential moderate risk, and aluminum, lead, and zinc low potential risks to aquatic biota. On the basis of the nature and

magnitude of the measured effects and the predicted risks to aquatic and terrestrial biota, the RPTS AOC does not pose an ecologically significant risk to resources at the J-Field or other APG areas.

S.8.8 Prototype Building Area of Concern

On the basis of the HQ and weight-of-evidence approaches for risk estimation, the PB AOC poses a moderate risk to ecological resources at this site. However, this risk is limited largely to soil invertebrates and microbiota and to vegetation growing at the site. There was little evidence of contaminant uptake by biota at the site, and modeled uptakes indicated moderate to extreme risks for only three receptors from two metals — aluminum and zinc. Eight parameters were evaluated by the effects assessment; adverse effects were indicated for five of the parameters: (1) reduced abundance of soil-dwelling protozoa, (2) reduced activity of extracellular nutrient-acquiring enzymes, (3) reduced plant biomass, (4) reduced soil respiration rate, and (5) reduced seedling emergence rates. These results suggest that soil contamination may be adversely affecting the nutrient dynamics at the site and thus plant production. However, the magnitude of observed effects was low, and potential impacts would likely be limited to the immediate vicinity of the AOC.

S.8.9 Potential Areas of Concern

Potential risks to aquatic biota were indicated for surface waters in one or two craters at the Ruins Site, but media toxicity was not evident at the other craters evaluated. Insufficient data were available to draw conclusions about the potential risks that craters pose to biota at the J-Field site. Any adverse risks would probably be greatest to aquatic biota that might directly use an individual crater, and these biota would be limited largely to aquatic invertebrates and amphibians.

S.8.10 Sitewide Ecological Receptors

Potential risks to wide-ranging ecological receptors were estimated by calculating a total ADD based on the sum of the ADDs calculated for each AOC at J-Field. These total doses were then used to calculate an HQ risk estimate for each receptor and PCOEC. A low risk was identified to the white-tailed deer from antimony and lead; to the American kestrel from lead; and to the tree swallow from lead, mercury, selenium, and zinc. A high risk to the white-tailed deer was identified for aluminum. Most of the estimated risks were the result of contaminant uptake from the TBP AOC. When the TBP AOC is excluded from the sitewide risk estimation, risks are no longer indicated for the American kestrel, and with the exception of the white-tailed deer, only very low risks are indicated for the other receptors. A reduced, but still moderate, risk is predicted for the white-tailed deer from aluminum, while the moderate risk identified for lead decreases to acceptable levels ($HQ < 1.0$).

The only sitewide receptor at more than a very low risk from contaminant exposure at J-Field is the white-tailed deer. The deer population at J-Field and nearby areas farther north on the Edgewood peninsula appears to be large and is unlikely to be significantly affected by contaminants at J-Field. In addition, the estimated risk is based on maximum concentration values that are within the range of reported aluminum background levels, the latter of which exceed the aluminum benchmark values for soil and surface water. Consequently, the overall risk to the local deer population is considered minor. Because the other sitewide receptors were either not at risk or only at a low risk from a few contaminants at J-Field, populations of these species are not likely to be significantly affected. The risks to sitewide receptors are primarily related to contaminant concentrations at the TBP AOC.

S.9 CONCLUSIONS

The ERA for the J-Field site was designed to (1) determine whether past site activities and current levels of contamination have adversely affected the ecological resources at the site, (2) determine whether current or future conditions at the site pose a potential adverse risk to ecological resources, and (3) identify areas of J-Field where remediation may be warranted from an ecological standpoint. The ERA addressed the following ecological questions about the contamination at the site:

- Are current levels of contaminants in environmental media producing demonstrable ecological effects on the population, community, or ecosystem; and, if so, what are the extent and magnitude of the effects?
- Are contaminated environmental media directly toxic to biota?
- What is the potential risk to biota of receiving contaminant doses through direct and indirect uptake from contaminated environmental media, and what are the extent and magnitude of any such risks?

The following conclusions address these questions:

- Some adverse ecological effects on the individual, population, and community are evident at all AOCs at J-Field. These effects are limited primarily to soil biota and vegetation in direct contact with contaminated soils. The effects vary in magnitude among the AOCs. They are relatively minor at the PB, RPTS, SBT, and SBDG AOCs. The adverse effects in these AOCs are also limited to small areas within the AOC boundaries and typically within specific features such as pits and trenches.

- More extensive adverse ecological effects are evident at the TBP, WPP, RCP, and RPDG AOCs. These effects occur to soil biota, terrestrial vegetation, and aquatic components. Effects at the WPP, RCP, and RPDG AOCs are restricted to specific portions of each AOC and do not appear to be widespread.
- Adverse ecological effects are evident throughout the TBP AOC, particularly at the Pushout Area and main pits. The effects are generally limited to terrestrial biota, with adverse effects on aquatic biota limited to the boundary between the Pushout Area and the marsh.
- Soil toxicity is evident at all AOCs but is generally limited to small areas (pits or trenches) within the AOCs. Soil toxicity is widespread and high at the TBP AOC. Soil toxicity is also indicated for multiple locations in the RPTS and PB AOCs, but the magnitude of the toxic effects is low.
- Limited surface water toxicity is evident at the WPP, RCP, and SBT AOCs. In testing, these surface waters were toxic only to the green alga *Selenastrum*. Surface water toxicity is also indicated at the TBP AOC, but it is limited to waters collected along the marsh-Pushout Area boundary.
- No sediment toxicity is evident at the WPP, RCP, and SBT AOCs. Sediment toxicity was found at the TBP, SBDG, and RPDG AOCs and the Ruins Site PAOC. At the TBP, toxicity was detected only for sediments collected along the marsh-Pushout Area boundary; sediments from the pond and other portions of the marsh exhibited no toxicity. Sediment toxicity at the other AOCs and the Ruins Site is not widespread and is generally of limited magnitude.
- Risk estimates based on modeling identify the potential for extreme risks from exposure to contaminated media (i.e., soils, sediments, and surface water) at several of the AOCs. Heavy metals (particularly aluminum, lead, and zinc) may pose the greatest risk to biota. Among the organic PCOECs modeled, risks from exposure to contaminants in soil were inferred only for trichloroethene. The inferred risks are low and are identified only for the TBP AOC. No organic PCOECs are predicted to pose risks at the other AOCs.
- At most AOCs, the ecological significance of the observed effects and predicted risks is low, and the potential risks are limited to small areas within the AOC boundaries. In contrast, the extent and magnitude of contamination at the TBP AOC may produce adverse effects that are ecologically significant

on a local scale (J-Field) and that may pose adverse risks to wide-ranging biota, including migratory waterfowl and top-level avian predators.

- Extreme risks to terrestrial receptors were indicated for some metals, aluminum in particular. It is important to note that these risk estimates are based on dose estimates derived by using an assumption of 100% bioavailability of the metals from the environmental media of interest. Actual bioavailability is not known, but it is very likely to be much less than 100%. Consequently, actual doses and risks are likely to be less than those estimated in this assessment.
- Although aluminum was identified as a soil PCOEC at all the AOCs, the retention of this metal can largely be attributed to the use of a very conservative ecological screening value. Aluminum concentrations in soils were below background levels at a number of the AOCs. Furthermore, the regional background level identified for aluminum exceeded the screening value by several orders of magnitude; risk estimation for aluminum on the basis of the conservative ecological screening value would produce an extreme risk estimate for this metal in background soils.

1 INTRODUCTION

The Environmental Management Division of the U.S. Army Aberdeen Proving Ground (APG), Maryland, is conducting a remedial investigation (RI) and feasibility study (FS) of the J-Field area at APG, pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. As part of that activity, Argonne National Laboratory (ANL) conducted an ecological risk assessment (ERA) of the J-Field site. This report presents the results of that assessment.

1.1 SITE BACKGROUND

The J-Field site is in the Edgewood Area of the APG in Harford County, Maryland (Figure 1.1). Since World War II, activities at the Edgewood Area have included the development, manufacture, testing, and destruction of chemical agents and munitions. Chemicals disposed of at J-Field include nerve agents (such as methyl phosphonothioic acid [VX]), blister agents, riot control agents, white phosphorus, chlorinated solvents, and drummed chemical wastes generated by research laboratories, process laboratories, pilot plants, and machine and maintenance shops (Benioff et al. 1995a). Table 1.1 summarizes disposal and detonation activities at J-Field.

Chemical agents and munitions were destroyed at J-Field by open burning and open detonation. Open burning consisted of placing wood dunnage in a pit, placing the materials to be burned on top of the dunnage, adding fuel oil, and igniting the materials. Following burning, some materials were decontaminated and recovered for disposal as scrap. Decontamination procedures included the use of a chlorinating agent known as "decontaminating agent, noncorrosive" (DANC). This agent is an organic N-chloroamide compound in solution containing 90-95% (by weight) 1,1,2,2-tetrachloroethane (TCLEA). It was used to decontaminate dichlorodiethyl sulfide (mustard), lewisite, and VX. The use of DANC to decontaminate scrap metals would have introduced TCLEA into the environment.

Testing of lethal chemical agents at J-Field ceased in 1969, and the site has seen only limited use for detonation of explosives-related materials since 1980 (Nemeth 1989). Contamination at J-Field was first detected during the 1977 and 1978 environmental surveys of the Edgewood Area conducted by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) (predecessor of the U.S. Army Environmental Center [AEC]). In 1986, the U.S. Environmental Protection Agency (EPA) issued a Resource Conservation and Recovery Act (RCRA) permit (MD3-21-002-1355) requiring a basewide RCRA Facility Assessment (RFA) and a hydrogeological assessment of J-Field. On February 21, 1990, while APG was pursuing the hydrogeological investigation of J-Field under RCRA, the Edgewood Area was added to the National Priorities List. The U.S. Department of the Army and EPA Region III signed a Federal Facility Agreement (FFA) in March 1990 requiring an

FIGURE 1.1 Location of J-Field in the Edgewood Area at Aberdeen Proving Ground (Source: Adapted from Hughes 1993)

TABLE 1.1 Summary of Disposal and Destruction Activities at J-Field

Site Name	Period of Use	Activity
<i>Areas of Concern</i>		
Toxic Burning Pits (originally 5 separate pits; only 2 remain open)	1940-1980	Disposal of high-explosive (HE)-filled munitions, nerve agents, mustard, liquid smoke, chlorinated solvents, and radioactive chemicals; open burning and detonation of HE in southeastern portion
White Phosphorus Burning Pits	Late 1940s-1980; occasional emergency disposal of white phosphorus	Open burning and detonation of white phosphorus, plasticized white phosphorus, and other chemicals; potential for disposal of chloroacetophenone (CN) and trichloroethene
Riot Control Burning Pit	Late 1940s-early 1970s; riot control agent disposal, 1960s-early 1970s	Open burning of chemicals, chemical-filled munitions, and riot control agents (CN and <i>o</i> -chlorobenzylidene malonitrile [CS])
Robins Point Demolition Ground	Late 1970s-present	Open detonation of explosive materials and sensitive and unstable chemicals
Robins Point Tower Site	Late 1950s-1960s	Potential test burn of radioactively contaminated wood
South Beach Demolition Ground	Late 1950s-1970s	Open detonation of HE
South Beach Trench	Late 1950s	Unknown
Prototype Building	World War II	Stored wastes and HE munitions; possible storage of solid wastes in building or nearby; building used to test bombing effects; periodically used for storage since World War II

TABLE 1.1 (Cont.)

Site Name	Period of Use	Activity
<i>Potential Areas of Concern</i>		
Site X1	Early 1950s-?	Unknown (collapsed concrete columns and relict soil piles in the field)
Area A	Unknown	Unknown (several abandoned trenches in the field)
Area B (Ford's Point Firing Position)	Early 1950s-?	Unknown (concrete slabs, dirt mounds, and scrap drums in the field)
Area C	?-1968	Potential test site for bombing of structures (building remnants and bomb craters)
Area D	Unknown	Possibly used as a bombing range (craters, dark areas on aerial photographs)
Ruins Site across from White Phosphorus Burning Pits	1940s-?	Bomb testing in cratered areas; use of suspect trench area and ponds is unknown (bomb craters, relict structures, discolored soil, ponds, and a trench)
Craters (distributed throughout J-Field)	1940s-?	Explosives testing and destruction (?)

Sources: Adapted from Nemeth (1989); EPA and U.S. Department of the Army (1990).

RI/FS for the entire Edgewood Area. The APG Environmental Management Division is conducting an RI/FS of the J-Field site pursuant to CERCLA, as amended, and the FFA.

For the RI/FS, J-Field was divided into eight areas of concern (AOCs): the Toxic Burning Pits (TBP), White Phosphorus Burning Pits (WPP), Riot Control Burning Pit (RCP), Robins Point Demolition Ground (RPDG), Robins Point Tower Site (RPTS), South Beach Demolition Ground (SBDG), South Beach Trench (SBT), and Prototype Building (PB) (Figure 1.2). In addition, seven potential areas of concern (PAOCs) were identified and evaluated as part of the RI/FS process. A

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FIGURE 1.2 Locations of Areas of Concern (AOCs), Potential Areas of Concern (POACs), and Principal Site Features at J-Field (Source: Adapted from Hughes 1993)

detailed description of each AOC and a discussion of the nature and extent of contamination at each AOC are provided in Yuen et al. (1999).

1.2 RELATIONSHIP OF THE ECOLOGICAL RISK ASSESSMENT TO THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROGRAM AT J-FIELD

The J-Field ERA was conducted as part of the overall RI/FS program at APG (ICF Kaiser Engineers 1993). As required under Subpart 300.430(d) of the National Contingency Plan (NCP), the J-Field RI consists of two distinct but integrated components: (1) a characterization investigation that identifies the nature and extent of contamination at the site and (2) a baseline risk assessment (BRA) that evaluates risks to human health and the environment from site contamination. The BRA for J-Field was conducted as two separate risk assessments: a human health risk assessment and an ecological risk assessment. The results of the J-Field characterization investigation are presented in Yuen et al. (1999), and the human health risk assessment is documented in Ripplinger et al. (1998).

Argonne National Laboratory conducted the ERA by using site-specific characterization data collected as part of the contaminant characterization phase of the RI as well as data collected by studies specific to the ERA. These data provided the information needed to determine whether remediation at J-Field is warranted, determine appropriate cleanup criteria, and provide the basis for developing and evaluating remedial alternatives in the FS. Figure 1.3 shows the relationship of the ERA to the overall RI/FS process.

Although numerous environmental data were collected for J-Field during past characterization studies, these data were not evaluated in this ERA nor in the human health risk assessment (Ripplinger et al. 1998) because of associated quality assurance (QA) and quality control (QC) uncertainties. The Quality Assurance Project Plan (QAPjP) developed for the J-Field RI (Prasad et al. 1995) identified stringent criteria for data review, validation, and evaluation. These QA/QC criteria could not be applied to historical data. However, such data were used in developing the work and sampling plans for the RI (Benioff et al. 1995a,b) and the ERA (Hlohowskyj et al. 1995).

A general approach to conducting ERAs was developed specifically for APG and is documented in a risk and biological impact assessment technical plan (ICF Kaiser Engineers 1993). To ensure that the J-Field ERA provides information applicable to other APG assessments, the J-Field ERA follows this general sitewide approach. However, the ERA differs from the general sitewide approach in that it focuses on the specific ecological properties of J-Field.

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FIGURE 1.3 Relationship of the Ecological Risk Assessment to the RI/FS Process at J-Field

1.3 SCOPE OF THE ECOLOGICAL RISK ASSESSMENT

1.3.1 Objectives

Because of past activities at J-Field, environmental media are contaminated with a variety of organic and inorganic chemicals. The potential or actual effects of this contamination on the ecological resources at the site are not known. As required under the NCP, however, decisions regarding remedial actions for J-Field must consider the potential and actual risks that contamination poses to environmental resources, including ecological resources.

The J-Field ERA was designed to (1) determine whether past activities and current levels of contamination have adversely affected the ecological resources at the site, (2) determine whether current or future conditions at the site pose a potential adverse risk to ecological resources, and (3) identify areas of J-Field where remediation may be warranted from an ecological standpoint. The ERA was designed to address the following ecological questions about contamination at the site:

- Are current levels of contaminants in environmental media producing demonstrable ecological effects on the population, community, or ecosystem? If so, what are the extent and magnitude of the effects?
- Are contaminated environmental media directly toxic to biota?
- What is the potential risk to biota of receiving contaminant doses through direct and indirect uptake from contaminated environmental media? What are the extent and magnitude of such risks?

The results of the ERA will assist APG in determining whether remedial action is necessary at any of the AOCs from an ecological perspective, and whether the AOCs support valuable biological resources that could be affected adversely by remedial activities.

1.3.2 Ecological Risk Assessment Approach

The J-Field ERA was designed to (1) meet to the extent possible the requirements for a quantitative-level risk assessment (Davis 1994), (2) follow EPA guidance for conducting environmental evaluations and ERAs under CERCLA (EPA 1989a; Davis 1994), and (3) conform with the EPA (1992) framework for ERAs (Figure 1.4). This level of risk assessment is the most scientifically rigorous approach and provides the most thorough weight of evidence for determining the potential for ecological risk. The J-Field ERA targeted assessment endpoints that are representative of several components of the ecosystem: aquatic and terrestrial vegetation, soil and

FIGURE 1.4 Framework for Conducting the Ecological Risk Assessment (Source: EPA 1992)

aquatic invertebrates, fish, and terrestrial wildlife. The ERA also evaluated effects at different levels of ecosystem organization: individuals, populations, and communities (Table 1.2). Details regarding the methods used in conducting the field and laboratory investigations can be found in Appendix A and in Dunn and Stull (1995), Hayse (1995), Hlohowskyj et al. (1995), Kuperman (1995), Philips et al. (1995), Johnson (1995), and Whaley (1996). The J-Field ERA is also consistent with the most recent EPA guidance (EPA 1997) for conducting ERAs under Superfund; that guidance was issued after the design and completion of the J-Field ERA.

The ERA was conducted in three steps (Figure 1.5): a screening step, an exposure and effects assessment step, and a risk characterization step. In the screening step, which is analogous to Steps 1 and 2 of the recent EPA (1997) Superfund ERA guidance, maximum reported media concentrations were compared with screening ecotoxicity values to identify contaminants that may

TABLE 1.2 General Assessment Endpoints, Ecological Receptors, Assessment Levels, and Measurement Endpoints for the J-Field Ecological Risk Assessment

Assessment Endpoint	Ecological Receptor	Assessment Level	Measurement Endpoint
Protection of the plant community from ecological changes related to contaminant exposure	Vegetation	Individual	Seed germination, growth, survival, tissue concentrations
		Population and community	Species diversity, total biomass
Protection of the soil invertebrate community and soil nutrient processes from ecological changes related to contaminant exposure	Soil invertebrates	Individual	Earthworm survival, tissue concentrations
		Population and community	Species diversity, trophic dominance, biomass, abundance
		Biological processes	Soil respiration, microbial enzyme activities
Protection of the terrestrial vertebrate community from ecological changes related to contaminant exposure	Terrestrial vertebrates	Individual	Modeling dose estimates, tissue concentrations
		Population and community	Species diversity, reproductive success, abundance
Protection of the aquatic community from ecological changes related to contaminant exposure	Aquatic biota	Individual	Acute and chronic toxicity, tissue concentrations
		Population and community	Species diversity

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FIGURE 1.5 General Approach for the J-Field Ecological Risk Assessment

be present at environmental concentrations that could result in exposures that incur unacceptable ecological risks. Contaminants that are retained by this screening assessment are then carried into the exposure and effects assessment step as potential contaminants of ecological concern (PCOECs).

The exposure and effects assessment step (Step 2 in Figure 1.5) evaluates (1) exposure of ecological receptors to the PCOECs (on the basis of dose modeling and tissue analysis) and (2) effects (on the basis of field and laboratory studies examining contaminant effects on biological processes; community organization, structure, and function; and growth, reproduction, and mortality). The exposure assessment predicts or measures the exposure and subsequent uptake of contaminants from the environment by the ecological resources of interest. The effects assessment identifies and quantifies the adverse effects caused by the contaminants, and, to the extent possible, evaluates cause-and-effects relationships (EPA 1992). In the final step of the assessment (Step 3 in Figure 1.5), the results of the exposure and effects assessments are brought together in a weight-of-evidence evaluation to characterize the risks to ecological resources from the PCOECs identified in the screening risk assessment step. These steps are consistent with Steps 3 through 7 of the recent EPA (1997) Superfund ERA guidance.

The weight-of-evidence evaluation considers potential risks to ecological resources for each AOC as well as for the J-Field site as a whole. The J-Field ERA was limited to evaluating only AOCs, PAOCs, and ecological resources that occur on the site proper. Potential impacts to ecological resources at nearshore locations were outside the scope of this assessment and were not directly evaluated in this ERA.

1.4 REPORT ORGANIZATION

The ERA report is organized as follows:

- Section 1 identifies the problems at J-Field and summarizes the purpose, scope, and approach of the ERA.
- Section 2 summarizes the overall environmental setting of the site and describes the ecological setting of each AOC.
- Section 3 presents the results of the screening ERA and identifies the PCOECs. This section also addresses problem formulation. Conceptual models are presented that identify source terms, contaminant transport pathways and exposure routes, assessment endpoints, and ecological receptors at each AOC and for the J-Field site as a whole. This section summarizes contaminant characterization data from the RI (Yuen et al. 1999), evaluates

contaminants by medium at each AOC and across the entire site, and presents a final list of PCOECs.

- Section 4 presents ecotoxicity profiles for each PCOEC, as well as the benchmark values used in the ERA.
- Section 5 presents the results of the exposure assessment, including the tissue residue analysis. Exposure point concentrations are presented for each PCOEC in the relevant environmental media at each AOC. The methods used for estimating contaminant uptake as an applied daily dose (ADD) from all appropriate uptake routes are described. Exposure factors for selected ecological receptors are summarized, and the estimated ADDs for each receptor are presented.
- Section 6 presents the results of the ecological effects assessment. The results of the field investigations and laboratory toxicity tests are given for each AOC.
- Section 7 presents the risk characterization for the site. The methods used for estimating a hazard quotient (HQ) are presented, and risk estimates based on the HQ and a weight-of-evidence evaluation are presented for each AOC and for the J-Field site as a whole. The ecological significance of the risk estimates and the uncertainty of the risk characterization process are discussed.
- Section 8 summarizes the results and conclusions of the assessment for each AOC and for the J-Field site as a whole. Additional ERA investigations are identified, as appropriate.
- Section 9 lists all the references cited.
- Section 10 identifies the individuals who prepared this ERA report.
- The appendixes provide details on field and laboratory methods, terrestrial vegetation surveys, wetlands delineation results, screening and benchmark values for contaminants, and additional ecotoxicological information for the PCOECs.

2 PHYSICAL AND ECOLOGICAL SETTING

The following sections summarize the environmental setting at J-Field and at each AOC. Detailed descriptions of the geophysical and hydrogeological environment of each AOC are provided in Volume 1 of the RI report (Yuen et al. 1999).

2.1 DESCRIPTION OF THE J-FIELD AREAS OF CONCERN

2.1.1 Toxic Burning Pits Area of Concern

The 9.0-acre TBP AOC is located in the southern portion of J-Field (Figure 1.2). Disposal operations at the TBP AOC began in the 1940s and have continued to the present, although the pits were used most extensively between the late 1940s and the 1960s.

Five disposal pits were used at the TBP AOC. The two existing (or main) burning pits, each covering about 4,500 ft², were the pits most actively used for the disposal of various chemical agents and explosives. Three other burning pits, now covered, were used to dispose of VX, mustard, and the primary components of liquid smoke — titanium tetrachloride and sulfur trioxide/chlorosulfonic acid. The main disposal pits were maintained by periodically pushing burned soil and ash out of the pits toward the adjacent marsh. The areas that now contain this material are referred to collectively as the "Pushout Area." This area covers about 67,000 ft² and extends more than 100 ft into the marsh.

The VX pit and mustard pit are about 100 and 150 ft long, respectively. The liquid smoke disposal pit is fairly small, covering an area of about 24 ft². High-explosive (HE) munitions were also disposed of by detonation along the southeastern edge of the TBP AOC (Nemeth 1989).

Storage and handling areas have been identified at the upper ends of both the VX pit and the mustard pit. A square pit, approximately 4 × 4 ft and 3 ft deep, is located at the current tree line south of the main burning pits; this pit may be the missing liquid smoke disposal pit (Yuen et al. 1999).

The TBP AOC is bounded to the northeast by marsh and to the south and southeast by woods and marsh (Nemeth 1989). Because the ground surface is highest in the northwestern part of the TBP AOC, surface water probably drains toward the south-southeast into the marsh area.

2.1.2 White Phosphorus Burning Pits Area of Concern

The 7.8-acre WPP AOC is near the Gunpowder River in the western part of J-Field (Figure 1.2). The area contains two pits used for disposal (by open burning and detonation) of white phosphorus, plasticized white phosphorus, munitions filled with white phosphorus, and materials contaminated with white phosphorus. After materials were burned and reburned in the pits, debris and soil were pushed out.

The WPP AOC has been used as a disposal site since the late 1940s or early 1950s. Aerial photographs show that in 1951, disposal operations were conducted in the southeastern portion of what is currently the open disposal area. The two existing pits were constructed sometime between 1951 and 1957 (Nemeth 1989).

During the late 1950s, the pits were extended to the Gunpowder River, and burned materials from the pits were pushed into the river. In 1986, a ditch was excavated to drain water from the pits. The ditch from the Northern Pit extends north toward a bermed depression constructed to hold the water. The ditch associated with the Southern Pit ends at what is assumed to be a pushout area. During wet weather, water collects in the pits and the bermed depression, even though surface runoff does not enter the pits (Nemeth 1989; Sonntag 1991).

The WPP AOC is an active emergency disposal facility. The existing pits and areas potentially affected by emergency disposal operations have been excluded from the RI/FS, and their investigation has been deferred pending relocation of the emergency disposal operations. However, some ecological data have been collected from this AOC and are discussed in this ERA. In addition to the AOC proper, two suspected burning areas and a suspected storage area have been identified at the WPP AOC (Yuen et al. 1999). The suspected burning areas are located in the northwestern and southwestern corners of the AOC. These areas were not documented in previous environmental assessments (Nemeth 1989), and their specific uses are unknown. The suspected storage area is located in the southwestern corner of the AOC.

2.1.3 Riot Control Pit Area of Concern

The 6.4-acre RCP AOC is located in a heavily wooded area in the southwestern part of J-Field (Figure 1.2). Except for a small area in the northeastern part of the site, the area is overgrown with vegetation. About 30 ft of an access road has been eroded, and the presence of several tall trees about 10 ft offshore in Chesapeake Bay indicates that this area is rapidly being eroded by wave action.

Disposal operations in the pit began in the late 1940s and continued until the early 1970s. The area immediately east of the access road to the South Beach was probably part of the site and

may have been used for burning operations during the 1950s. A trench was excavated in the area between 1957 and 1960 and was later extended southwest to the Gunpowder River to provide drainage from the pit. Between 1960 and the early 1970s, the trench was used for burning riot control agents, munitions filled with such agents, and material contaminated with these agents (Nemeth 1989).

2.1.4 Prototype Building Area of Concern

The 8.9-acre PB AOC is located in a grassland area in the southwestern part of J-Field, northwest of the TBP AOC and north of the RCP AOC (Figure 1.2). The building, constructed during World War II, is an open-sided, three-level reinforced concrete structure. It was originally used for testing the effectiveness of bombs. Since World War II, the building and the areas to the west and north have been used intermittently for temporary storage of solid waste (Nemeth 1989). Two suspected burning areas have also been identified — one northeast and one west of the PB AOC — on the basis of a review of archival information.

2.1.5 South Beach Demolition Ground Area of Concern

The 2.4-acre SBDG AOC was located along the southern beach of J-Field (Figure 1.2). The area was used as a demolition site for HE munitions during the 1960s and 1970s, and possibly during the 1950s (Nemeth 1989). Munitions were detonated either on the surface or under several feet of soil. It is reported that remnants of munitions detonated in this area are visible about 100 ft offshore during low tide. At high tide, most of the demolition ground area is 1-2 ft below water. A few demolition craters, which are assumed to be remnants of SBDG operations, are visible just inland from the shoreline and east of the end of Rickett's Point Road (Figure 1.2).

2.1.6 South Beach Trench Area of Concern

The 1.1-acre SBT AOC is located near the southern beach of J-Field, southeast of the RCP AOC (Figure 1.2). The trench, about 75 ft long and 12 ft wide, was excavated between 1957 and 1960. It may have been a borrow pit for nearby demolition activities. No information has been found regarding past chemical or hazardous material disposal in this area; however, chemical analyses of soil samples collected from the trench during the RFA showed low levels of chlordane and naphthalene (Nemeth 1989).

2.1.7 Robins Point Demolition Ground Area of Concern

The 7.0-acre RPDG AOC is in the eastern part of J-Field, close to the Bush River (Figure 1.2). The site was first used during the late 1970s for destroying HE and HE-filled munitions. The site was also reportedly used during the 1980s for destroying small amounts of sensitive and unstable chemicals by detonation with explosives (Nemeth 1989).

The original site, now inactive and considered an AOC for the purposes of the RI/FS, was a small clearing near the edge of the adjacent marsh. In 1985, the clearing was enlarged, and a berm was built on the eastern edge of the enlarged clearing. Later demolition activities occurred in an area west of the berm; the berm prevented surface runoff from entering the marsh (Nemeth 1989). The area west of the berm continues to be used for disposal operations.

2.1.8 Robins Point Tower Site Area of Concern

The 7.1-acre RPTS AOC is located near Robins Point at the southeastern tip of the Gunpowder Peninsula (Figure 1.2). The wooden observation tower was built between 1957 and 1960. The road connecting Robins Point with Rickett's Point Road has existed since about 1917, when APG became an army installation. However, aerial photographs suggest that the area was not used until the 1950s. The Robins Point area was used for launching and observing rockets (Nemeth 1989).

Around 1958, the Robins Point area may have been used for at least one test burn of wood contaminated with radioactive material (including radium and strontium). According to Nemeth (1989), the test burn was to be conducted in a trench (20 ft long, 5 ft wide, and 5 ft deep), and no more than 500 lb of material was to be burned in small increments. Nemeth (1989) reported that a 1950 U.S. Army Environmental Hygiene Agency (USAEHA) report recommended that the routine burning of radioactively contaminated materials be conducted in a closed incinerator; correspondence in the USAEHA project file indicates that this recommendation was accepted. The possibility remains, however, that a test burn of radioactively contaminated wood did occur at either the RPDG or the RPTS. Records do not indicate which site was used. However, it is likely that the RPTS was used because the RPDG site was wooded and not yet in use in 1959. In addition, aerial photographs from the 1960s show no roads or open areas at the RPDG site.

2.1.9 Potential Areas of Concern

In addition to the eight AOCs identified at J-Field, 17 other areas have been identified as PAOCs (Benioff et al. 1995a): Site X1, Areas A through D, two suspected storage areas associated with the TBP AOC and the WPP AOC, four suspected burning areas (two near the WPP AOC and

two near the PB AOC), one suspected filled trench near the SBT AOC, one clearing near the southwestern corner of the Prototype Building, one suspected disposal area southwest of the TBP AOC, the craters at J-Field, one ruins site east of the WPP AOC, and one demolition area southeast of the TBP area. Detailed descriptions of these PAOCs are provided in Volume 1 of the RI report (Yuen et al. 1999) and in the field sampling plan (FSP) (Benioff et al. 1995b).

2.1.9.1 Site X1

Site X1 is located in the northwestern portion of J-Field, approximately 300 ft southwest of the intersection of Rickett's Point Road and the access road leading to Area B (Figure 1.2). Aerial photographs show the site as early as 1951. They also show a cleared area about 120 × 100 ft in size. An access road, still visible today, extended from Rickett's Point Road to Site X1.

The site includes two ruins subsites approximately 100 ft apart in an east-west orientation. Collapsed concrete columns are present at each subsite, and both subsites are surrounded by a ridge of soil piles. Vegetation within the subsites appears to be younger than that in surrounding areas, and no evidence of bomb craters exists. A brick foundation wall is visible on the ground in the eastern subsite, and a small, partially buried drum is visible in a soil pile at the western subsite.

Three very shallow surface soil depressions near the access road seasonally retain ponded water. Each depression is approximately rectangular and about 6 ft wide. The origin and use of these depressions are unknown.

2.1.9.2 Area A

Located in the northern part of J-Field (Figure 1.2), Area A is characterized by grids of linear features and two water-filled trenches, as they appeared on aerial photographs. The access road to the Ford's Point Firing Station dissects the central part of the site. When inspected, the site was swampy. The grid pattern shown in aerial photographs is caused by drainage grids commonly used to drain wetlands in this region.

One S-shaped trench and one straight trench are present within the drainage grid. The S-shaped trench is located next to the road and is separated from the straight trench by a dirt pile. Both trenches are about 6-7 ft wide. No scrap metal has been found on the ground surface nearby. The past use of the trenches is unclear.

About 400 ft west of the S-shaped trench is an old building site. A small shack appears there in 1965 aerial photographs. A few glass bottles and ceramic sherds are now scattered on the ground. Soil piles surround the site. A prominent, straight, long drainage about 3 ft wide extends from behind the site to the swamp north of J-Field. This drainage is readily noticeable in aerial photographs.

2.1.9.3 Area B

Area B (also known as the Ford's Point Firing Station) is located at the end of an access road in the northeastern portion of J-Field along the Bush River (Figure 1.2). The site is a large open area vegetated with reed grass (*Phragmites*). The concrete slabs along the eastern boundary of the site with the Bush River probably serve as shoreline erosion control. Historical aerial photographs indicate that the site has existed since at least 1951; however, the nature of activities conducted at the site are not known. Concrete debris with embedded pipes is present in the southern portion of the site, and soil mounds and two scrap drums were found near the western boundary of the site.

2.1.9.4 Area C

Area C is a ruins site in the north-central portion of J-Field, near the intersection of Rickett's Point Road and the access road to Area B (Figure 1.2). Aerial photographs from 1965 show two buildings near the Rickett's Point Road intersection and a wall near the eastern portion of Area C. Later aerial photographs indicate that the buildings were destroyed sometime before 1968, and remnants of a concrete wall and bricks are currently present on the ground surface. Bomb craters are also visible near the site. The destroyed buildings may have served as access control to the Ford's Point Firing Station, and the concrete wall in the eastern portion of the site was probably a bombing target.

2.1.9.5 Area D

Area D, located about 400 ft east of the Ruins Site (Figure 1.2), is a flooded swamp area. The area has a dark tone in aerial photographs and is dotted with many craters. No road extends to this site. The site probably was used for munitions targeting.

2.1.9.6 Craters

Numerous craters are scattered across J-Field. The craters are visible in large-scale historical aerial photographs and in the field. Many of these craters fill with water in the spring.

2.1.9.7 Ruins Site across Road from WPP

A ruins site located across Rickett's Point Road from the WPP (Figure 1.2) contains two building ruins, two connected artificial ponds, four retaining wall structures, and a suspected filled

trench. These features are discernible in the 1965 aerial photographs. The western part of the site, where the two building ruins are located, was flooded at the time the site was inspected.

This site was used for munitions testing during World War II. Bomb craters are common, especially near the four retaining-wall structures. Probably because of bombing, only remnants of buttressed columns and partially destroyed steel-reinforced walls remain in the field. No metal scrap was found on the ground surface. The building ruins are in the eastern part of the site. One is a steel-reinforced concrete building, and the other is a steel-reinforced brick building. Circular scars are common on the buildings' outside walls. Two small ponds connected by a ditch are near the southern part of the site. One of the ponds is rectangular, the other is of an irregular shaped. The past use of the ponds is not known.

A suspected filled trench, about 7-8 ft wide, was identified in an area about 80 ft southeast of the building ruins. It is partially ponded with water. The suspected filled trench extends southeast for more than 100 ft. Traces of roadbed are discernible near the end of the feature. The roads connect to Rickett's Point Road. A steel tube with a cylinder inside was found next to a pile of soil between the filled trench and the two building ruins. The past use of the trench is not clear.

In the 1965 aerial photographs, a dark-toned area appears in the southwestern part of the site. This area was inspected in the field and was found to be flat and covered with vegetation that is younger than that in the surrounding area. No scrap metal was found on the ground surface. The previous use of this area is unknown.

2.2 TOPOGRAPHY AND SOILS

J-Field is located at the southernmost end of the Gunpowder Neck Peninsula, within the Edgewood Area of APG. The overall topography of the site and each AOC is nearly flat, with a maximum relief of about 10 ft. The ground surface slopes gently either toward marshy areas along the southern and eastern shores of J-Field or toward Chesapeake Bay and on-site surface waters. In some locations along Chesapeake Bay, wave erosion has formed short, steep cliffs 2-10 ft high (Hughes 1993).

Although much of the J-Field surface soil appears relatively undisturbed and supports a variety of vegetation and wildlife, the soil at some AOCs is disturbed from past activities (Table 2.1). For example, construction of disposal trenches and pits, as well as open burning and detonation, have greatly altered the structure of the surface soil in the TBP, WPP, and RPDG AOCs. In other areas, such as the RPTS AOC, past activities have resulted in much less severe disturbance of surface soils. The PB AOC shows little evidence of surface soil disturbance.

TABLE 2.1 Occurrence of Major Aquatic and Terrestrial Habitats near Each Area of Concern at J-Field

AOC	Area ^a (acres)	Surface Soil Disturbance Evident	Tidal Marsh	Nontidal Marsh	Wet-Mesic Forest	Upland Forest	Grassland	Pond	Ephemeral Pond or Craters ^b
PB	8.9	No	- ^c	-	-	-	+	-	-
WPP	7.8	Yes	+	+	-	-	+	+	+
RCP	6.4	Yes	-	+	+	+	-	-	+
SBT	1.1	Yes	-	+	+	+	-	+	+
SBDG	2.4	Yes	-	+	+	+	-	-	+
TBP	9.0	Yes	+	-	+	+	+	+	+
RPDG	7.0	Yes	+	+	-	+	+	-	+
RPTS	7.1	No	+	+	+	+	+	-	-

^a Approximate area; includes pits, trenches, and buildings (where present), as well as immediate surroundings.

^b Pits, trenches, depressions, and craters are seasonally flooded and represent potential, seasonally available surface water habitat.

^c - = habitat absent; + = habitat present.

2.3 SURFACE WATER HYDROLOGY

The southern and eastern shores of J-Field are covered by an extensive marsh system (Figure 2.1). The entire site is located within the 50-yr floodplain of the Chesapeake Bay. The marshes may be flooded during storms or very high tides but are not affected by the normal 1- to 2-ft daily tides. The water level in the marshes is generally about 2 ft above high tide in Chesapeake Bay. The disposal pits at J-Field originally drained into either these marshes or the Gunpowder and Bush Rivers. During the 1970s, drainage from the disposal pits was blocked. Currently, surface water can be 1-2 ft deep in the pits at the TBP and WPP AOCs during the wet season, generally March to June (Hughes 1993). Several ponds are located within the marshy areas of J-Field. The largest pond, about 1.5 m deep, is southeast of the TBP AOC (Figure 2.1). The two streams on the eastern side of J-Field are the only streams on the site, and they do not carry much runoff except during storms. No AOCs are associated with either of these streams.

Numerous detonation craters of various size are present throughout the site and are similar to small freshwater ponds. Some of these craters retain water throughout the year. Other craters fill with water only during the spring rainy season and may serve as habitat for some biota at that time. Detonation craters are associated with all of the AOCs except the PB AOC.

FIGURE 2.1 Locations of Woods, Marshes, Ponds, Open Fields, and Streams at J-Field
(Source: Adapted from Hughes 1993)

2.4 HABITATS AND BIOTA

J-Field contains a variety of aquatic and terrestrial habitats (Figure 2.1). Forests represent the dominant habitat at J-Field, and grassland habitat is present in some locations. The site also contains extensive tidal and nontidal marsh habitats. Stream, pond, and lake habitats are few; one pond is located at the southern end of the site. Table 2.1 identifies the different habitat types within the AOCs.

2.4.1 Vegetation and Wetlands

The Gunpowder Neck Peninsula consists of open fields (mowed and unmowed grass), bare ground, and second-growth woods dominated by maple, oak, and sweet gum. J-Field supports extensive second-growth woods as well as freshwater wetlands (Figure 2.1). Drier upland areas support occasional stands of tulip trees or mixed deciduous hardwoods, including Spanish oak, hickory, and scarlet oak, with an open understory. Persimmon, black locust, and black cherry are also frequently found throughout the upland forested areas. Lower elevations contain extensive forested areas (including forested wetlands) dominated by sweet gum and red maple. Willow, oak, black gum, swamp chestnut oak, and sycamore dominate wetter areas. The understory is open, with greenbrier and high-bush blueberry increasing in abundance in lower and wetter areas. Forested habitats are present at the RPTS, SBT, SBDG, and RCP AOCs. Forested habitats are also present around the RPDG and TBP AOCs.

Old open-field areas are not common at J-Field but do occur around the WPP, RPDG, TBP, and PB AOCs (Figure 2.1). These areas are a result of past and ongoing human activities, such as infrequent mowing, and are covered with upland grasses and forbs, such as broom sedge, velvet grass, purple-top grass, and grama grass.

J-Field supports tidal and nontidal marsh and wet-mesic forest wetland habitats. The tidal marshes occur along most of the eastern and southern shorelines of J-Field and intermittently along the Gunpowder River shoreline. These marshes are dominated by common reed and cattail, and they are occasionally inundated by Chesapeake Bay waters (during major storms or unusually high tides). However, these wetlands are separated from the bay by beach ridges and are not directly influenced by daily tidal fluctuations. The largest tidal marsh is located next to the TBP AOC at the southern end of J-Field (Figure 2.1). This marsh supports an extensive area of common reed and includes a large pond. Floating mats of common reed grow along the periphery of the pond; these mats are formed by the intertwining root system of the plants.

Nontidal marshes exist throughout the interior of J-Field. Such wetland habitats are associated with most of the AOCs and are also found throughout the interior of the J-Field site.

Wet-mesic forest wetlands also occur in portions of J-Field and are associated with the RCP, SBT, TBP, and RPTS AOCs.

2.4.2 Fish and Wildlife

No detailed surveys or investigations of fish and wildlife were conducted at J-Field before this ERA was conducted. However, more than 120 bird, 40 mammal, 22 reptile, 15 amphibian, and 40 fish species have been reported at APG (USATHAMA 1993), and some of these species are likely to be found at J-Field. Terrestrial wildlife known to occur at J-Field include the eastern box turtle, spring peeper, spotted salamander, red fox, muskrat, and white-tailed deer. Common birds observed at the site include barn and tree swallows, great blue heron, American goldfinch, eastern bluebird, American robin, osprey, and common flicker; the bald eagle (a federal threatened species) was observed near the RPTS AOC on two occasions.

Although more than 40 species of fish have been reported at APG, little habitat exists on the J-Field site to support most of these species. The largest J-Field habitat that supports fish is the pond near the TBP AOC (Figure 2.1). Fish collected from this pond include the blue-spotted sunfish, banded killifish, spottail shiner, and golden shiner. No suitable habitat for fish exists at the PB, RCP, RPTS, or RPDG AOCs.

3 SCREENING ECOLOGICAL RISK ASSESSMENT AND PROBLEM FORMULATION

The nature and extent of environmental contamination at J-Field were determined through the contaminant characterization portion of the RI; the results of that investigation are presented in Volume 1 of the RI report (Yuen et al. 1999). A preliminary conceptual model that identifies contaminant sources, contaminant migration and exposure pathways, and human and ecological receptors was developed to support the Field Sampling Plan (FSP) for the site (Benioff et al. 1995b). After characterization activities under the RI were completed, the conceptual model developed in the FSP was refined to reflect the site-specific data collected during the RI.

The revised conceptual model presented in Volume 1 of the RI report (Yuen et al. 1999, Section 5.2) identified six types of sites at J-Field: burning pits, demolition grounds, suspected burning areas, ruin sites, storage areas, and craters. On the basis of the extent of contamination present in these sites, only the burning pits, demolition grounds, and suspected burning areas are considered primary contaminant sources; contamination at the other sites is very limited.

Primary release mechanisms from the source areas identified in Volume 1 of the RI (Yuen et al. 1999) include direct disposal of solid and liquid waste on the soil surface or in pits and trenches, open burning and detonation, and pushout operations. Secondary contaminant sources include contaminated soils, sediment, surface water, non-aqueous-phase liquids, and groundwater. Release mechanisms from these sources include wind dispersion, gaseous emissions, leaching, infiltration and percolation, surface runoff, evaporation, and groundwater and surface water dispersion.

The RI conceptual model applies only generally to the ecological resources at J-Field. Many of the contaminant sources and release mechanisms identified in the conceptual model are relevant to the ecological resources at the site, but the importance of any single source or release mechanism varies among the AOCs and across the J-Field site. Therefore, an ecological conceptual model was developed for J-Field that focuses on the ecologically important contaminant sources and pathways, and more detailed models were developed for each AOC.

3.1 SOURCE CHARACTERIZATION, EXPOSURE PATHWAYS, AND ECOLOGICAL CONCEPTUAL MODELS

During the initial phases of the ERA, a series of ecological conceptual models of the fate and transport of contaminants at the J-Field site and at each AOC were developed to determine the potential exposure of ecological resources. Characterization data from Volume 1 of the RI, aerial photographs, U.S. Geological Survey (USGS) topographic maps, data from previous investigations

at J-Field, and preliminary field surveys of ecological habitats at the site were used to develop these models. The conceptual models were then used to identify appropriate assessment and measurement endpoints and representative ecological receptors for each AOC, guide sampling activities associated with the ecological field studies and media toxicity evaluations, and develop the list of potential contaminants of ecological concern (PCOECs).

3.1.1 J-Field Site

Contamination has resulted from past operations and activities at the J-Field site. The primary sources are the contaminated surface and subsurface soils (Figure 3.1), which are associated with the disposal pits, burning trenches, and pushout areas. It was not possible, however, to identify specific contaminant sources at some AOCs, such as the PB and RPTS AOCs.

Primary contaminant release mechanisms include surface runoff, infiltration and percolation of precipitation, wind dispersion of particulates, and gaseous emission. Because of surface runoff and percolation, sediment, groundwater, and surface water have become contaminated and represent secondary contaminant sources at the site.

Ecological resources at J-Field may be exposed to contaminants through various exposure routes (Figure 3.1). Contaminated surface soils, sediment, and surface water are the environmental media most likely to be encountered by biota. For terrestrial biota, the principal uptake route is considered to be ingestion of contaminated food, soil, and surface water; dermal absorption and inhalation represent lesser pathways in the conceptual models for the site. Direct exposure to contaminated groundwater is limited to deep-rooted vegetation that may be exposed via root uptake of contaminated groundwater. Exposure by way of groundwater discharge into the Gunpowder and Bush Rivers or Chesapeake Bay is outside the scope of this ERA and thus is not evaluated here. However, groundwater discharge to on-site marshes is evaluated. For the aquatic biota that inhabit freshwater habitats on the J-Field site proper, the principal exposure routes are direct absorption from surface water and sediment and ingestion of contaminated food and media. Habitats and biota in Chesapeake Bay are outside the scope of this ERA (but are being evaluated by other investigations), and pathways to the bay are not identified in the conceptual models for the site. However, biota that inhabit the bay would also be exposed, primarily through direct uptake from surface water and sediment and ingestion of contaminated food and environmental media.

3.1.2 Toxic Burning Pits Area of Concern

The principal contaminant sources at the TBP AOC are the surface and subsurface soils associated with the two main burning pits, HE demolition ground, VX pit, mustard pit, liquid smoke

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FIGURE 3.1 Site Conceptual Model for J-Field (solid arrows identify principal exposure pathways and solid circles identify appropriate receptors for each exposure route)

disposal pit, and Pushout Area (Figure 3.2). Surface soil is the environmental medium of greatest concern; soil contaminants include heavy metals and organic compounds. These contaminants may be released by surface runoff, precipitation infiltration and percolation, and gaseous emission of volatile organic compounds (VOCs). Contaminant transport from these sources has resulted in contamination of sediment and surface water in the marsh-pond ecosystem that borders the Pushout Area and the southern boundary of the AOC (Figure 2.1). Surface water and sediment are contaminated primarily with heavy metals; some organic compounds have also been detected.

Groundwater in the surficial aquifer beneath the site is contaminated with heavy metals and high levels of VOCs, and it discharges to the marsh and pond. Details regarding the nature and extent of contamination at the AOC are presented in Volume 1 of the RI report (Yuen et al. 1999). The PCOECs at the TBP AOC are identified in Section 3.2 of this report.

The principal exposure point for terrestrial biota is the surface soil of the pits and the Pushout Area. Exposure at these areas would primarily occur via incidental ingestion of contaminated soil and food chain transfer of contaminants; burrowing species may also be exposed to VOCs and semivolatile organic compounds (SVOCs) via inhalation. Dermal absorption may be an exposure route for some biota. Terrestrial biota may be exposed by drinking contaminated surface water at the marsh and pond. Aquatic biota that inhabit the marsh and pond may be exposed to contaminated sediment and surface water, and contaminant uptake could occur through direct contact or ingestion. Direct exposure to contaminated groundwater would be limited to vegetation via root uptake.

3.1.3 White Phosphorus Burning Pits Area of Concern

The soils in the two pits and the pushout area are the primary contaminant sources at the WPP AOC (Figure 3.3). Contaminants may be released from these areas by surface runoff, infiltration and percolation, and gaseous emission. Secondary contaminant sources, resulting primarily from surface runoff of contaminated soils, include sediment and ephemeral surface water in the pits and depressed portion of the pushout area. Surface water and soil from the northwest and southwest suspected burning areas are contaminated with heavy metals and organic compounds. A detailed description of the WPP AOC, including the nature and extent of contamination, is presented in Volume 1 of the RI (Yuen et al. 1999). The PCOECs for the AOC are summarized in Section 3.2 of this report.

Ecological resources would be exposed primarily through food chain transfer and incidental ingestion of contaminated soil at the pits, pushout area, and suspect burning areas. Burrowing biota may also be exposed by inhaling VOCs and SVOCs. No fish inhabit the surface waters at the WPP AOC; thus, exposure to contaminated surface water would be limited to herpetofauna species that use the surface waters for reproduction and terrestrial biota that may drink from these waters.

FIGURE 3.2 Conceptual Model for the Toxic Burning Pits Area (solid arrows identify principal exposure pathways and solid circles identify appropriate receptors for each exposure route)

FIGURE 3.3 Conceptual Model for the White Phosphorus Pits Area (solid arrows identify principal exposure pathways and circles identify appropriate receptors for each exposure route)

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Terrestrial vegetation may be exposed to soil contaminants via root uptake. No groundwater pathways to ecological receptors were identified for the WPP AOC.

3.1.4 Riot Control Burning Pit Area of Concern

The primary contaminant source at the RCP AOC is the soil associated with the pit and trench (Figure 3.4). Contaminants detected in the surface soil include heavy metals, SVOCs, and VOCs. Surface runoff from the pit via the trench and groundwater flow from the surficial aquifer below the site may transport contaminants to a nearby marsh habitat. The pit also represents an ephemeral surface water body that may be contaminated. Surface water from the pit and southwest (downgradient) of the pit contained elevated levels of the same metals found in the soils, but no organic contaminants. A description of the site and the nature and extent of contamination present is given in RI Volume 1 (Yuen et al. 1999). The PCOECs are summarized in Section 3.2 of this report.

Principal exposure routes from contaminated soil at the pits include food chain uptake and incidental ingestion of soil. Terrestrial biota would be exposed to contaminated soil at and near the pit. The pit also represents a seasonal surface water body, and a drinking water pathway to terrestrial biota may be present during the spring and fall rainy seasons. Because of the nature of the surface waters at this AOC, exposure pathways to aquatic biota would be limited to invertebrates and amphibians that inhabit the marsh area southwest of the RCP AOC or use the ephemerally inundated pit for reproduction. The exposure pathway for vegetation is root uptake of contaminants from surface soil and, to a lesser extent, from groundwater. No direct groundwater exposure pathway was identified for terrestrial wildlife, although terrestrial wildlife may ingest vegetation that has been exposed via root uptake of groundwater.

3.1.5 Prototype Building Area of Concern

In contrast to the AOCs discussed previously, no obvious contaminant point sources are evident at the PB AOC. No open burning or detonation activities are known to have occurred at the PB AOC, although two suspected burning areas have been identified. Originally used to test the effectiveness of bombs, the site was intermittently used for temporary storage of solid waste. A detailed description of the site, including the nature and extent of contamination, is presented in RI Volume 1 (Yuen et al. 1999). The PCOECs for the PB AOC are summarized in Section 3.2 of this report.

The principal contaminant source is soil at the storage areas and suspected burn areas. No surface water bodies and no surface discharge of groundwater occur at this AOC. Elevated levels of heavy metals were detected in the soils around the building, and low levels of pesticides were

FIGURE 3.4 Conceptual Model for the Riot Control Burning Pit Area (solid arrows identify principal exposure pathways and solid circles identify appropriate receptors for each exposure route)

detected in surface soils to the east, north, and south of the building. Low levels of organic compounds were also detected in soil samples collected to the east and south of the building. No contamination was evident at the two suspected burning areas. Surface runoff from the PB AOC flows predominantly to the Gunpowder River, and elevated levels of some metals have been detected in surface water samples collected from that river.

Exposure of biota at the PB AOC would be limited to terrestrial species. Exposure could occur via food chain uptake, incidental ingestion of contaminated soil, and, to a lesser extent, inhalation of VOCs and SVOCs (Figure 3.5). No surface water or groundwater pathways were identified for this AOC.

3.1.6 South Beach Demolition Ground Area of Concern

The SBDG AOC is located along the southern portion of J-Field on Chesapeake Bay (Figure 1.2). The area was used as an HE demolition site. Such materials were detonated either on the ground surface or under several feet of soil. Most of the demolition occurred on the beach; because of shoreline erosion, this area is now about 50 ft offshore of J-Field. At high tide, most of the demolition ground is 1-2 ft under water. A detailed description of the site is presented in RI Volume 1 (Yuen et al. 1999).

Because the demolition ground is located offshore, it was not evaluated in this ERA (offshore areas are out of the scope of this ERA). However, craters are visible onshore. In particular, a large crater, about 12 ft deep and 25 ft across, is located within the trees just onshore of the SBDG. This crater, which appears to be the remnant of a detonation crater, frequently contains standing water. The only contaminants detected in the soil, sediment, and the surface water at concentrations at or above background or the detection limit were copper and manganese, respectively (Yuen et al. 1999).

Exposure to contaminated media would occur primarily at the detonation crater (Figure 3.6). Terrestrial biota would be exposed via food uptake, incidental ingestion of soil and sediment, and ingestion of water from the crater. Aquatic biota (especially amphibians that use the crater for reproduction) would be exposed through direct contact with contaminated surface water and sediment and incidental ingestion of contaminated media.

3.1.7 South Beach Trench Area of Concern

The SBT AOC contains a trench about 75 ft long and 12 ft wide that was excavated in the late 1950s. The trench may have been a borrow area for demolition activities at the SBDG AOC; no

FIGURE 3.5 Conceptual Model for the Prototype Building Area (solid arrows identify principal exposure pathways and solid circles identify appropriate receptors for each exposure route)

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FIGURE 3.6 Conceptual Model for the South Beach Demolition Ground Area (solid circles identify appropriate receptors for each exposure route)

information has been found regarding past chemical or hazardous material disposal in the pits. A detailed description of the SBT AOC is presented in RI Volume 1 (Yuen et al. 1999).

Although chlordane and naphthalene were previously detected in a soil sample from the trench, characterization activities during the RI failed to detect these contaminants, Target Compound List (TCL) organic compounds, pesticides, or polychlorinated biphenyls (PCBs) in sediment samples from the trench. Heavy metals were detected in the sediment samples at concentrations at or less than background or detection limits. No organic compounds, pesticides, or PCBs were detected in surface water collected from the trench. Several metals were also detected in the surface water; however, except for potassium, all reported concentrations were at or below background levels. The results of the contaminant characterization of the AOC are presented in RI Volume 1 (Yuen et al. 1999). On the basis of these results, no contaminant sources have been identified at the SBT AOC, and the site poses no known risk to ecological resources at the site. Risk assessment activities at this AOC focused on collecting data to verify that the site poses no risk to biota.

3.1.8 Robins Point Demolition Ground Area of Concern

No contaminant sources are evident in the eastern, inactive portion of the RPDG AOC, although craters are present throughout the area. A trace amount of 2,4-dinitrotoluene and a slightly elevated level of silver were reported from single soil samples; no other contaminants were measured in surface soils at levels exceeding background or detection limits. Surface water collected from the clear area east of the berm had zinc and copper concentrations exceeding background, and water samples from the marsh next to the RPDG AOC had elevated levels of several heavy metals. Most of the metals detected above background concentrations in surface water were not detected in sediment samples. A detailed description of the nature and extent of contamination at the AOC is presented in RI Volume 1 (Yuen et al. 1999). The PCOECs are identified in Section 3.2 of this report.

According to the RI characterization results, surface water that ponds in the clear area of the AOC east of the berm represents the principal contaminant source at the inactive portion of the RPDG AOC. The source of the elevated metal concentrations detected in these surface waters may be the soils of the western, active portion of the demolition ground and the berm that separates the active and inactive portions of the site. Exposure of terrestrial biota would occur primarily via ingestion of water (Figure 3.7). In addition, amphibians that use the ponded water for reproduction could be exposed to contaminants through dermal absorption and ingestion.

IHA9813

FIGURE 3.7 Conceptual Model for the Robins Point Demolition Ground Area (solid circles identify appropriate receptors for each exposure route)

3.1.9 Robins Point Tower Site Area of Concern

No sources of contamination were identified for the RPTS AOC, and no information has been found to suggest that chemical or hazardous materials were generated, handled, or disposed of at the site. The nature and extent of contamination at this AOC are described in RI Volume 1 (Yuen et al. 1999). Most contaminants were present at levels below detection limits. A low concentration of one SVOC, benzo(b)fluoranthene, was detected in a single sample. On the basis of these RI characterization results, no exposure pathways were identified for ecological resources at the site, and the site is considered to pose no risk to ecological receptors. Risk assessment activities at the site focused on collecting data to verify that the site poses no risk to biota.

3.1.10 Potential Areas of Concern

In addition to the eight AOCs identified at the J-Field site, several PAOCs were identified at the J-Field site (Benioff et al. 1995b, Appendix B): Site X1, Area A, Area B, Area C, Area D, the craters, and the Ruins Site. The PAOCs were characterized as part of the RI contaminant characterization activities at J-Field (Yuen et al. 1999).

Site X1 consists of two ruins subsites located in the northwestern part of J-Field. Both subsites are surrounded by a ridge of soil piles; no craters have been found near this site. Three shallow, rectangular depressions about 6 ft wide contain seasonally ponded water. Two of the depressions exhibited signs of soil disturbance and had associated soil piles. Exploratory geophysical surveys and an x-ray fluorescence (XRF) survey were conducted at these two depressions; the results of these surveys are presented in RI Volume 1 (Yuen et al. 1999). Magnetic anomalies were found near the center of each depression, but no ground-penetrating radar anomalies were detected. The XRF field survey, conducted in 1996, detected no significant metal anomalies. No surveys were conducted at the third depression because no evidence of soil disturbance or soil piles was found there.

Soil samples collected from nine locations at Site X1 were analyzed for metals. Concentrations of metals above background were detected at only two locations, both in the western ruins subsite. Lead was detected at a concentration of 109 mg/kg at one location, and selenium was detected at a concentration of 0.45 mg/kg, only slightly above background (0.40 mg/kg), at the other location.

The characterization results for Area A are presented in RI Volume 1 (Yuen et al. 1999). Metal concentrations in sediment samples collected from the trenches were below background concentrations. Passive soil gas sampling of two trenches in Area A detected several organic compounds, including trichloroethene (TRCLE). However, no organic compounds were detected in

sediment samples collected from the trenches. On the basis of these results, Area A is not considered to pose a risk to ecological resources.

Area B (Ford's Point Firing Station) is a large open area near the northeastern portion of J-Field. No significant metal anomalies were detected during a 1996 XRF field survey of the site. Surface soils collected from 10 locations were analyzed for metals. The analysis results are presented in RI Volume 1 (Yuen et al. 1999). Metal concentrations were below background levels in most of the samples. Low levels of cadmium, lead, mercury, nickel, and zinc were detected in soil samples from the southern portion of the site. Elevated levels of copper and vanadium were detected in samples from the center of the site, and an elevated level of cadmium was measured in samples from one location in the western portion of the site.

Characterization results for Area C are presented in RI Volume 1 (Yuen et al. 1999). An XRF field survey conducted in 1996 detected no significant metal anomalies. Surface soil samples were collected from four locations in 1996 and analyzed for metals. Except for mercury, metal concentrations were below background levels at all sampling locations.

Area D and the craters were characterized together because of the nature of these sites; the results of the characterization of these sites are presented in RI Volume 1 (Yuen et al. 1999). Testing of bombs and projectiles constituted the primary activities at these PAOCs in the past. Because metals are common components of ordnance and are persistent in the environment, sediments from craters were collected and analyzed for Target Analyte List (TAL) metals. These samples were also analyzed for explosives. Surface water was not analyzed. Because VOCs and SVOCs are not components of ordnance, no analyses for these compounds were conducted. No explosives contamination was found in sediment samples from the 16 craters. Copper, arsenic, and silver were detected at levels above background in sediments from some craters.

No surface water analyses were conducted at the Ruins Site. However, elevated levels of several metals were reported in two sediment samples collected from the eastern portion of this site (Yuen et al. 1999), and surface water at these locations may also show elevated levels of some metals. Low emission rates of some organic compounds were detected in passive soil gas analyses; however, except for TRCLE, the compounds detected occur naturally and are not considered to have been artificially introduced to the site. No metal contamination was detected in soils at the Ruin Site; reported concentrations did not exceed background levels.

Surface soils and depressions that hold ponded water are the primary contaminant sources at Site X1. Surface soils are the primary contaminant sources at Areas A and B. The craters represent the primary contaminant sources at Area D, the craters, and the Ruins Site. A single conceptual model was developed for these PAOCs (Figure 3.8). Exposure to wildlife would occur primarily via food uptake, ingestion of drinking water, and incidental ingestion of soil or sediment; vegetation may

FIGURE 3.8 Conceptual Model for Site X1, Area B, Area C, Area D, the Craters, and the Ruins Site (solid circles identify appropriate receptors for each exposure route)

be exposed via root uptake. Amphibians that permanently inhabit inundated craters or use seasonally flooded craters for reproduction may particularly be at risk.

3.2 CONTAMINANTS OF ECOLOGICAL CONCERN

The ERA work plan presented a preliminary list of potential chemicals of concern for both human health and ecological resources (Hlohowskyj et al. 1995). The list was adapted from ICF Kaiser Engineers (1993) and Benioff et al. (1995a,b), and it was based on characterization data collected at J-Field before 1993. A list of PCOECs was developed for each AOC and the J-Field site as a whole on the basis of the data collected as part of the contaminant characterization portion of RI Volume 1 (Yuen et al. 1999). The PCOECs were identified by comparing media concentrations with chemical-specific factors, including background concentrations, regulatory standards, and ecological screening values. The detection frequency, capacity to biomagnify, and importance as a micro- or macronutrient were also considered. The following sections discuss the way the contaminant data were collected and evaluated to develop the PCOEC lists.

3.2.1 Contaminant Data Collection and Analysis

Characterization of the nature and extent of contamination at J-Field followed the procedures and protocols in the J-Field FSP (Benioff et al. 1995a) and the QAPjP (Prasad et al. 1995). Data used in identifying the PCOECs were collected according to the procedures in the U.S. Army Corps of Engineers CERCLA work plan (COE 1992) and were evaluated according to the protocols and procedures established in the QAPjP.

Volume 1 of the RI (Yuen et al. 1999) identifies locations of media sampling for chemical analysis by AOC. Section 3.2.1 of that report presents QA and QC activities related to laboratory and field audits. Section 3.2.2 of the report describes QA procedures for data review, validation, and evaluation, including considerations of laboratory and field precision, sampling and analysis accuracy, sample representativeness, and data completeness and comparability. Historical data collected before the J-Field characterization activities presented in RI Volume 1 (Yuen et al. 1999) were not used in this risk assessment because of uncertainties regarding QA and QC of the historical data. The more recent data also more accurately reflect current conditions at the site.

3.2.2 Contaminant Evaluation

Chemical characterization data collected during the RI activities (Yuen et al. 1999) were evaluated to identify PCOECs for detailed consideration in the ERA. The procedure for selecting the PCOECs (Figure 3.9) follows the general approach recommended in the Human Health Evaluation

IHA9615

FIGURE 3.9 Screening Process for Selecting Contaminants of Ecological Concern

Manual (EPA 1989b) and EPA Region III guidance for identifying contaminants of concern (EPA 1993b). The approach used in selecting the PCOECs was also consistent with the screening approach used for the J-Field human health risk assessment (Ripplinger et al. 1998).

Contaminant characterization data were assembled by location and environmental media (e.g., surface soil, surface water, sediment) and evaluated with respect to analytical methods, detection limits, QC samples, and blanks. Data exceeding QC requirements, or classified as "B qualified" (detected concentration was less than 10 times [for a common laboratory contaminant] or 5 times [for all other compounds] the concentration in a blank sample) or "R qualified" (rejected by analytical laboratory) were not used. The following steps were then performed, in order, using the remaining data for each AOC (and PAOC) and medium sampled:

- The detection frequency of each contaminant was evaluated, and all contaminants with detection frequencies of less than 1% were eliminated from further consideration.
- Contaminant concentrations were compared with reported background concentrations (ICF Kaiser Engineers 1995). Contaminants were retained for further consideration as PCOECs if the reported maximum concentration exceeded maximum background levels.
- Maximum contaminant concentrations were compared with ecological screening values. Contaminants that exceeded screening values and those for which no screening values were available were retained for further evaluation as PCOECs.

Concentrations were compared with background levels primarily for metals and inorganic ions. Many organic contaminants on the TCL do not occur naturally, and the background concentrations for these compounds were assumed to be zero. Some organic compounds, such as polycyclic aromatic hydrocarbons (PAHs) and PCBs, are widely distributed in the environment as a result of anthropogenic sources, and background concentrations have been identified for the region (ICF Kaiser Engineers 1995). Thus, some organic compounds were screened against background levels. No contaminants were eliminated from further consideration solely on the basis of comparison with background concentrations.

Contaminant concentrations reported for surface waters at each AOC were compared with the AWQC for the protection of aquatic biota (EPA 1986), EPA ecotox threshold values (EPA 1996a), EPA Region III Biological Technical Assistance Group (BTAG) screening guidelines (1996b), and other screening values obtained from the open scientific literature (Suter and Tsao 1996; Eisler 1985a, 1986a). Concentrations were compared with AWQC chronic values, or acute values if chronic values were not available.

Sources of ecological screening values for sediment included the EPA ecotox threshold values (EPA 1996a), EPA Region III BTAG ecological screening guidelines (EPA 1996b), Long and Morgan (1990), Jones et al. (1996), and the open scientific literature. Screening values for soil were the most difficult to obtain; sources included Will and Suter (1994), National Oceanic and Atmospheric Administration (undated), and the EPA Region III BTAG screening guidelines (EPA 1996b). Although soil screening values are available for human health, these were not used in the screening process.

The final PCOECs were those that exceeded background or ecological screening values. A contaminant was also retained for further evaluation if no background or screening values were available for comparison. The screening process also considered essential plant and animal nutrients and bioconcentration and bioaccumulation potential. Because of the nature of past human activities and the nature and extent of contamination at J-Field, some of the final PCOECs were of concern at some AOCs but not at others, and only a few were of concern at all AOCs. Section 3.2.3 summarizes the results of the screening process by medium and AOC, and Section 3.2.4 presents the final list of PCOECs.

3.2.3 Preliminary Contaminants of Ecological Concern

Tables 3.1 through 3.21 summarize the contaminant characterization data and PCOEC screening results for soil, surface water, and sediment. For contaminants with a detection frequency less than 100%, the reported range extends from one-half the analytical detection limit to the maximum detected concentration.

3.2.3.1 Soil

Metals are the principal and most widespread PCOECs detected at J-Field, whereas VOCs and SVOCs are present at discrete areas associated with the pits and trenches. Tables 3.1 through 3.8 summarize the PCOEC screening for soils at each AOC. Several chemicals for which soils were analyzed were eliminated from consideration as PCOECs because of a 0% detection frequency; these are not included in the screening summary tables. Others were eliminated because they were present at levels that did not exceed background levels or ecological screening levels. Contaminants were not uniformly eliminated for all AOCs and media; a particular PCOEC may have been eliminated for one AOC but retained for further consideration for another AOC. For example, cadmium was retained as a soil PCOEC for the TBP AOC (Table 3.1) but excluded for the Robins Point Tower AOC.

Some contaminants present at or below background levels, such as calcium, potassium, and sodium, are essential micro- and macronutrients and were therefore eliminated as PCOECs. Others

TABLE 3.1 Results of the Contaminant Screening Process for Soils at the Toxic Burning Pits Area

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values ^a (µg/kg)	Retained as Contaminant of Concern?
1,1,2,2-Tetrachloroethane	13/83	2-2,500	_ ^b	300.0	Yes ^c
1,1-Dichloroethene	11/88	6-100	-	-	Yes ^d
1,2-Dichloroethene (total)	16/83	4-170	-	300.0	No ^e
2,4,6-Trichloroaniline	17/46	20-7,900	-	-	Yes ^d
2-Butanone	1/37	6-37	-	-	Yes ^d
2-Methylnaphthalene	10/48	71-1,250	ND ^f	-	Yes ^g
2-Methylphenol	5/47	75-1,250	ND	100.0	Yes ^h
4-Methylphenol	4/47	91-1,250	ND	100.0	Yes ^h
Acetone	4/23	3-20	-	-	Yes ^d
Aluminum	57/57	4,240,000-22,600,000	1,390,000-17,300,000	1,000	Yes ^{h,i}
Antimony	32/57	0.1-501,000	ND	480	Yes ^h
Aroclor 1248	1/2	19.75-570	ND	100.0	Yes ^h
Arsenic	57/59	0.11-1,440,000	124-5,290	10,000 ^j	Yes ^h
Barium	59/59	2,110-1,580,000	9,830-125,000	440,000	Yes ^h
Benzene	8/83	6-100	-	100.0	No ^e
Benzo(b)fluoranthene	4/48	50-1,250	35-350	100.0	Yes ^{h,i}
Benzo(k)fluoranthene	4/48	42-1,250	36-140	100.0	Yes ^{h,i}
Beryllium	53/57	0.07-1,380	266-1,420	10,000 ^j	No ^k
bis(2-Chloroethyl)ether	1/140	20-1,250	-	-	No ^l
Cadmium	48/59	0.23-35,500	266-1,400	2,500	Yes ^h
Calcium	57/57	155,000-36,000,000	71,400-2,170,000	-	No ^m
Carbon disulfide	5/37	2-38	-	-	Yes ^d
Chlorobenzene	6/83	5-100	-	100.0	No ^e
Chloroform	5/83	6-50	-	300.0	No ^e
Chromium	57/59	6.95-878,000	3,530-68,900	33,000 ⁿ	Yes ^{h,i}
Cobalt	47/57	2.5-108,000	620-25,600	100,000	Yes ^h

TABLE 3.1 (Cont.)

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values ^a (µg/kg)	Retained as Contaminant of Concern?
Copper	56/57	2-4,320,000	3,000-27,500	15,000	Yes ^{h,i}
Cyanide	9/34	0.35-120,000	ND	5.0	Yes ^h
Diethyl phthalate	5/48	49-2,000	40-72	-	Yes ^g
Fluorene	1/48	189.5-1,250	ND	100.0	Yes ^h
Hexachlorobenzene	15/94	20-3,100	ND	1,000,000 ^o	No ^e
Hexachloroethane	10/94	20-1,250	ND	-	Yes ^g
Iron	57/57	7,470,000-154,000,000	2,610,000-23,500,000	12,000	Yes ^{h,i}
Lead	59/59	6,050-94,200,000	5,490-117,000	10,000	Yes ^{h,i}
m&p-Xylene	1/46	20-50	-	100.0	No ^e
Magnesium	57/57	765,000-3,880,000	63,000-3,920,000	4,400.0	Yes ^p
Manganese	57/57	46,500-633,000	4,950-1,140,000	330,000	Yes ^p
Mercury	39/59	0.03-3,600	26-90	58.0	Yes ^{h,i}
Methylene chloride	37/81	4-100	-	300.0	No ^e
N-Nitrosodiphenylamine	4/48	170-1,250	ND	-	Yes ^g
Nickel	54/57	3.5-84,500	855-24,100	2,000	Yes ^{h,i}
Nitroglycerin	1/9	5,000-15,300	-	-	Yes ^d
Phenol	4/94	20-1,250	ND	100.0	Yes ^h
Potassium	57/57	298,000-1,460,000	36,300-1,700,000	-	No ^m
Pyrene	14/94	20-1,250	35-620	100.0	Yes ^{h,i}
Selenium	40/59	0.09-7,120	130-497	1,800	Yes ^h
Silver	38/59	0.04-41,900	ND	2,000.0 ^j	Yes ^h
Sodium	48/57	22-521,000	341,000-658,000	-	No ^m
Tetrachloroethene	15/83	2.0-1,000	-	300.0	Yes ^c
Thallium	2/57	0.15-19,300	ND	1.0	Yes ^h
Toluene	10/83	4-50	-	100.0	No ^e
Trichloroethene	35/83	3-2,800	-	300.0	Yes ^c

TABLE 3.1 (Cont.)

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values ^a (µg/kg)	Retained as Contaminant of Concern?
Vanadium	57/57	4,290-32,700	8,800-59,200	58,000	No ^k
Zinc	57/57	20,200-17,800,000	4,890-242,000	10,000.0	Yes ^{h,i}

^a Ecological screening value from EPA Region III BTAG ecological screening levels (EPA 1996b) unless otherwise noted.

^b A hyphen indicates that contaminant value was unavailable.

^c Contaminant was retained because the maximum reported concentration exceeded the ecological screening value; no background value was available.

^d Contaminant was retained because the background concentration and the ecological screening value were not available.

^e Contaminant was eliminated from further consideration because the maximum reported concentration did not exceed the ecological screening value; no background concentration was available.

^f ND = not detected.

^g Contaminant was retained because the maximum reported concentration exceeded the background concentration; no ecological screening value was available.

^h Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.

ⁱ The maximum reported background concentration exceeded the ecological screening value.

^j Ecological screening value from Will and Suter (1995a).

^k Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.

^l Contaminant was eliminated because it was detected in less than 1% of the samples.

^m Contaminant was eliminated on the basis of its importance as a micro- or macro-nutrient.

ⁿ Mean soil concentration reported by USGS for the eastern United States for soils that supported native plants and that were altered very little from their natural conditions (Shacklette and Boerngen 1984).

^o Ecological screening value from Will and Suter (1995b).

^p Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.

TABLE 3.2 Results of the Contaminant Screening Process for Soils at the White Phosphorus Burning Pits Area

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values ^a (µg/kg)	Retained as Contaminant of Concern?
Aluminum	24/24	322,000-24,400,000	1,390,000-17,300,000	1,000	Yes ^{b,c}
Antimony	3/24	89-2,900	ND ^d	480.0	Yes ^b
Arsenic	24/24	352-8,200	124-5,290	10,000 ^e	No ^f
Barium	23/24	1,100-190,000	9,830-125,000	440,000	No ^f
Benz(a)anthracene	1/5	140-262	53-230	100.0	Yes ^{b,c}
Benzo(a)pyrene	2/5	72-262	57-440	100.0	Yes ^{g,c}
Benzo(b)fluoranthene	3/5	57-420	35-350	100.0	Yes ^{b,c}
Benzo(k)fluoranthene	1/5	69-374.5	36-140	100.0	Yes ^{b,c}
Beryllium	23/24	57.5-857	266-1,420	10,000 ^e	No ^h
bis(2-Ethylhexyl)phthalate	1/5	120-374.5	ND	- ⁱ	Yes ^j
Cadmium	7/24	157-2,700	266-1,400	2,500	Yes ^b
Calcium	24/24	86,600-10,900,000	66,800-1,980,000	-	No ^k
Chromium	23/24	419-36,200	3,530-69,800	33,000 ^l	Yes ^{g,c}
Chrysene	2/5	88-290	55-380	100.0	Yes ^{g,c}
Cobalt	22/24	680-6,980	620-25,600	100,000	No ^h
Copper	23/24	1,205-67,300	3,000-27,500	15,000	Yes ^{b,c}
di-n-Butylphthalate	2/5	51-374.5	ND	200,000 ^e	No ^f
Fluoranthene	2/5	160-290	20-320	100.0	Yes ^{g,c}
Indeno(1,2,3-cd)pyrene	1/5	76-262	40-210	100.0	Yes ^{b,c}
Iron	24/24	1,160,000-37,200,000	2,610,000-23,500,000	12,000	Yes ^{b,c}
Lead	24/24	1,830-231,000	5,490-117,000	10,000	Yes ^{b,c}
Magnesium	24/24	65,600-2,400,000	63,000-3,920,000	4,400	Yes ^{g,c}
Manganese	24/24	11,700-302,000	4,950-1,140,000	330,000	No ^h
Mercury	5/24	22-132	26-90	58.0	Yes ^{b,c}
Nickel	23/24	1,100-17,300	855-24,100	2,000	Yes ^{g,c}
Potassium	24/24	27,400-1,280,000	36,300-1,700,000	-	No ^m

TABLE 3.2 (Cont.)

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values ^a (µg/kg)	Retained as Contaminant of Concern?
Pyrene	2/5	107-262	35-620	100.0	Yes ^{g,c}
Selenium	7/24	84-1,150	130-497	1,800	No ^f
Silver	1/24	36.5-880	570-713	2,000 ^e	No ^f
Sodium	23/24	8,900-599,000	206,000-937,000	-	No ^{m,k}
Vanadium	22/24	1,520-31,000	8,800-59,200	58,000	No ^h
Zinc	24/24	8,520-588,000	4,890-242,000	10,000	Yes ^{b,c}

^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless otherwise noted.

^b Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.

^c The maximum reported background concentration exceeded the ecological screening value.

^d ND = not detected.

^e Ecological screening value from Will and Suter (1995a).

^f Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.

^g Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.

^h Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.

ⁱ A hyphen indicates that contaminant value was unavailable.

Footnotes continued on next page.

Footnotes for Table 3.2 (Cont.)

- ^j Contaminant was retained because the maximum reported concentration exceeded the background concentration; no ecological screening value was available.
- ^k Contaminant was eliminated on the basis of its importance as a micro- or macro-nutrient.
- ^l Mean soil concentration reported by USGS for the eastern United States for soils that supported native plants and that were altered very little from their natural condition (Shacklette and Boerngen 1984).
- ^m Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.

TABLE 3.3 Results of the Contaminant Screening Process for Soils at the Riot Control Pit Area

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values ^a (µg/kg)	Retained as Contaminant of Concern?
Aluminum	22/22	4,910,000-26,300,000	1,390,000-17,300,000	1,000	Yes ^{b,c}
Antimony	11/22	98-2,210	ND ^d	480	Yes ^b
Arsenic	22/22	1,220-7,400	124-5,290	10,000 ^e	No ^f
Barium	22/22	27,200-83,500	9,830-125,000	440,000	No ^g
Beryllium	22/22	130-477	266-1,420	10,000 ^e	No ^g
Cadmium	16/22	197-6,800	266-1,400	2,500	Yes ^b
Calcium	22/22	372,000-1,890,000	66,800-1,980,000	- ^h	No ^{i,j}
Chromium	22/22	6,400-191,000	3,530-68,900	33,000 ^k	Yes ^{b,c}
Cobalt	22/22	1,970-5,960	620-25,600	100,000	No ^g
Copper	22/22	5,390-1,770,000	3,000-27,500	15,000	Yes ^{b,c}
Iron	22/22	4,780,000-19,000,000	2,610,000-23,500,000	12,000	Yes ^{c,l}
Lead	22/22	8,800-1,070,000	5,490-117,000	10,000	Yes ^{b,c}
Magnesium	22/22	760,000-1,910,000	63,000-3,920,000	4,400	Yes ^{c,l}
Manganese	22/22	24,800-244,000	4,950-1,140,000	330,000	No ^g
Mercury	18/22	28-120	26-90	58	Yes ^{b,c}
Methylene chloride	5/15	5-100	-	300	No ^m
Nickel	20/22	1,240-20,000	855-24,100	2,000	Yes ^{c,l}
Potassium	22/22	220,000-691,000	36,300-1,700,000	-	No ^{i,j}
Selenium	16/22	93-846	130-497	1,800	No ^f
Silver	4/22	40-9,010	570-713	2,000 ^e	Yes ^b
Sodium	22/22	19,700-649,000	206,000-937,000	-	No ^{i,j}
Vanadium	22/22	9,070-29,700	8,800-59,200	58,000	No ^{c,g}
Zinc	22/22	23,000-385,000	4,890-242,000	10,000	Yes ^{b,c}

See footnotes on next page.

Footnotes for Table 3.3

- ^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless otherwise noted.
- ^b Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.
- ^c The maximum reported background concentration exceeded the ecological screening value.
- ^d ND = not detected.
- ^e Ecological screening value from Will and Suter (1995a).
- ^f Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.
- ^g Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^h A hyphen indicates that contaminant value was unavailable.
- ⁱ Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^j Contaminant was eliminated from further consideration because of its known importance as a micro- or macro-nutrient.
- ^k Mean soil concentration reported by USGS for the eastern United States for soils that supported native plants and that were altered very little from their natural conditions (Shacklette and Boerngen 1984).
- ^l Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ^m Contaminant was eliminated from further consideration because the maximum reported concentration was less than the ecological screening value; no background concentration was available.

TABLE 3.4 Results of the Contaminant Screening Process for Soils at the Prototype Building Area

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
4,4'-DDD	1/9	1.9-6.2	0.50-7.83	100	No ^b
4,4'-DDE	2/9	1-30	0.50-392	100	No ^{b,c}
4,4'-DDT	5/9	1.95-16	0.50-143	100	No ^{b,c}
Acetone	1/5	5-7	- ^d	-	Yes ^e
Aldrin	1/9	1-2	ND ^f	100	No ^g
Aluminum	15/15	5,090,000-18,400,000	1,390,000-17,300,000	1,000	Yes ^{c,h}
Antimony	1/15	102.5-1,750	ND	480	Yes ^h
Arsenic	15/15	828-4,400	124-5,290	10,000 ⁱ	No ^b
Barium	15/15	47,000-94,300	9,830-125,000	440,000	No ^b
Benzo(k)fluoranthene	2/13	49-225	36-140	100	Yes ^{c,h}
Beryllium	15/15	318-790	266-1,420	10,000 ⁱ	No ^b
Cadmium	15/15	452-3,500	266-1,400	2,500	Yes ^h
Calcium	15/15	790,000-2,090,000	66,800-1,980,000	-	No ^j
Chromium	15/15	5,520-17,500	3,530-68,900	33,000 ^k	No ^{b,c}
Cobalt	15/15	2,690-8,300	620-25,600	10,000	No ^c
Copper	15/15	3,860-74,900	3,000-27,500	15,000	Yes ^{c,h}
Cyanide	4/9	95-2,600	ND	5	Yes ^h
Endrin aldehyde	1/9	1.9-7.5	ND	-	Yes ^l
Iron	15/15	4,050,000-15,500,000	2,610,000-23,500,000	12,000	Yes ^{c,m}
Lead	15/15	5,700-59,800	5,490-117,000	10,000	Yes ^{c,m}
Magnesium	15/15	498,000-1,180,000	63,000-3,920,000	4,400	Yes ^{c,m}
Manganese	15/15	42,700-439,000	4,950-1,140,000	330,000	Yes ^{c,m}
Mercury	4/15	25-130	26-90	58	Yes ^{c,h}
Methylene chloride	2/5	6-8	-	300	No ⁿ
Nickel	15/15	3,950-14,400	855-24,100	2,000	Yes ^{c,m}
Potassium	15/15	271,000-693,000	36,300-1,700,000	-	No ^{j,o}

TABLE 3.4 (Cont.)

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
Selenium	4/15	55-456	130-497	1,800	No ^b
Sodium	6/15	11,600-84,500	206,000-937,000	-	No ^o
Vanadium	15/15	8,700-21,500	8,800-59,200	58,000	No ^{b,c}
Zinc	15/15	20,700-190,000	4,890-242,000	10,000	Yes ^{c,m}

^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless otherwise noted.

^b Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.

^c The maximum reported background concentration exceeded the ecological screening value.

^d A hyphen indicates that contaminant value was unavailable.

^e Contaminant was retained because the background concentration and the ecological screening value were not available.

^f ND = not detected.

^g Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.

^h Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.

ⁱ Ecological screening value from Will and Suter (1995a).

^j Contaminant was eliminated from further consideration because of its known importance as a micro or macro-nutrient.

^k Mean soil concentration reported by USGS for the eastern United States for soils that supported native plants and that were altered very little from their natural conditions (Shacklette and Boerngen 1984).

^l Contaminant was retained because the maximum reported concentration exceeded the background concentration; no ecological screening value was available.

^m Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.

ⁿ Contaminant was eliminated from further consideration because the maximum reported concentration was less than the ecological screening value; no background concentration was available.

^o Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.

TABLE 3.5 Results of the Contaminant Screening Process for Soils at the South Beach Trench Area

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
Aluminum	5/5	3,710,000-10,300,000	1,390,000-17,300,000	1,000	Yes ^{b,c}
Arsenic	5/5	1,100-4,800	124-5,290	10,000 ^d	No ^e
Barium	5/5	14,700-46,000	9,830-125,000	440,000	No ^e
Beryllium	5/5	130-400	266-1,420	10,000 ^d	No ^e
Cadmium	4/5	480-3,300	266-1,400	2,500	Yes ^f
Calcium	5/5	145,000-409,000	66,800-1,980,000	- ^g	No ^{h,i}
Chromium	5/5	5,500-13,800	3,530-68,900	33,000 ^j	No ^{c,e}
Cobalt	5/5	2,200-4,600	620-25,600	100,000	No ^e
Copper	5/5	5,000-31,500	3,000-27,500	15,000	Yes ^f
Iron	5/5	4,490,000-11,300,000	2,610,000-23,500,000	12,000	Yes ^{b,c}
Lead	5/5	7,600-27,700	5,490-117,000	10,000	Yes ^{b,c}
Magnesium	5/5	613,000-1,480,000	63,000-3,920,000	4,400	Yes ^{b,c}
Manganese	5/5	26,200-59,100	4,950-1,140,000	330,000	No ^{e,c}
Nickel	5/5	5,800-13,600	885-24,100	2,000	Yes ^{b,c}
Potassium	5/5	245,000-509,000	36,300-1,700,000	-	No ^{h,i}
Sodium	1/5	12,700-248,000	206,000-937,000	-	No ^{h,i}
Vanadium	5/5	7,100-19,800	8,800-59,200	58,000	No ^{e,c}
Zinc	5/5	17,600-105,000	4,890-242,000	10,000	Yes ^{b,c}

See footnotes on next page.

Footnotes for Table 3.5

- ^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless otherwise noted.
- ^b Contaminant was retained because the maximum reported concentration was below the maximum background concentration but exceeded the ecological screening value.
- ^c The maximum reported background concentration exceeded the ecological screening value.
- ^d Ecological screening value from Will and Suter (1995a).
- ^e Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^f Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.
- ^g A hyphen indicates that contaminant value was unavailable.
- ^h Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ⁱ Contaminant was eliminated on the basis of its importance as a micro- or macro-nutrient.
- ^j Mean soil concentration reported by USGS for the eastern United States for soils that supported native plants and that were altered very little from their natural conditions (Shacklette and Boerngen 1984).

TABLE 3.6 Results of the Contaminant Screening Process for Soils at the Robins Point Demolition Ground Area

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
2,4-Dinitrotoluene	1/7	25.8-1,140	ND ^b	- ^c	Yes ^d
Aluminum	7/7	4,640,000-9,330,000	1,390,000-17,300,000	1,000	Yes ^{e,f}
Antimony	1/7	318.5-894	ND	480	Yes ^g
Arsenic	7/7	1,150-4,380	124-5,290	10,000 ^h	No ⁱ
Barium	7/7	22,300-41,400	9,830-125,000	440,000	No ⁱ
Beryllium	5/7	83.5-358	266-1,420	10,000 ^h	No ⁱ
Calcium	7/7	91,200-151,000	66,800-1,980,000	-	No ^{j,k}
Chromium	7/7	5,220-12,700	3,530-68,900	33,000 ^l	No ^{i,f}
Cobalt	3/7	1,495-5,230	620-25,600	100,000	No ^{i,f}
Copper	7/7	7,110-15,300	3,000-27,500	15,000	Yes ^{e,f}
Iron	7/7	5,360,000-14,100,000	2,610,000-23,500,000	12,000	Yes ^{e,f}
Lead	7/7	11,400-37,800	5,490-117,000	10,000	Yes ^{e,f}
Magnesium	7/7	434,000-968,000	63,000-3,920,000	4,400	Yes ^{e,f}
Manganese	7/7	20,300-115,000	4,950-1,140,000	330,000	No ^{i,f}
Mercury	3/7	29.5-106	26-90	58	Yes ^{g,f}
Nickel	5/7	2,240-8,050	855-24,100	2,000	Yes ^{e,f}
Potassium	7/7	111,000-374,000	36,300-1,700,000	-	No ^{j,k}
Silver	1/7	127.5-10,300	ND	2,000 ^h	Yes ^g
Sodium	2/7	18,700-44,600	206,000-937,000	-	No ^{j,k}
Vanadium	7/7	11,000-21,000	8,800-59,200	58,000	No ⁱ
Zinc	7/7	25,300-81,900	4,890-242,000	10,000	Yes ^{e,f}

See footnotes on next page.

Footnotes for Table 3.6

- ^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless otherwise noted.
- ^b ND = not detected.
- ^c A hyphen indicates that contaminant value was unavailable.
- ^d Contaminant was retained because the maximum reported concentration exceeded the background concentration; no ecological screening value was available.
- ^e Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ^f The maximum reported background concentration exceeded the ecological screening value.
- ^g Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.
- ^h Ecological screening value from Will and Suter (1995a).
- ⁱ Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^j Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^k Contaminant was eliminated on the basis of its importance as a micro- or macro-nutrient.
- ^l Mean soil concentration reported by USGS for the eastern United States for soils that supported native plants and that were altered very little from their natural conditions (Shacklette and Boerngen 1984).

TABLE 3.7 Results of the Contaminant Screening Process for Soils at the Robins Point Tower Site

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
Aluminum	6/6	4,970,000-7,140,000	1,390,000-17,300,000	1,000	Yes ^{b,c}
Arsenic	6/6	2,080-2,800	124-5,290	10,000 ^d	No ^e
Barium	6/6	19,000-36,600	9,830-125,000	440,000	No ^e
Benzo(b)fluoranthene	1/4	67-217	35-350	100	Yes ^{b,c}
Beryllium	6/6	227-438	266-1,420	10,000 ^d	No ^e
Cadmium	2/6	191-554	266-1,400	2,500	No ^e
Calcium	6/6	82,500-232,000	66,800-1,980,000	- ^f	No ^{g,h}
Chromium	6/6	6,250-9,500	3,530-68,900	33,000 ⁱ	No ^{c,e}
Cobalt	5/6	860-4,280	620-25,600	100,000	No ^e
Copper	6/6	4,480-10,300	3,000-27,500	15,000	No ^{c,e}
Iron	6/6	7,580,000-119,000,000	2,610,000-23,500,000	12,000	Yes ^{c,j}
Lead	6/6	9,510-22,700	5,490-117,000	10,000	Yes ^{b,c}
Magnesium	6/6	481,000-836,000	63,000-3,920,000	4,400	Yes ^{b,c}
Manganese	6/6	44,300-512,000	4,950-1,140,000	330,000	Yes ^{b,c}
Mercury	6/6	52-151	26-90	58	Yes ^{c,j}
Nickel	6/6	3,670-5,520	855-24,100	2,000	Yes ^{b,c}
Potassium	6/6	223,000-327,000	36,300-1,700,000	-	No ^{g,h}
Selenium	5/6	106-450	130-497	1,800	No ^e
Vanadium	6/6	12,100-19,600	8,800-59,200	58,000	No ^{c,e}
Zinc	6/6	24,400-37,500	4,890-242,000	10,000	Yes ^{b,c}

See footnotes on next page.

Footnotes for Table 3.7

- ^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless otherwise noted.
- ^b Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ^c The maximum reported background concentration exceeded the ecological screening value.
- ^d Ecological screening value from Will and Suter (1995a).
- ^e Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^f A hyphen indicates that contaminant value was unavailable.
- ^g Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^h The contaminant was eliminated on the basis of its importance as a micro- or macro-nutrient.
- ⁱ Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.
- ^j Mean soil concentration reported by USGS for the eastern United States for soils that supported native plants and that were altered very little from their natural conditions (Shacklette and Boerngen 1984).

TABLE 3.8 Results of the Contaminant Screening Process for Soils at the Potential Areas of Concern

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
<i>Ruins Site PAOC</i>					
Aluminum	2/2	5,490,000-6,230,000	1,390,000-17,300,000	1,000	Yes ^{b,c}
Arsenic	2/2	2,210-2,260	124-5,290	10,000 ^d	No ^e
Barium	2/2	30,900-39,700	9,830-125,000	440,000	No ^e
Beryllium	2/2	290-365	266-1,420	10,000 ^d	No ^e
Cadmium	½	190.5-696	266-1,400	2,500	No ^e
Calcium	2/2	130,000-286,000	66,800-1,980,000	- ^f	No ^{g,h}
Chromium	2/2	6,480-6,770	3,530-68,900	33,000 ⁱ	No ^{e,e}
Cobalt	2/2	2,980-3,860	620-25,600	100,000	No ^e
Copper	2/2	4,600-7,380	3,000-27,500	15,000	No ^{e,e}
Iron	2/2	6,020,000-7,460,000	2,610,000-23,500,000	12,000	Yes ^{b,c}
Lead	2/2	11,500-21,000	5,490-117,000	10,000	Yes ^{b,c}
Magnesium	2/2	619,000-731,000	63,000-3,920,000	4,400	Yes ^{b,c}
Manganese	2/2	57,200-110,000	4,950-1,140,000	330,000	No ^{e,e}
Mercury	½	33.5-74	26-90	58	Yes ^{b,c}
Nickel	2/2	6,080-6,300	855-24,100	2,000	Yes ^{b,c}
Potassium	2/2	206,000-253,000	36,300-1,700,000	-	No ^{g,h}
Selenium	½	101.5-277	130-497	1,800	No ^e
Sodium	2/2	64,700-83,500	206,000-937,000	-	No ^{g,h}
Vanadium	2/2	8,940-11,200	8,800-59,200	58,000	No ^{e,e}
Zinc	2/2	18,100-29,400	4,890-242,000	10,000	Yes ^{b,c}
<i>Craters PAOC</i>					
2,4,6-Trichloroaniline	2/2	50-50	-	-	Yes ^j

See footnotes on next page.

Footnotes for Table 3.8

- ^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless otherwise noted.
- ^b Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ^c Maximum background concentration exceeded the ecological screening value.
- ^d Ecological screening value from Will and Suter (1995a).
- ^e Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^f A hyphen indicates that contaminant value was unavailable.
- ^g Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^h Contaminant was eliminated on the basis of its importance as a micro- or macro-nutrient.
- ⁱ Mean soil concentration reported by USGS for the eastern United States for soils that supported native plants and that were altered very little from their natural conditions (Shacklette and Boerngen 1984).
- ^j Contaminant was retained because the background concentration and the ecological screening value were not available.

TABLE 3.9 Results of the Contaminant Screening Process for Surface Water at the Toxic Burning Pits Area

Analyte	Frequency of Detection	Range of Concentrations (µg/L)	Range of Background Concentrations (µg/L)	Ecological Screening Value (µg/L) ^a	Retained as Contaminant of Concern?
1,1-Oxathiane	2/9	1.19-12.2	. ^b	-	Yes ^c
1,1,2,2-Tetrachloroethane	14/29	2-4,348	-	2,400	Yes ^d
1,1,2-Trichloroethane	8/29	1-138	-	9,400	No ^e
1,2-Dichloroethene (total)	7/15	5-1,700	-	11,600	No ^e
1,4-Dithiane	1/4	0.67-2.12	-	-	Yes ^c
1,4-Oxathiane	1/4	1.19-11.4	-	-	Yes ^c
2-Hexanone	2/29	5-125	-	428,000	No ^e
Acetone	12/22	5-32	-	9,000,000	No ^e
Aluminum	12/14	23.5-18,000	64-10,200	87 ^f	Yes ^{g,h}
Antimony	1/14	10-32.9	2-25	30.0	Yes ^g
Arsenic	9/14	1-36.3	1-3.2	190.0	No ⁱ
Barium	14/14	43.3-559	8.5-179	10,000	No ⁱ
Cadmium	1/14	1.5-13.4	ND ^j	2.88 ^k	Yes ^g
Calcium	14/14	19,400-205,000	2,190-83,800	116,000	Yes ^g
Chloroethane	2/29	5-125	-	-	Yes ^c
Chromium	4/14	2.5-64.8	2.5-14.2	11 ^k	Yes ^{g,h}
cis-1,2-Dichloroethene	8/14	2-1,809	-	11,600	No ^e
Cobalt	4/14	3-104	2.5-21.1	35,000	No ⁱ
Copper	11/14	1.5-525	2.5-9.7	32.7 ^k	Yes ^g
DIMP	2/13	0.196-0.45	-	-	Yes ^c
Dithiane	2/9	0.67-3.56	-	-	Yes ^c
Iron	14/14	458-181,100	152-26,700	1,000 ^f	Yes ^{g,h}
Lead	10/14	0.5-1,590	0.8-18.0	14.4 ^f	Yes ^{g,h}
Magnesium	14/14	15,600-228,000	1,010-229,000	-	No ^l
Manganese	14/14	70.4-3,700	20-4,810	14,500	No ^m
Mercury	2/14	0.05-1.7	ND	1.3	Yes ^g

TABLE 3.9 (Cont.)

Analyte	Frequency of Detection	Range of Concentrations (µg/L)	Range of Background Concentrations (µg/L)	Ecological Screening Value (µg/L) ^a	Retained as Contaminant of Concern?
Nickel	3/14	6-116	5.0-23.7	431 ^k	No ⁱ
Potassium	14/14	3,410-38,700	1,220-73,400	53,000	No ^{h,m}
Selenium	2/14	0.5-3.4	ND	5.0	No ⁱ
Silver	2/14	2-7.6	0.2-2.5	31.4 ^k	No ⁱ
Sodium	14/14	55,500-958,000	1,810-2,010,000	680,000 ^f	Yes ^{h,n}
Total organic halides	7/7	54-5,500	-	-	Yes ^c
trans-1,2-Dichloroethene	3/14	2-239	-	11,600	No ^e
Trichloroethene	15/29	2-3,615	-	21,900	No ^e
Vanadium	6/14	2.5-42.7	5-60.8	10,000	No ^m
Vinyl chloride	6/29	2-125	-	11,600	No ^e
Zinc	14/14	11.8-4,040	2.5-78	290 ⁱ	Yes ^g

^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) or EPA ambient water quality criteria (EPA 1986) unless otherwise noted.

^b A hyphen indicates that contaminant value was unavailable.

^c Contaminant was retained because the background concentration and the ecological screening value were not available.

^d Contaminant was retained because the maximum reported concentration exceeded the ecological screening value; no background value was available.

^e Contaminant was eliminated from further consideration because the maximum reported concentration was less than the ecological screening value; no background concentration was available.

^f Screening value from Suter and Tsao (1996).

^g Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.

^h The maximum reported background concentration exceeded the ecological screening value.

ⁱ Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.

Footnotes continued on next page.

Footnotes for Table 3.9 (Cont.)

- ^j ND = not detected.
- ^k This AWQC is a function of water hardness, which was calculated using the median concentrations of calcium and magnesium.
- ^l Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^m Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ⁿ Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.

TABLE 3.10 Results of the Contaminant Screening Process for Surface Water at the White Phosphorus Burning Pits Area

Analyte	Frequency of Detection	Range of Concentrations (µg/L)	Range of Background Concentrations (µg/L)	Ecological Screening Value (µg/L) ^a	Retained as Contaminant of Concern?
Acetone	4/7	4.0-13.0	.. ^b	9,000,000	No ^c
Aluminum	6/7	46-8,390	64-10,200	87 ^d	Yes ^{e,f}
Antimony	1/7	0.8-10.0	1.5-25.0	30	No ^g
Arsenic	4/7	0.9-8.2	1.0-3.2	190	No ^h
Barium	7/7	27.7-123.0	8.5-179	10,000	No ^g
Beryllium	2/7	0.5-1.5	0.1-2.5	5.3	No ^g
Calcium	7/7	6,700-49,300	2,190-83,800	116,000 ^d	No ^g
Chromium	3/7	4.0-16.0	2.5-14.2	11 ⁱ	Yes ^{f,j}
Cobalt	4/7	3.5-20.5	2.5-21.1	35,000	No ^g
Copper	4/7	4.8-52.3	2.5-9.7	15.4 ⁱ	Yes ^j
Iron	7/7	368-28,400	152-26,700	1,000 ^d	Yes ^{f,j}
Lead	7/7	2.8-76.1	0.8-18.0	4.7 ⁱ	Yes ^{f,j}
Magnesium	7/7	3,790-131,000	1,010-229,000	-	No ^k
Manganese	7/7	60-499	20-4,810	14,500	No ^g
Mercury	2/7	0.05-0.12	ND ^l	0.012 ^d	Yes ^j
Potassium	7/7	1,750-41,500	1,220-73,400	53,000 ^d	No ^g
Selenium	1/7	0.5 - 3.2	ND	5.0	No ^h
Sodium	7/7	3,180-1,120,000	1,810-2,010,000	680,000	Yes ^{e,f}
Zinc	7/7	24.3-411.0	2.5-78.0	137.8 ⁱ	Yes ^j

See footnotes on next page.

Footnotes for Table 3.10

- ^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) or EPA ambient water quality criteria (AWQC) (EPA 1986) unless otherwise noted.
- ^b A hyphen indicates that contaminant value was unavailable.
- ^c Contaminant was eliminated from further consideration because the maximum reported concentration was less than the ecological screening value; no background concentration was available.
- ^d Screening value from Suter and Tsao (1996).
- ^e Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ^f The maximum reported background concentration exceeded the ecological screening value.
- ^g Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^h Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.
- ⁱ AWQC is a function of water hardness, which was calculated using the median concentrations of calcium and magnesium.
- ^j Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.
- ^k Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^l ND = not detected.

TABLE 3.11 Results of the Contaminant Screening Process for Surface Water at the Riot Control Pit Area

Analyte	Frequency of Detection	Range of Concentrations (µg/L)	Range of Background Concentrations (µg/L)	Ecological Screening Value (µg/L) ^a	Retained as Contaminant of Concern?
Acetone	2/2	4-11	- ^b	9,000,000	No ^c
Aluminum	3/3	132-406	64-10,200	87 ^d	Yes ^{e,f}
Barium	3/3	35-41	8.5-179.0	10,000	No ^g
Calcium	3/3	17,600-47,600	2,190-83,800	116,000 ^d	No ^g
Copper	1/3	11.5-24.6	2.5-9.7	68.7 ^h	No ⁱ
Iron	3/3	85-1,540	152-26,700	1,000 ^d	Yes ^{e,f}
Lead	1/3	0.45-1.33	0.8-18.0	43.7 ^h	No ^g
Magnesium	3/3	3,600-170,000	1,010-229,000	-	No ^j
Manganese	3/3	63-318	20-4,810	14,500	No ^g
Potassium	3/3	101,00-41,900	1,220-73,400	53,000 ^d	No ^g
Sodium	3/3	1,490-1,100,000	1,810-2,010,000	680,000	Yes ^{e,f}
Zinc	3/3	12.2-34.2	2.5-78.0	607 ^h	No ^g

^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) or EPA ambient water quality criteria (AWQC) (EPA 1986) unless otherwise noted.

^b A hyphen indicates that contaminant value was unavailable.

^c Contaminant was eliminated from further consideration because the maximum reported concentration was less than the ecological screening value; no background concentration was available.

^d Screening value from Suter and Tsao (1996).

Footnotes continued on next page.

Footnotes for Table 3.11 (Cont.)

- ^e Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ^f The maximum reported background concentration exceeded the ecological screening value.
- ^g Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^h This AWQC is a function of water hardness, which was calculated by using the median concentrations of calcium and magnesium.
- ⁱ Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.
- ^j Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.

TABLE 3.12 Results of the Contaminant Screening Process for Surface Water at the South Beach Demolition Ground Area

Analyte	Frequency of Detection	Concentration (µg/L)	Range of Background Concentrations (µg/L)	Ecological Screening Values (µg/L) ^a	Retained as Contaminant of Concern?
Aluminum	1/1	256	64-10,200	87 ^b	Yes ^{c,d}
Barium	1/1	28.0	8.5-179.0	10,000	No ^e
Calcium	1/1	6,070	2,190-83,800	116,000 ^b	No ^e
Iron	1/1	5,260	152-26,700	1,000 ^b	Yes ^{c,d}
Lead	1/1	1.6	0.8-18.0	0.7 ^f	Yes ^{c,d}
Magnesium	1/1	3,820	1,010-229,000	. ^g	No ^h
Manganese	1/1	1,210	20-4,810	14,500	No ^e
Potassium	1/1	5,780	1,220-73,400	53,000 ^b	No ^{d,e}
Sodium	1/1	7,750	1,810-2,010,000	680,000	No ^{d,e}
Zinc	1/1	67.4	2.5-78.0	39.2 ^f	Yes ^{c,d}

^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) or EPA ambient water quality criteria (AWQC) (EPA 1986) unless otherwise noted.

^b Screening value from Suter and Tsao (1996).

^c Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.

^d The maximum reported background concentration exceeded the ecological screening value.

^e Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.

^f This AWQC is a function of water hardness, which was calculated using the concentrations of calcium and magnesium.

^g A hyphen indicates that the contaminant was not analyzed.

^h Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.

TABLE 3.13 Results of the Contaminant Screening Process for Surface Water at the South Beach Trench Area

Analyte	Frequency of Detection	Concentration (µg/L)	Range of Background Concentrations (µg/L)	Ecological Screening Values (µg/L) ^a	Retained as Contaminant of Concern?
Aluminum	1/1	159	64-10,200	87 ^b	Yes ^{c,d}
Arsenic	1/1	1.6	1.0-3.2	190	No ^e
Calcium	1/1	5,890	2,190-83,800	116,000 ^b	No ^e
Cobalt	1/1	7.3	2.5-21.1	35,000	No ^e
Iron	1/1	1,290	152-26,700	1,000 ^b	Yes ^{c,d}
Magnesium	1/1	2,060	1,010-229,000	- ^f	No ^g
Manganese	1/1	263	20-4,810	14,500	No ^e
Potassium	1/1	4,220	1,220-73,400	53,000 ^b	No ^{d,e}
Silver	1/1	4.0	0.2-2.5	0.3 ^h	Yes ^{d,i}
Sodium	1/1	4.3	1,810-2,010,000	680,000	No ^{d,e}
Zinc	1/1	76.7	2.5-78.0	22.2	Yes ^{c,d}

^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) or EPA ambient water quality criteria (AWQC) (EPA 1986) unless otherwise noted.

^b Screening value from Suter and Tsao (1996).

^c Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.

^d The maximum reported background concentration exceeded the ecological screening value.

^e Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.

^f A hyphen indicates that contaminant value was unavailable.

^g Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.

^h This AWQC is a function of water hardness, which was calculated by using the median concentrations of calcium and magnesium.

ⁱ Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.

TABLE 3.14 Results of the Contaminant Screening Process for Surface Water at the Prototype Building Area

Analyte	Frequency of Detection	Range of Concentrations (µg/L)	Range of Background Concentrations (µg/L)	Ecological Screening Values (µg/L) ^a	Retained as Contaminant of Concern?
Aluminum	2/2	1,410-1,660	64-10,200	87 ^b	Yes ^{c,d}
Barium	2/2	52.2-53.4	8.5-179.0	10,000	No ^e
Calcium	2/2	46,900-48,600	2,190-83,800	116,000 ^b	No ^e
Iron	2/2	2,520-3,010	152-26,700	1,000 ^b	Yes ^{c,d}
Lead	2/2	3.22-4.92	0.8-18.0	37.6 ^f	No ^e
Magnesium	2/2	130,000-150,000	1,010-229,000	- ^g	No ^h
Manganese	2/2	151-189	20-4,810	14,500	No ^e
Potassium	2/2	41,000-42,400	1,220-73,400	53,000 ^b	No ^{d,e}
Sodium	2/2	1,110,000-1,140,000	1,810-2,010,000	650,000 ^b	Yes ^{c,d}
Zinc	2/2	25.1-27.3	2.5-78.0	548	No ^d

^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) or EPA ambient water quality criteria (AWQC) (EPA 1986) unless otherwise noted.

^b Screening value from Suter and Tsao (1996).

^c Contaminant was retained because the maximum reported concentration was below the maximum background concentration but exceeded the ecological screening value.

^d The maximum reported background concentration exceeded the ecological screening value.

^e Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.

^f This AWQC is a function of water hardness, which was calculated by using the median concentrations of calcium and magnesium.

^g A hyphen indicates that contaminant value was unavailable.

^h Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.

TABLE 3.15 Results of the Contaminant Screening Process for Surface Water at the Robins Point Demolition Ground Area

Analyte	Frequency of Detection	Range of Concentrations (µg/L)	Range of Background Concentrations (µg/L)	Ecological Screening Value (µg/L) ^a	Retained as Contaminant of Concern?
Aluminum	8/8	564-30,300	64-10,200	87 ^b	Yes ^{c,d}
Arsenic	6/8	0.9-11.8	1.0-3.2	190	No ^e
Barium	8/8	38.2-275.0	8.5-179.0	10,000	No ^e
Beryllium	4/8	0.5-4.3	0.1-2.5	5.3	No ^e
Cadmium	2/8	1.5-4.5	ND ^f	3.2 ^g	Yes ^c
Calcium	8/8	3,960-109,000	2,190-83,800	116,000 ^b	No ^e
Chromium	5/8	2.5-39.3	2.5-14.2	11 ^g	Yes ^{c,d}
Cobalt	5/8	3.5-39.2	2.5-21.1	35,000	No ^e
Copper	8/8	8.2-75.1	2.5-9.7	36.4 ^g	Yes ^c
Iron	8/8	691-191,000	152-26,700	1,000 ^b	Yes ^{c,d}
Lead	8/8	2.5-228.0	0.8-18.0	17 ^g	Yes ^{c,d}
Magnesium	8/8	2,590-122,000	1,010-229,000	- ^h	No ⁱ
Manganese	8/8	331-5,260	20-4,810	14,500	No ^e
Mercury	4/8	0.05-1.00	ND	0.012 ^g	Yes ^c
Nickel	3/8	6.0-73.2	5.0-23.7	480 ^g	No ^e
Potassium	8/8	3,040-38,200	1,220-73,400	53,000 ^b	No ^{j,d}
RDX	2/6	0.36-3.80	-	190 ^k	Yes ^l
Silver	2/8	0.34-2.0	0.2-2.5	0.1 ^g	Yes ^{m,d}
Sodium	8/8	2,350-844,000	1,810-2,010,000	680,000	Yes ^{m,d}
Vanadium	4/8	2.5-83.8	2.5-23.2	10,000	No ^e
Zinc	8/8	32.2-582.0	2.5-78.0	323 ^g	Yes ^c

See footnotes on next page.

Footnotes for Table 3.15

- ^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) or EPA ambient water quality criteria (AWQC) (EPA 1986) unless otherwise noted.
- ^b Screening value from Suter and Tsao (1996).
- ^c Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.
- ^d The maximum reported background concentration exceeded the ecological screening value.
- ^e Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.
- ^f ND = not detected.
- ^g This AWQC is a function of water hardness, which was calculated using the median concentrations of calcium and magnesium.
- ^h A hyphen indicates that contaminant value was unavailable.
- ⁱ Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^j Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^k Screening value from Talmadge and Opresko (1996).
- ^l Contaminant was eliminated from further consideration because the maximum reported concentration was less than the ecological screening value; no background concentration was available.
- ^m Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.

TABLE 3.16 Results of the Contaminant Screening Process for Surface Water at the Robins Point Tower Site

Analyte	Frequency of Detection	Range of Concentrations (µg/L)	Range of Background Concentrations (µg/L)	Ecological Screening Values (µg/L) ^a	Retained as Contaminant of Concern?
Acetone	2/2	4.0-11.0	- ^b	9,000,000	No ^c
Aluminum	½	46-642	64-10,200	87 ^d	Yes ^{e,f}
Arsenic	½	0.9-6.2	1.0-3.2	190	No ^g
Barium	2/2	35.7-38.4	8.5-179.0	10,000	No ^h
Calcium	2/2	4,560-36,700	2,190-83,800	116,000 ^d	No ^h
Cobalt	½	6.5-20.8	2.5-21.1	35,000	No ^h
Iron	2/2	412-1,580	152-26,700	1,000 ^d	Yes ^{e,f}
Lead	2/2	2.13-15.00	0.8-18.0	9.5 ⁱ	Yes ^{e,f}
Magnesium	2/2	3,140-87,000	1,010-229,000	-	No ^j
Manganese	2/2	120-781	20-4,810	14,500	No ^h
Potassium	2/2	6,210-29,100	1,220-73,400	53,000 ^d	No ^h
Sodium	2/2	11,100-635,000	1,810-2,010,000	680,000 ^d	No ^h
Zinc	2/2	17.6-3,860.0	2.5-78.0	220 ⁱ	Yes ^k

^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) or EPA ambient water quality criteria (AWQC) (EPA 1986) unless otherwise noted.

^b A hyphen indicates that contaminant value was unavailable.

^c Contaminant was eliminated from further consideration because the maximum reported concentration was less than the ecological screening value; no background concentration was available.

^d Screening value from Suter and Tsao (1996).

Footnotes continued on next page.

Footnotes for Table 3.16 (Cont.)

- ^e Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ^f The maximum reported background concentration exceeded the ecological screening value.
- ^g Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.
- ^h Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ⁱ This AWQC is a function of water hardness, which was calculated by using the median concentrations of calcium and magnesium.
- ^j Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^k Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.

TABLE 3.17 Results of the Contaminant Screening Process for Sediment at the Toxic Burning Pits Area

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
1,1,2,2-Tetrachloroethane	3/10	6-23	ND ^b	940 ^c	No ^d
1,1,2-Trichloroethane	3/10	4-16	ND	1,251 ^c	No ^d
1,2-Dichloroethane	2/10	3-16	ND	250 ^e	No ^d
1,2-Dichloroethene (cis + trans)	4/10	4-72	ND	400 ^e	No ^d
1,4-Dichlorobenzene	1/7	89-402.5	ND	350 ^c	Yes ^f
2,4-Dinitrotoluene	1/16	25.8-2,110	ND	- ^g	Yes ^h
2-Butanone	1/10	6.5-200	ND	270 ^e	No ^d
2-Hexanone	1/10	3-16	ND	22 ^e	No ^d
4,4'-DDD	4/4	2.7-6.5	0.61-8.30	16.0	No ⁱ
4,4'-DDE	4/4	4.2-9.3	0.61-11	2.2	Yes ^{j,k}
4-Methyl-2-pentanone	1/10	2-16	ND	33.2 ^e	No ^d
Acetone	6/9	2-200	7-11	8.7 ^e	Yes ^{f,k}
Aluminum	10/10	5,260,000-26,900,000	537,000-28,050,000	-	No ^l
Antimony	3/10	116-15,900	200-18,000	150,000	No ⁱ
Arsenic	10/10	1,110-14,100	120-18,900	8,200 ^c	Yes ^{j,k}
Barium	10/10	35,400-927,000	2,740-130,000	-	Yes ^h
Beryllium	10/10	291-1,050	86-2,590	-	No ^l
Cadmium	8/10	290-7,040	29.5-3,420	1,200 ^c	Yes ^{f,k}
Calcium	10/10	606,000-5,720,000	88,800-9,590,000	-	No ^l
Chromium	10/10	7,190-80,200	4,920-117,000	81,000 ^c	No ^{i,k}
Cobalt	7/10	1,315-9,000	976-35,100	-	No ^l
Copper	10/10	12,600-515,000	2,110-78,700	34,000	Yes ^{f,k}
di-n-Butylphthalate	1/7	110-402.5	ND	11,000	No ^d
Ethylbenzene	1/10	3-16	ND	3,600 ^c	No ^d
Fluoranthene	1/7	61-402.5	40-600	600	No ^d
Hexachlorobenzene	1/7	84-402.5	ND	22	Yes ^f
Iron	10/10	4,920,000-35,600,000	2,540,000-54,300,000	-	No ^l
Lead	10/10	8,260-1,780,000	1,640-91,100	46,700	Yes ^{f,k}

TABLE 3.17 (Cont.)

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
Magnesium	10/10	793,000-5,110,000	51,400-6,510,000	-	No ^l
Manganese	10/10	31,400-160,000	6,340-1,590,000	460,000 ^e	No ⁱ
Mercury	6/10	28-1,710	58-398	150	Yes ^{f,k}
Methylene chloride	7/10	5-16	ND	370 ^e	No ^d
Nickel	9/10	2,540-35,200	1,890-70,100	20,900	Yes ^{j,k}
Potassium	10/10	246,000-1,640,000	31,025-3,730,000	-	No ^l
Pyrene	1/7	64-402.5	44-480	665 ^e	No ⁱ
Selenium	9/10	125.5-1,760	146-2,805	-	No ^l
Silver	2/10	48-3,740	15-875	1,000	Yes ^f
Sodium	10/10	162,000-1,780,000	293,000-6,310,000	-	No ^l
Toluene	2/10	2-16	ND	670 ^e	No ^d
Trichloroethene	4/10	6.5-29	ND	1,600 ^e	No ^d
Vanadium	10/10	11,800-50,200	4,740-93,000	-	No ^l
Vinyl chloride	2/10	6.5-54	ND	-	Yes ^h
Zinc	10/10	28,700-3,410,000	8,270-284,000	150,000	Yes ^{f,k}

^a Ecological screening values from EPA Region III BTAG screening levels (EPA 1996b) unless otherwise noted.

^b ND = not detected.

^c Screening value from EPA ecotox thresholds (EPA 1996a).

^d Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.

Footnotes continued on next page.

Footnotes for Table 3.17 (Cont.)

- ^e Screening value from Jones et al. (1997).
- ^f Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.
- ^g A hyphen indicates that contaminant value was unavailable.
- ^h Contaminant was retained because the maximum reported concentration exceeded the background concentration; no ecological screening value was available.
- ⁱ Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^j Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ^k The maximum reported background concentration exceeded the ecological screening value.
- ^l Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.

TABLE 3.18 Results of the Contaminant Screening Process for Sediment at the Robins Point Demolition Ground Area

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
Aluminum	2/2	6,790,000-10,100,000	537,000-28,050,000	- ^b	No ^c
Arsenic	2/2	2,900-3,430	120-18,900	8,200 ^d	No ^{e,f}
Barium	2/2	43,400-48,200	2,740-130,000	-	No ^c
Beryllium	½	124-1,320	86-2,590	-	No ^c
Calcium	2/2	882,000-2,000,000	88,800-9,590,000	-	No ^c
Chromium	2/2	10,600-12,700	4,920-117,000	81,000 ^d	No ^{e,f}
Copper	2/2	25,300-30,000	2,110-78,700	34,000	No ^{e,f}
Iron	2/2	10,200,000-11,100,000	2,540,000-54,300,000	-	No ^c
Lead	2/2	54,600-56,700	1,640-91,100	46,700	Yes ^{f,g}
Magnesium	2/2	1,110,000-1,770,000	51,400-6,510,000	-	No ^c
Manganese	2/2	44,200-48,500	6,340-1,590,000	460,000 ^h	No ^{e,f}
Mercury	2/2	114-157	58-398	150	Yes ^{f,g}
Nickel	½	3,490-11,700	1,890-70,100	20,900	No ^{e,f}
Potassium	2/2	267,000-496,000	31,025-3,730,000	-	No ^c
Silver	2/2	659-1,810	15-875	1,000	Yes ⁱ
Sodium	2/2	312,000-1,260,000	293,000-6,310,000	-	No ^c
Vanadium	2/2	17,000-21,000	4,740-93,000	-	No ^c
Zinc	2/2	121,000-127,000	8,270-284,000	150,000	No ^{e,f}

See footnotes on next page.

Footnotes for Table 3.18

- ^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless noted otherwise.
- ^b A hyphen indicates that contaminant value was unavailable.
- ^c Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^d Screening value from EPA ecotox thresholds (EPA 1996a).
- ^e Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^f The maximum reported background concentration exceeded the ecological screening value.
- ^g Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ^h Lowest effects level as reported in Jones et al. (1997).
- ⁱ Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.

TABLE 3.19 Results of the Contaminant Screening Process for Sediment at the Area A Potential Area of Concern

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern
2-Butanone	1/7	6-15	ND ^b	271 ^c	No ^d
Acetone	4/7	6-67	7-11	8.8 ^c	Yes ^e
Aluminum	7/7	5,700,000-13,500,000	537,000-28,050,000	- ^f	No ^g
Arsenic	7/7	844-3,840	120-18,900	8,200 ^h	No ⁱ
Barium	7/7	21,200-54,300	2,740-130,000	-	No ^g
Beryllium	7/7	159-334	86-2,590	-	No ^g
bis(2-Ethylhexyl)phthalate	1/6	190-226	40-9,300	890,000	No ⁱ
Cadmium	1/7	184-566	29.5-3,420	1,200 ^h	No ⁱ
Calcium	7/7	198,000-381,000	88,800-9,590,000	-	No ^g
Chromium	7/7	4,280-16,300	4,920-117,000	81,000 ^h	No ⁱ
Cobalt	4/7	800-2,220	976-35,100	-	No ^g
Copper	7/7	3,420-6,140	2,110-78,700	34,000	No ⁱ
di-n-Butylphthalate	4/6	45-232.5	ND	11,000	No ^d
Ethylbenzene	1/7	3-7	ND	3,600 ^h	No ^d
Iron	7/7	4,180,000-19,600,000	2,540,000-54,300,000	-	No ^g
Lead	7/7	4,350-11,700	1,640-91,100	46,700	No ⁱ
Magnesium	7/7	496,000-1,210,000	51,400-6,510,000	-	No ^g
Manganese	7/7	8,980-31,600	6,340-1,590,000	460,000 ^c	No ⁱ
Mercury	1/7	28-125	58-398	150	No ⁱ
Methylene chloride	7/7	3-4	5-11	375 ^c	No ⁱ
Nickel	7/7	3,250-7,910	1,890-70,100	20,900	No ⁱ
Potassium	7/7	253,000-611,000	31,025-3,730,000	-	No ^g
Selenium	3/7	98-390	146-1,805	-	No ^g
Sodium	7/7	64,300-363,000	293,000-6,310,000	-	No ^g
Toluene	3/7	2-7	ND	670 ^c	No ^d

TABLE 3.19 (Cont.)

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern
Vanadium	7/7	6,130-23,700	4,740-93,000	-	No ^g
Xylenes (total)	1/7	1-7	ND	40	No ^d
Zinc	7/7	13,200 - 28,300	8,270-284,000	150,000	No ⁱ

^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless otherwise noted.

^b ND = not detected.

^c Screening value is from Jones et al. (1997).

^d Contaminant was eliminated because the maximum reported concentration was less than the ecological screening value.

^e Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value; the maximum background concentration exceeded the ecological screening value.

^f A hyphen indicates that contaminant value was unavailable.

^g Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.

^h Screening value from EPA ecotox thresholds (EPA 1996a).

ⁱ Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.

**TABLE 3.20 Results of the Contaminant Screening Process for Sediment at the Ruins Site
Potential Area of Concern**

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
Aluminum	24/24	1,550,000-13,400,000	537,000-28,050,000	- ^b	No ^c
Antimony	3/24	102-652	200-18,000	150,000	No ^d
Arsenic	24/24	511-6,870	120-18,900	8,200 ^e	No ^{d,f}
Barium	24/24	14,400-2,250,000	2,740-130,000	-	Yes ^g
Beryllium	22/24	66-511	86-2,590	-	No ^c
Cadmium	13/24	180-10,700	29.5-3,420	1,200 ^e	Yes ^{f,h}
Calcium	24/24	92,400-8,350,000	88,800-9,590,000	-	No ^c
Chromium	23/24	478.5-98,600	4,920-117,000	81,000 ^e	Yes ^f
Cobalt	18/24	780-4,510	976-35,100	-	No ^c
Copper	20/24	1,375-199,000	2,110-78,700	34,000	Yes ^{f,h}
Iron	24/24	2,460,000-2,470,0000	2,540,000-54,300,000	-	No ^c
Lead	24/24	3,590-138,000	1,640-91,100	46,700	Yes ^{f,h}
Magnesium	24/24	153,000-9,310,000	51,400-6,510,000	-	Yes ^g
Manganese	24/24	8,970-196,000	6,340-1,590,000	460,000 ⁱ	No ^{d,f}
Mercury	9/24	22-44	58-398	150	No ^{d,f}
Nickel	20/24	1,255-16,200	1,890-70,100	20,900	No ^{d,f}
Potassium	24/24	130,000-440,000	31,025-3,730,000	-	No ^c
Selenium	5/24	96-5,770	146.5-1,805	-	Yes ^g
Silver	4/24	42-153	15-875	1,000	No ^d
Sodium	16/24	10,350-101,000	293,000-6,310,000	-	No ^c
Vanadium	24/24	4,110-27,000	4,740-93,000	-	No ^c
Zinc	24/24	7,930-88,600	8,270-284,000	150,000	No ^{d,f}

See footnotes on next page.

Footnotes for Table 3.20

- ^a Ecological screening values from EPA Region III BTAG screening levels (EPA 1996b) unless noted otherwise.
- ^b A hyphen indicates that contaminant value was unavailable.
- ^c Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^d Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^e Screening value from EPA ecotox thresholds (EPA 1996a).
- ^f The maximum reported background concentration exceeded the ecological screening value.
- ^g Contaminant was retained because the maximum reported concentration exceeded the background concentration; no ecological screening value was available.
- ^h Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.
- ⁱ Screening value from Jones et al. (1997).

**TABLE 3.21 Results of the Contaminant Screening Process for Sediment at the Craters
Potential Area of Concern**

Analyte	Frequency of Detection	Range of Concentrations (µg/kg)	Range of Background Concentrations (µg/kg)	Ecological Screening Values (µg/kg) ^a	Retained as Contaminant of Concern?
Aluminum	16/16	858,000-13,500,000	537,000-28,050,000	- ^b	No ^c
Antimony	5/16	136-931	200-18,000	150,000	No ^d
Arsenic	14/16	105-4,710	120-18,900	8,200 ^e	No ^{d,f}
Barium	16/16	10,900-239,000	2,740-130,000	-	Yes ^g
Beryllium	16/16	107-714	86-2,590	-	No ^c
Cadmium	12/16	143.5-2,540	29.5-3,420	1,200 ^e	Yes ^{f,h}
Calcium	16/16	44,000-6,990,000	88,800-9,590,000	-	No ^c
Chromium	16/16	1,320-19,900	4,920-117,000	81,000 ^e	No ^{d,f}
Cobalt	13/16	855-5,860	976-35,100	-	No ^c
Copper	16/16	2,050-85,900	2,110-78,700	34,000	Yes ^{f,i,j}
Iron	16/16	412,000-37,200,000	2,540,000-54,300,000	-	No ^c
Lead	16/16	3,680-35,100	1,640-91,100	46,700	No ^{d,f}
Magnesium	16/16	82,400-1,820,000	51,400-6,510,000	-	No ^c
Manganese	16/16	4,960-95,300	6,340-1,590,000	460,000 ^j	No ^{d,f}
Mercury	8/16	26.5-254	58-398	150	Yes ^{f,h}
Nickel	13/16	1,050-14,000	1,890-70,100	20,900	No ^{d,f}
Potassium	16/16	93,800-891,000	31,025-3,730,000	-	No ^c
Silver	4/16	43.5-4,760	15-1,750	1,000	Yes ^{f,i,j}
Sodium	16/16	46,200-191,000	243,000-6,310,000	-	No ^c
Vanadium	16/16	1,000-25,000	4,740-93,000	-	No ^c
Zinc	16/16	3,660-122,000	8,270-466,000	150,000	No ^{d,f}

See footnotes on next page.

Footnotes for Table 3.21

- ^a Ecological screening value from EPA Region III BTAG screening levels (EPA 1996b) unless noted otherwise.
- ^b A hyphen indicates that contaminant value was unavailable.
- ^c Contaminant was eliminated from further consideration because the maximum reported concentration was less than the maximum background concentration; no ecological screening value was available.
- ^d Contaminant was eliminated from further consideration because the maximum reported concentration was less than both the maximum background concentration and the ecological screening value.
- ^e Screening value from EPA ecotox thresholds (EPA 1996a).
- ^f The maximum reported background concentration exceeded the ecological screening value.
- ^g Contaminant was retained because the maximum reported concentration exceeded the background concentration; no ecological screening value was available.
- ^h Contaminant was retained because the maximum reported concentration, although below the maximum background concentration, exceeded the ecological screening value.
- ⁱ Contaminant was retained because the maximum reported concentration exceeded the maximum reported background concentration and the ecological screening value.
- ^j Lowest effects concentration as reported in Jones et al. (1997).

were present at concentrations above background concentrations but below screening levels and were also eliminated from further consideration. Contaminants present at concentrations below background levels but exceeding screening values were retained for further evaluation in the ERA.

3.2.3.2 Surface Water

The principal contaminants identified in surface waters at J-Field were heavy metals. Most of the chemicals for which surface waters were evaluated were eliminated because they were present at levels that did not exceed screening values. Tables 3.9 through 3.16 summarize the screening process for surface water contaminants by AOC; they do not include contaminants with 0% detection. As noted for the PCOECs for soil, some contaminants were identified as PCOECs at some AOCs but not at others. At several AOCs, some surface water PCOECs were detected at concentrations exceeding ecological screening values, but below background concentrations.

3.2.3.3 Sediment

As was the case for soils and surface water, metals were the dominant PCOECs in sediments at J-Field. Some VOCs and SVOCs were also identified as PCOECs. Tables 3.17 through Table 3.21 summarize the results of the screening process; they do not include contaminants with 0% detection. Some contaminants were eliminated from consideration as PCOECs because their reported concentrations did not exceed screening levels.

3.2.4 Final Contaminants of Ecological Concern

Table 3.22 presents the final list of the PCOECs, by media, for each AOC. At some areas, no PCOECs were identified for particular media. It should be noted that for a number of the PCOECs, the maximum reported background concentrations exceeded the ecological screening values, while other PCOECs were reported at concentrations exceeding the screening values but below background levels. In some cases, this reflects the very conservative nature of the ecological screening value. This final list represents the contaminants modeled to predict daily doses and estimate risks to ecological receptors.

TABLE 3.22 Final List of Potential Contaminants of Ecological Concern for J-Field by Media and Area of Concern

Area of Concern	Soil		Surface Water		Sediment	
	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs
Toxic Burning Pits	Aluminum ^a	11DCE	Aluminum ^a	1,1-Oxathiane	Arsenic ^{a,b}	1,4-Dichlorobenzene
	Antimony	2-Butanone	Antimony	1,4-Dithiane	Barium	2,4-DNT
	Arsenic	2-Methylphenol	Cadmium	1,4-Oxathiane	Cadmium ^a	4,4-DDE ^b
	Barium	2-Methylnaphthalene	Chromium ^a	Chloroethane	Copper ^a	Acetone ^a
	Cadmium	2,4,6-Trichloroaniline	Copper	DIMP	Lead ^a	Hexachlorobenzene
	Chromium ^a	4-Methylphenol	Iron ^a	Dithiane	Mercury ^a	Vinyl chlorine
	Cobalt	Acetone	Lead ^a	TCLEA	Nickel ^{a,b}	
	Copper ^a	Aroclor 1248	Mercury	TOH	Silver	
	Iron ^a	Benzo(b)fluoranthene ^a	Sodium ^{a,b}		Zinc ^a	
	Lead ^a	Benzo(k)fluoranthene ^a	Zinc			
	Magnesium ^b	Carbon disulfide				
	Manganese ^b	Cyanide				
	Mercury ^a	Diethyl phthalate				
	Nickel ^a	Fluorene				
	Selenium	Hexachloroethane				
	Silver	N-Nitrosodiphenylamine				
	Thallium	Nitroglycerin				
	Zinc ^a	Phenol				
		Pyrene ^a				
		TCLEA				
		TCLEE				
		TRCLE				

TABLE 3.22 (Cont.)

Area of Concern	Soil		Surface Water		Sediment	
	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs
White Phosphorus Pits	Aluminum ^a Antimony Cadmium Chromium ^{a,b} Copper ^a Iron ^a Lead ^a Magnesium ^{a,b} Mercury ^a Nickel ^{a,b} Zinc ^a	Benz(a)anthracene ^a Benzo(a)pyrene ^{a,b} Benzo(b)fluoranthene ^a Benzo(k)fluoranthene ^a bis(2-Ethylhexyl)phthalate Chrysene ^{a,b} Fluoranthene ^{a,b} Indeno(1,2,3-cd)pyrene ^a Pyrene ^{a,b}	Aluminum ^{a,b} Chromium ^a Copper Iron ^a Lead ^a Mercury Sodium ^{a,b} Zinc			
Riot Control Pit	Aluminum ^a Antimony Cadmium Chromium ^a Copper ^a Iron ^{a,b} Lead ^a Magnesium ^{a,b} Mercury ^a Nickel ^{a,b} Silver Zinc ^a		Aluminum ^{a,b} Iron ^{a,b} Sodium ^{a,b}			

TABLE 3.22 (Cont.)

Area of Concern	Soil		Surface Water		Sediment	
	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs
Prototype Building	Aluminum ^a Antimony Cadmium Copper ^a Iron ^{a,b} Lead ^{a,b} Magnesium ^{a,b} Manganese ^b Mercury ^a Nickel ^{a,b} Zinc ^{a,b}	Acetone Benzo(k)fluoranthene ^a Cyanide Endrin aldehyde	Aluminum ^{a,b} Iron ^{a,b} Sodium ^{a,b}			
South Beach Demolition Ground			Aluminum ^{a,b} Iron ^{a,b} Lead ^{a,b} Zinc ^b			
South Beach Trench	Aluminum ^{a,b} Cadmium Copper ^a Iron ^{a,b} Lead ^{a,b} Magnesium ^{a,b} Nickel ^{a,b} Zinc ^{a,b}		Aluminum ^{a,b} Iron ^{a,b} Silver Zinc ^b			

TABLE 3.22 (Cont.)

Area of Concern	Soil		Surface Water		Sediment	
	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs
Robins Point Demolition Ground	Aluminum ^{a,b}	2,4-Dinitrotoluene	Aluminum ^a	RDX	Lead ^{a,b}	
	Antimony		Cadmium		Mercury ^{a,b}	
	Copper ^{a,b}		Chromium ^a		Silver	
	Iron ^{a,b}		Copper			
	Lead ^{a,b}		Iron ^a			
	Magnesium ^{a,b}		Lead ^a			
	Mercury ^a		Mercury			
	Nickel ^{a,b}		Silver ^b			
	Silver		Sodium ^{a,b}			
	Zinc ^{a,b}		Zinc			
	Robins Point Tower Site		Aluminum ^{a,b}		Benzo(b)fluoranthene ^{a,b}	
Iron ^a		Iron ^{a,b}				
Lead ^{a,b}		Lead ^{a,b}				
Magnesium ^{a,b}		Zinc				
Manganese ^b						
Mercury ^a						
Nickel ^{a,b}						
Zinc ^{a,b}						
Area A PAOC						
Ruins Site PAOC	Aluminum ^{a,b}					Acetone
	Iron ^{a,b}					
	Lead ^{a,b}					
	Magnesium ^{a,b}					
	Mercury ^{a,b}					
	Nickel ^{a,b}					
	Zinc ^{a,b}					
				Barium		
				Cadmium ^a		
				Chromium ^a		
				Copper ^a		
				Lead ^a		
				Magnesium		
				Selenium		

TABLE 3.22 (Cont.)

Area of Concern	Soil		Surface Water		Sediment	
	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs	Metals	SVOCs and VOCs
Craters PAOC		2,4,6-Trichloroaniline			Barium Cadmium ^{a,b} Copper ^a Mercury ^{a,b} Silver	

^a The reported maximum background concentration for the PCOEC exceeded the ecological screening value.

^b The reported maximum concentration of the PCOEC was less than the background concentration.

3.3 ASSESSMENT ENDPOINTS AND ECOLOGICAL RECEPTORS

Although many ecological resources occur at J-Field (Section 2.4), it is beyond the scope of this ERA to evaluate risks to every resource. Rather, assessment endpoints were selected for evaluating whether contaminants are affecting or could affect ecological resources at the site. Recent EPA Superfund guidance for ecological risk assessment (EPA 1997) defines assessment endpoints as "...explicit expressions of the actual environmental values (e.g., ecological resources) that are to be protected. Valuable ecological resources include those without which ecosystem function would be significantly impaired, those providing critical resources... and those perceived as valuable by humans...." The assessment endpoints identified for J-Field targeted ecological resources that, because of their ecological characteristics, represent important components of the local ecosystem and that are in direct contact with potentially contaminated media.

For terrestrial resources at the J-Field site, three general assessment endpoints were identified (Table 1.2). One assessment endpoint was the protection of plant communities from ecological changes related to contaminant exposure and in particular the maintenance of plant species diversity, survival, and biomass production at levels similar to those at areas not exposed to site PCOECs. The testable hypotheses associated with this assessment endpoint are: (1) Is plant species diversity reduced as a result of exposure to PCOECs in site soils? (2) Are PCOEC concentrations in site soils at levels that may adversely affect plant reproductive success and survival? and (3) Is plant biomass reduced as a result of exposure to PCOECs present in site soils? This assessment endpoint was selected on the basis of the ecologically relevant attributes associated with terrestrial vegetation, namely food production and habitat. Terrestrial vegetation is ecologically important because of its role as the base of the food chain (e.g., primary producers occupying the first trophic level) and because of its role in providing habitat (for nesting, foraging, and shelter) for vertebrate and invertebrate biota. Furthermore, because plants are immobile and rooted directly in potentially contaminated soils, they also represent a receptor category that may be expected to incur maximum exposure to soil-related PCOECs.

A second terrestrial assessment endpoint was the protection of terrestrial vertebrate communities from ecological changes related to contaminant exposure. The associated testable hypothesis may be stated as: *Could terrestrial wildlife utilizing the site be exposed to site PCOECs at levels that could result in contaminant doses that might adversely impact reproduction, survival, and/or growth?* This assessment endpoint targeted the small mammal herbivore (primary consumer) community because of its important role as the principal food source for higher trophic level predators, such as birds-of-prey. This assessment endpoint also targeted insectivorous birds and top-level predators. The former are ecologically relevant because of their roles in maintaining invertebrate populations and their high potential for exposure to site contaminants, while the latter are ecologically relevant because of their function in population control of lower trophic level biota. In general, top-level predators are especially susceptible and sensitive to bioaccumulating PCOECs

such as PCBs, and thus may be at particular risk at those locations where bioaccumulating contaminants are present.

The third terrestrial assessment endpoint was the protection of the soil biota communities and associated soil nutrient processes from ecological changes related to contaminant exposure. This assessment endpoint may also be stated as: *The maintenance of soil biota community structure and of biological processes associated with decomposition and nutrient processing at levels comparable to those in soils not exposed to site-derived PCOECs.* The testable hypotheses associated with this endpoint are: (1) *Are soil biota survival, abundance, diversity, and/or community structure reduced as a result of exposure to PCOECs in site soils?* and (2) *Are soil processes associated with decomposition and nutrient cycling being adversely affected as a result of PCOEC levels in site soils?* This endpoint was identified on the basis of the ecological roles of soil biota in food production for vertebrate biota and in maintaining plant communities via seed dispersal and herbivory, and the importance of soil biota as scavengers and decomposers and in nutrient cycling. Disruptions in one or more of these ecological parameters could lead to localized disruption of ecosystem structure and function. Because they occur directly on or in soils, these receptors may be expected to incur maximum exposure to potential soil PCOECs.

For aquatic resources, the general assessment endpoint was the protection of aquatic communities from ecological changes related to contaminant exposure, including maintenance of aquatic invertebrate species diversity and plankton and fish survival at levels similar to those at areas not exposed to site PCOECs. Testable hypotheses associated with this endpoint are: (1) *Is macroinvertebrate species diversity reduced as a result of exposure to PCOECs in site surface water and sediment?* (2) *Could semi-aquatic wildlife utilizing aquatic habitats at the site be exposed to PCOECs at levels that may result in adverse impacts to reproduction, survival, and/or growth?* and (3) *Are the growth and/or survival of plankton, fish, and amphibians being adversely impacted by PCOECs in surface water and sediment?* Components of the aquatic community addressed by this endpoint include phytoplankton and zooplankton because of their ecological relevance as food for higher trophic level organisms, fish because they represent the dominant fully aquatic vertebrate component of aquatic ecosystems at J-Field, and semiaquatic mammals and birds because they represent either high-level predators (e.g., great blue heron) or species of management and regulatory concern (e.g., waterfowl, piscivorous birds such as the osprey and bald eagle).

A variety of measurement endpoints were identified for evaluating potential or actual ecological changes that may occur or have occurred as a result of exposure to site PCOECs. The EPA (1997) defines a measurement endpoint as "A measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint. As used in this guidance ... measurement endpoints can include measures of effect and measures of exposure...." The measurement endpoints identified for this ERA included measures of survival, growth, reproductive success, abundance and biomass production, enzyme activity, tissue concentration, diversity, and community structure (summarized in Table 1.2). These measurement endpoints were identified in

detail in the J-Field ERA work plan (Hlohowskyj et al. 1995) and are summarized in Appendix A of this ERA report.

Receptor species considered to be representative of the assessment endpoints were selected on the basis of their trophic level, habitats, commercial or recreational importance, or regulatory status. Species were selected as trophic level indicators according to the PCOEC. For contaminants that are biomagnified (e.g., mercury), the assessment endpoint targeted species at the top of the food chain as appropriate representative receptors. For most metals and other contaminants that are not biomagnified, the assessment endpoints focused on primary producers, herbivores, and detritivores as appropriate representative receptors.

ICF Kaiser Engineers (1993) identified a list of generally appropriate representative receptors for APG. However, not all the receptors identified in that list are appropriate for J-Field. For example, the absence from most of the J-Field AOCs of permanent aquatic habitats that can support fish and year-round residence by amphibians limits the variety of aquatic receptors. Therefore, a list of representative receptors was developed on the basis of the assessment endpoints selected for APG, the APG species list, and field observations of biota at J-Field. This receptor list was presented in the work plan for the J-Field ERA (Hlohowskyj et al. 1995).

The assessment endpoints and their representative receptor species would not all be expected to inhabit or visit all the AOCs. Individual members of species with small home ranges, such as the deer mouse and eastern cottontail rabbit, are likely to use only a single AOC if suitable habitat is available in that AOC. In contrast, wide-ranging species, such as the white-tailed deer, red-tailed hawk, and great blue heron, may use or visit several AOCs within a single day. Thus, assessment endpoints and representative ecological receptors were identified for the overall J-Field site as well as for each AOC.

In addition to vegetation and wildlife species, soil-inhabiting micro- and macroinvertebrate communities were also selected as representative receptors, because of their importance in decomposer food webs, nutrient cycling pathways, and the formation and maintenance of the biological, chemical, and physical characteristics of soil ecosystems (Edwards et al. 1970; Crossley 1977; Seastedt 1984). In areas with contaminated soils, these biota live in direct contact with the contaminated media, and adverse effects on these biota may significantly affect higher-level components of the terrestrial ecosystem.

3.3.1 Toxic Burning Pits Area of Concern

The TBP AOC contains the largest and most varied habitats of any of the AOCs. The pond and marsh area is the largest and most significant freshwater habitat at J-Field and is the only on-site habitat that supports a fish community. Because of its diverse aquatic and terrestrial habitats, the

TBP AOC could contain the greatest number of aquatic and terrestrial receptors (Table 3.23). All of these receptors have been collected or observed at the AOC, and they represent all the major classes of biota that may occur at J-Field. They include species that occupy a variety of trophic levels, including terrestrial and aquatic primary producers, low-level consumers, and top-level predators. Some receptors, such as the leopard frog and the white-footed mouse, have small home and foraging ranges that could be completely contained within the AOCs. In contrast, wide-ranging receptors, such as the red-tailed hawk and the white-tailed deer, have very large home and foraging ranges and are likely to visit or use the TBP AOC on a more limited basis.

3.3.2 White Phosphorus Pits Area of Concern

The principal habitats at the WPP AOC are the grassland habitat, which covers most of the AOC and the suspected burn areas, and the ephemeral pond habitats within the main pits and immediately northwest of the main pits. The receptor species identified at this AOC (Table 3.24) may use one or both habitats. Some receptors are likely restricted to the WPP AOC, and others are capable of moving among the AOCs.

The red-spotted newt may be particularly vulnerable to surface water contaminants because of its reproductive behavior. This newt is a terrestrial, forest-floor species and is not expected to occur at the AOC during much of the year because of the predominantly grassland and marsh habitats at the site. In spring, however, the adults move to breed in ephemeral flooded pools that form as a result of runoff of snow melt and precipitation. The main pits and a small area in the northwestern corner of the AOC fill with water. These types of temporary, fishless ponds provide breeding habitat for the newts, as well as a variety of other amphibians, such as spring peepers, chorus frogs, and tree frogs.

3.3.3 Riot Control Burning Pit Area of Concern

The list of receptors identified for the RCP AOC (Table 3.25) includes many of the same species identified for the WPP AOC. However, species that forage or inhabit open, grassland areas are not expected at this AOC because it is a forested site. Although the white-tailed deer is an ecological receptor for this site, its overall exposure to site contamination would probably be low. The white-tailed deer is a wide-ranging species, and the RCP AOC could represent, at most, only a small portion of its large home range. Aquatic receptors include the leopard frog, which may inhabit the marsh year-round, and red-spotted newts, which may use the pit only for reproduction.

TABLE 3.23 Assessment Endpoints and Representative Ecological Receptors for the Toxic Burning Pits Area

Assessment Endpoint and Representative Receptor	Habitat Type	Occurrence at the AOC	Exposure Point Media	Likely to Visit Other AOCs? ^a
<i>Protection of Plant Communities from Ecological Changes Related to Contaminant Exposure</i>				
Grasses (<i>Andropogon</i> spp.)	Upland	Pushout Area and main pit area	Soil	No
Maple (<i>Acer</i> spp.)	Upland	Southern portion of AOC	Soil	No
Common reed	Wetlands	Marsh	Sediment	No
<i>Protection of Aquatic Communities from Ecological Changes Related to Contaminant Exposure</i>				
Phytoplankton and zooplankton	Quiet surface waters	Pond and marsh	Surface water	No
Golden shiner	Quiet surface waters	Pond and marsh edges	Surface water	No
Leopard frog	Quiet surface waters	Marsh and pond margins	Surface water	No
Great blue heron	Surface waters and wetlands	Marsh and pond margins	Surface water	Yes
Mallard duck	Wetlands with nearby grasslands	Pond, marsh, and Pushout Area	Soil, surface water, and sediment	Yes
Muskrat	Surface waters and wetlands	Marsh and pond	Surface water and sediment	No
<i>Protection of Soil Biota Communities from Ecological Changes Related to Contaminant Exposure</i>				
Macroinvertebrates	Grasslands and forests soils	All area soil	Soil	No
Bacteria and fungi	Grasslands and forests soils	All area soil	Soil	No
<i>Protection of Terrestrial Vertebrate Communities from Ecological Changes Related to Contaminant Exposure</i>				
American kestrel	Semi-open grasslands	Pushout Area and main pit area	Soil and surface water	Yes
Red-tailed hawk	Wetlands, grasslands, and forests	Entire AOC	Soil and surface water	Yes
American robin	Wetlands, grasslands, and forests	Entire AOC	Soil and surface water	Yes

TABLE 3.23 (Cont.)

Assessment Endpoint and Representative Receptor	Habitat Type	Occurrence at the AOC	Exposure Point Media	Likely to Visit Other AOCs? ^a
Tree swallow	Grasslands with wooded edges or nearby woodlots	Entire AOC	Soil and surface water	Yes
White-tailed deer	Old fields, grass- lands, and forests	Entire AOC	Soil and surface water	Yes
White-footed mouse	All upland habitats	Entire AOC	Soil and surface water	No
Eastern cottontail	Upland habitats and marsh edges	Entire AOC	Soil and surface water	No
Red fox	Wetlands, grasslands, and forests	Entire AOC	Soil and surface water	Yes

^a The likelihood of an individual of the receptor species to visit other AOCs is based on the typical size of that species' home range or foraging territory.

3.3.4 Prototype Building Area of Concern

The biota selected as representative receptors for the PB AOC require or use open, grassland habitats (Table 3.26). Because of the absence of forest habitat, no forest-dwelling species were identified for this AOC. Similarly, because no aquatic habitats occur at this AOC, no aquatic or semiaquatic species were selected as receptors.

3.3.5 South Beach Demolition Ground Area of Concern

Biota at the SBDG AOC would be exposed to contamination primarily at the large detonation crater, and receptors are limited to species that inhabit or use that crater (Table 3.27). These representative receptors are all identified as receptors for other AOCs as well. They include species with both small and large home ranges, and they encompass multiple trophic levels. Wide-ranging species are not likely to use the detonation crater to a great extent.

3.3.6 South Beach Trench Area of Concern

No contaminant sources were identified in the RI characterization of the SBT AOC, and no contamination was detected in soils, sediment, or surface water (Yuen et al. 1999). As a result, no contaminant pathways or ecological receptors were identified for this AOC.

TABLE 3.24 Assessment Endpoints and Representative Ecological Receptors for the White Phosphorus Burning Pits Area

Assessment Endpoint and Representative Receptor	Habitat Type	Occurrence at the AOC	Exposure Point Media	Likely to Visit Other AOCs? ^a
<i>Protection of Plant Communities from Ecological Changes Related to Contaminant Exposure</i>				
Grasses (<i>Andropogon</i> spp.)	Upland	Pushout area and main pit area Suspected burning area	Soil	NA ^b
<i>Protection of Aquatic Communities from Ecological Changes Related to Contaminant Exposure</i>				
Phytoplankton and zooplankton	Quiet surface waters	Marsh and ponded area	Surface water	No
Leopard frog	Quiet surface waters	Marsh and ponded area	Surface water	No
Red-spotted newt	Upland forests for adults, ephemeral pools for reproduction	Ponded area	Surface water	No
Mallard duck	Wetlands with nearby grasslands	Pushout area, marsh, and ponded area	Soil, surface water, and sediment	Yes
<i>Protection of Soil Biota Communities from Ecological Changes Related to Contaminant Exposure</i>				
Macroinvertebrates	Grasslands and forests soils	All area soil	Soil	No
Bacteria and fungi	Grasslands and forests soils	All area soil	Soil	No
<i>Protection of Terrestrial Vertebrate Communities from Ecological Changes Related to Contaminant Exposure</i>				
American kestrel	Semi-open grasslands	Entire AOC	Soil and surface water	Yes
Red-tailed hawk	Wetlands, grasslands, and forests	Entire AOC	Soil and surface water	Yes
American robin	Wetlands, grasslands, and forests	Entire AOC	Soil and surface water	Yes
Tree swallow	Grasslands with wooded edges or nearby woodlots	Entire AOC	Soil and surface water	Yes

TABLE 3.24 (Cont.)

Assessment Endpoint and Representative Receptor	Habitat Type	Occurrence at the AOC	Exposure Point Media	Likely to Visit Other AOCs? ^a
White-tailed deer	Old fields, grasslands, and forests	Entire AOC	Soil and surface water	Yes
White-footed mouse	All upland habitats	Entire AOC	Soil and surface water	No
Eastern cottontail	Upland habitats and marsh edges	Entire AOC	Soil and surface water	No
Red fox	Wetlands, grasslands, and forests	Entire AOC	Soil and surface water	Yes

^a The likelihood of an individual of the receptor species to visit other AOCs is based on the typical size of that species' home range or foraging territory.

^b NA = not applicable.

3.3.7 Robins Point Demolition Ground Area of Concern

Biota at the RPDG AOC could be exposed to contamination at the clear area east of the berm and at the adjacent marsh. The medium of concern at these areas is surface water. The principal receptors for this AOC are small herbivorous mammals, omnivorous and predatory birds, and red-spotted newts (Table 3.28).

3.3.8 Robins Point Tower Site Area of Concern

No contamination sources were identified by the RI characterization of the RPTS AOC, and no contamination was detected in soils at the site (Yuen et al. 1999). However, evaluation of the characterization data for the RPTS AOC following the screening process for selecting PCOECs identified zinc in ponded surface water at concentrations exceeding the ambient water quality criteria (AWQC) for the protection of freshwater biota (EPA 1986). Ecological receptors selected for evaluation to verify that the site poses no risks to biota are the red-spotted newt, American robin, red fox, and white-footed mouse.

TABLE 3.25 Assessment Endpoints and Representative Ecological Receptors for the Riot Control Burning Pit Area

Assessment Endpoint and Representative Receptor	Habitat Type	Occurrence at the AOC	Exposure Point Media	Likely to Visit Other AOCs? ^a
<i>Protection of Plant Communities from Ecological Changes Related to Contaminant Exposure</i>				
Maple (<i>Acer</i> spp.)	Upland	Entire AOC	Soil	NA ^b
<i>Protection of Aquatic Communities from Ecological Changes Related to Contaminant Exposure</i>				
Phytoplankton and zooplankton	Ephemeral pools and quiet waters	Ephemeral pools and marsh	Surface water	No
Red-spotted newt	Upland forests for adults, ephemeral pools for reproduction	Entire AOC	Soil and surface water	No
Leopard frog	Quiet surface waters	Marsh	Surface water	No
<i>Protection of Soil Biota Communities from Ecological Changes Related to Contaminant Exposure</i>				
Macroinvertebrates	Forest soils	Forested areas	Soil	No
Bacteria and fungi	Forest soils	Forested areas	Soil	No
<i>Protection of Terrestrial Vertebrate Communities from Ecological Changes Related to Contaminant Exposure</i>				
American robin	Wetlands, grasslands, and forests	Entire AOC	Soil and surface water	Yes
White-tailed deer	Old fields, grasslands, and forests	Entire AOC	Soil and surface water	Yes
White-footed mouse	All upland habitats	Entire AOC	Soil and surface water	No
Eastern cottontail	Upland habitats and marsh edges	Entire AOC	Soil and surface water	No
Red fox	Wetlands, grasslands, and forests	Entire AOC	Soil and surface water	Yes

^a The likelihood of an individual of the receptor species to visit other AOCs is based on the typical size of that species' home range or foraging territory.

^b NA = not applicable.

TABLE 3.26 Assessment Endpoints and Representative Ecological Receptors for the Prototype Building Area

Assessment Endpoint and Representative Receptor	Habitat Type	Occurrence at the AOC	Exposure Point Media	Likely to Visit Other AOCs? ^a
<i>Protection of Plant Communities from Ecological Changes Related to Contaminant Exposure</i>				
Grasses (<i>Andropogon</i> spp.)	Upland	Entire AOC	Soil	NA ^b
<i>Protection of Soil Biota Communities from Ecological Changes Related to Contaminant Exposure</i>				
Macroinvertebrates	Grasslands	Entire AOC	Soil	No
Bacteria and fungi	Grasslands	Entire AOC	Soil	No
<i>Protection of Terrestrial Vertebrate Communities from Ecological Changes Related to Contaminant Exposure</i>				
American kestrel	Semi-open grasslands	Entire AOC	Soil	Yes
Red-tailed hawk	Wetlands, grasslands, and forests	Entire AOC	Soil	Yes
American robin	Wetlands, grasslands, and forests	Entire AOC	Soil	Yes
Tree swallow	Open areas with wooded margins or nearby woodlots	Entire AOC	Soil	Yes
White-tailed deer	Old fields, grasslands, and forests	Entire AOC	Soil	Yes
White-footed mouse	All upland habitats	Entire AOC	Soil	No
Eastern cottontail	Upland habitats and marsh edges	Entire AOC	Soil	No
Red fox	Wetlands, grasslands, and forests	Entire AOC	Soil	Yes

^a The likelihood of an individual of the receptor species to visit other AOCs is based on the typical size of that species' home range or foraging territory.

^b NA = not applicable.

TABLE 3.27 Assessment Endpoints and Representative Ecological Receptors for the South Beach Demolition Ground Area

Assessment Endpoint and Representative Receptor	Habitat Type	Occurrence at the AOC	Exposure Point Media	Likely to Visit Other AOCs? ^a
<i>Protection of Aquatic Communities from Ecological Changes Related to Contaminant Exposure</i>				
Phytoplankton and zooplankton	Quiet surface waters	Detonation crater	Surface water	NA ^b
Red-spotted newt	Upland forests for adults, ephemeral pools for reproduction	Detonation crater	Surface water	No
Leopard frog	Quiet surface waters	Detonation crater	Surface water	No
<i>Protection of Terrestrial Vertebrate Communities from Ecological Changes Related to Contaminant Exposure</i>				
American robin	Wetlands, forests, and grasslands	Detonation crater	Surface water	Yes
White-tailed deer	Old fields, forests, and grasslands	Detonation crater	Surface water	Yes
White-footed mouse	All upland habitats	Detonation crater	Surface water	No
Eastern cottontail	Marsh edges, upland habitats	Detonation crater	Surface water	No
Red fox	Wetlands, forests, and grasslands	Detonation crater	Surface water	Yes

^a The likelihood of an individual of the receptor species to visit other AOCs is based on the typical size of that species' home range or foraging territory.

^b NA = not applicable.

TABLE 3.28 Assessment Endpoints and Representative Ecological Receptors for the Robins Point Demolition Ground Area

Assessment Endpoint and Representative Receptor	Habitat Type	Occurrence at the AOC	Exposure Point Media	Likely to Visit Other AOCs? ^a
<i>Protection of Plant Communities from Ecological Changes Related to Contaminant Exposure</i>				
Grasses (<i>Andropogon</i> spp.)	Upland	Clear area east of berm	Soil	NA ^b
<i>Protection of Aquatic Communities from Ecological Changes Related to Contaminant Exposure</i>				
Phytoplankton and zooplankton	Quiet waters	Ponded water in clear area	Surface water	No
Red-spotted newt	Upland forest for adults, ephemeral pools for reproduction	Ponded water in clear area	Surface water	No
<i>Protection of Soil Biota Communities from Ecological Changes Related to Contaminant Exposure</i>				
Macroinvertebrates	Forest and grasslands	Entire AOC	Soil	No
Bacteria and fungi	Forest and grasslands	Entire AOC	Soil	No
<i>Protection of Terrestrial Vertebrate Communities from Ecological Changes Related to Contaminant Exposure</i>				
American robin	Wetlands, grasslands, and forest	Clear area east of berm	Soil and surface water	Yes
American kestrel	Semi-open grasslands	Entire AOC	Soil and surface water	Yes
Red-tailed hawk	Wetlands, forest, and grasslands	Entire AOC	Soil and surface water	Yes
White-tailed deer	Old fields, forest, and grasslands	Clear area east of berm	Soil and surface water	Yes
White-footed mouse	All upland habitats	Clear area east of berm	Soil and surface water	No
Eastern cottontail	Uplands and marsh edges	Clear area east of berm	Soil and surface water	No
Red fox	Wetlands, forest, and grasslands	Detonation crater	Soil and surface water	Yes

^a The likelihood of an individual of the receptor species to visit other AOCs is based on the typical size of that species' home range or foraging territory.

^b NA = not applicable.

3.3.9 Potential Areas of Concern

The principal habitats associated with the PAOCs are permanent and temporary crater-based ponds. The media of concern are surface water and sediment. Because of the small size and/or temporary nature of these aquatic habitats, the red-spotted newt and the leopard frog were selected as receptors.

3.3.10 J-Field Sitewide

Evaluation of potential ecological risks from the entire J-Field site focused on those resources that may be expected to visit or occur in all or most of the AOCs during the course of their normal foraging activities. Thus the assessment endpoint focused on the protection of terrestrial vertebrate communities (the only ecological resources capable of visiting multiple AOCs). Thus, the representative ecological receptors selected for the overall J-Field site (Table 3.29) are wide-ranging receptors that could visit more than a single AOC. However, the marsh and pond habitats at the TBP AOC are probably the most suitable habitat for this species, and on this basis the great blue heron is not a good sitewide receptor. For example, the great blue heron has a very large foraging range (≥ 500 ha) that, if centered on the TBP AOC, would include all of J-Field.

TABLE 3.29 Sitewide Assessment Endpoint and Representative Ecological Receptors for J-Field

Assessment Endpoint and Representative Receptor	Habitat Type	Exposure Point Media	Occurrence at J-Field ^a
<i>Protection of Terrestrial Vertebrate Communities from Ecological Changes Related to Contaminant Exposure</i>			
Tree swallow	Grasslands with wooded edges or nearby woodlots	Soil and surface water	TBP, WPP, PB, RPDG
American kestrel	Semi-open grasslands	Soil and surface water	TBP, WPP, PB, RPDG
Red-tailed hawk	Wetlands, grasslands, and forests	Soil and surface water	TBP, WPP, PB, RPDG
White-tailed deer	Old fields, grasslands, and forests	Soil and surface water	All AOCs
Red fox	Wetlands, grasslands, and forests	Soil and surface water	All AOCs

^a Occurrence is based on the typical size of the home range or foraging area of the receptor species and the presence of appropriate habitat at each AOC.

4 ECOLOGICAL EFFECTS OF CONTAMINATION

The ecological effect of a chemical contaminant depends on many factors, such as the contaminant's bioavailability, its concentration in the environment and/or receptor organism, synergistic interactions among contaminants, the duration and frequency of receptor biota exposure to that contaminant, the species of the receptor, the metabolic rate of the species, and the characteristics of the metabolic processes of the species (EPA 1988). Contaminants in the environment can affect receptor biota and ecosystems in both lethal and sublethal ways, such as the following:

- Altered developmental rates, metabolic and physiologic processes and functions, or behavior;
- Increased susceptibility to disease, parasitism, or predation;
- Disrupted reproductive functions; and
- Mutations or other reduction in the viability of offspring (EPA 1989a).

When the potential effects of an environmental contaminant on biotic receptors are being evaluated, the toxicity of the contaminant must be determined. The determination should be based on field data, monitoring data, and the results of toxicity testing of contaminated media (EPA 1989a).

The following sections summarize toxicology information from the scientific literature for the PCOECs at the J-Field site. The summaries present information on contaminant toxicity; likely mechanisms of toxicity; and potential effects on receptor biota, populations, and ecosystems.

4.1 METALS

4.1.1 Aluminum

Aluminum is widely found in nature and has been reported to produce a variety of adverse effects on vegetation, fish, and wildlife. In terrestrial plants, aluminum ions in soils damaged fine root filaments and reduced water and nutrient uptake (Miller 1988). Mackay et al. (1990) reported a significant reduction in the establishment of white clover cultivar seedlings in soils at aluminum concentrations of 50 mg/kg soil or more, and a severe reduction in shoot growth at a concentration of 150 mg/kg soil. High leaf levels of aluminum (up to 317 mg/kg) associated with aluminum sulfate

fertilization may cause poor growth in blueberries (Peterson et al. 1987). Adverse synergistic effects between aluminum and other metals have resulted in nutrient deficiencies and decreased growth (e.g., Hecht-Buchholz et al. 1987; Korcak 1988).

In aquatic systems, aluminum can be highly toxic to fishes (Baker and Schofield 1982; Neville 1985) and amphibians (Clark and LaZerte 1985). Ingersoll et al. (1990a,b) reported reduced survival and egg hatchability in fish at water concentrations of $<300 \mu\text{g/L}$ and reduced weight with exposure to concentrations of $>34 \mu\text{g/L}$. Under various pH regimes, *Rana pipiens* tadpoles experienced 100% mortality following exposure to aluminum concentrations of 250-1,000 $\mu\text{g/L}$ (Freda and MacDonald 1989).

4.1.2 Arsenic

Background concentrations of arsenic are generally $<10 \mu\text{g/L}$ in surface water and $<15 \text{ mg/kg}$ in soil; uncontaminated soils in the United States have a mean arsenic concentration of 7.4 mg/kg soil (Eisler 1988a). Commercial use and production of arsenic compounds, such as agricultural insecticides and herbicides, have raised local concentrations above natural background concentrations in some areas. In the United States, arsenic levels $>240,000 \mu\text{g/L}$ in surface water and $2.5 \times 10^6 \text{ mg/kg}$ soil (DW) in arsenic-pesticide-treated soils have been reported (Eisler 1988a). At APG, regional background concentrations range up to $10.3 \mu\text{g/L}$ in surface water and from 249 to $3,740 \mu\text{g/kg}$ in soil (ICF Kaiser Engineers 1995). Arsenic concentrations of up to $3,500 \text{ mg/kg}$ sediment (DW) in contaminated areas (Eisler 1988a), up to 30 mg/kg sediment in Lake Michigan (Eisler 1988a), and $47\text{-}209 \mu\text{g/g}$ sediment in Lake Texoma (Hunter et al. 1981) have been reported. Regional sediment concentrations near APG range from 239 to $19,400 \mu\text{g/kg}$ (ICF Kaiser Engineers 1995).

Arsenic toxicity depends strongly on its chemical form and oxidation state. In general, inorganic arsenic compounds are more toxic than organic compounds, and trivalent forms are the most toxic (Eisler 1988a). Biota may take up arsenic via ingestion, inhalation, or absorption through body surfaces, and cells take up arsenic via the active transport system normally used in phosphate transport (Eisler 1988a).

Adverse effects on crops and vegetation, such as poor growth, seedling death, defoliation, and inhibition of photosynthesis, have been reported at concentrations of 1-25 mg water soluble arsenic/kg soil (equivalent to approximately 25-85 mg total arsenic/kg soil) (Eisler 1988a). Data on effects of arsenic on soil biota and insects are limited. Tolerant soil microbiota can withstand arsenic concentrations as high as $1,600 \text{ mg/kg}$ soil (NAS 1977). In contrast, reduced growth and metabolism in sensitive species have been reported at arsenic concentrations of 375 mg/kg soil (NAS 1977), and soils with arsenic levels of $150\text{-}165 \text{ mg/kg}$ soil lost their earthworm biota and showed reduced quantities of microfauna (Eisler 1988a).

Mammals and birds are exposed to arsenic primarily by ingestion of contaminated vegetation and water. Arsenic is bioconcentrated by organisms but is not biomagnified in the food chain (Eisler 1988a). In birds, arsenic poisoning produces many effects, including loss of muscular coordination, slowness, loss of righting reflex, seizures, and death. Single oral doses producing 50% fatality in sensitive species (such as the turkey) range from 17 to 33 mg/kg body weight. In mammals, arsenic toxicosis can produce trembling, extreme weakness, vomiting, and death (Eisler 1988a). Because arsenic detoxification and excretion are rapid, poisoning is generally caused by acute or subacute exposures. Single doses reported to produce 50% fatality in sensitive mammal species ranged in concentration from 2.5 to 33.0 mg/kg body weight. Susceptible species have been adversely affected at chronic arsenic doses of 1 to 10 mg/kg body weight or 50 mg/kg diet (Eisler 1988a).

Adverse effects on aquatic biota have been reported at concentrations of 19-85 $\mu\text{g/L}$ (Eisler 1988a). Fish exposed to 1-2 mg/L total arsenic for 2-3 days exhibited gill hemorrhages; fatty infiltration of the liver; and necroses of the heart, liver, and ovarian tissues. Developing toad embryos exhibited increased malformity or mortality following a 7-day exposure to 40 μg trivalent arsenic/L, and concentrations of 48 μg pentavalent arsenic/L significantly reduced growth in freshwater algae (EPA 1986). Many organisms accumulate arsenic from water, but there is little evidence of magnification through aquatic food chains (NAS 1977; Eisler 1988a). The AWQC for trivalent arsenic for the protection of aquatic life are 360 and 190 $\mu\text{g/L}$ for acute and chronic exposure, respectively (EPA 1986). Although no criteria for the protection of aquatic life have been developed for pentavalent arsenic because of insufficient data, the lowest-observed-effect levels for freshwater acute and chronic exposure are 850 and 48 $\mu\text{g/L}$.

4.1.3 Barium

Soil barium concentrations in the United States range from 15 to 5,000 mg/kg soil (Peterson and Girling 1981). Sheppard and Evenden (1990) reported a mean barium concentration of 630 $\mu\text{g/g}$ for soils from 64 sites throughout Canada. At APG, regional soil concentrations range from 9,830 to 202,000 $\mu\text{g/kg}$. Plants can bioaccumulate barium and have been reported to contain 4-40 mg/kg plant material (DW). Little information is available to indicate that barium is toxic to plants, and no information was found in the literature regarding adverse effects of barium on terrestrial wildlife.

Barium concentrations in American drinking water range from 0.6 to 10 $\mu\text{g/L}$; upper limits in some midwestern and western states range from 100 to 3,000 $\mu\text{g/L}$ (EPA 1986). The human health AWQC for barium is 1,000 $\mu\text{g/L}$. Experimental data indicate that soluble barium concentrations in freshwater would have to exceed 50,000 $\mu\text{g/L}$ before toxicity to aquatic biota would be expected (EPA 1986). Barium ions rapidly precipitate as barium sulfate or barium carbonate, which are highly insoluble and nontoxic. Soluble barium is also removed from solution by sedimentation and adsorption by clays, hydroxides, and organic matter. Because of the general absence of toxic soluble

forms of barium in freshwater systems, AWQC for barium for the protection of aquatic life are considered unnecessary (EPA 1986).

4.1.4 Cadmium

Soil pH, organic matter, and hydrous oxides strongly influence cadmium adsorption and its bioavailability; in general, adsorption increases with increasing soil pH (Page et al. 1981; Xian and Shokohifard 1989). Typical soil concentrations range from 0.5 to 1.0 $\mu\text{g/g}$, although concentrations of up to 30 $\mu\text{g/g}$ have been reported for unpolluted shale-derived soils in California (Page et al. 1981). For APG, regional soil concentrations range from 0.57 to 1.4 $\mu\text{g/g}$ (ICF Kaiser Engineers 1995). In freshwater systems, cadmium availability is strongly controlled by the adsorption and desorption process, pH, and Eh. Background cadmium concentrations in uncontaminated waters have been reported as 0.05-0.02 $\mu\text{g/L}$ (Eisler 1985b). Regional surface water concentrations near APG range from 0.5 to 5.0 $\mu\text{g/L}$ (ICF Kaiser Engineers 1995).

Plants readily take up cadmium from the soil (Fassett 1980; Eisler 1985b). The soil concentration of cadmium that will adversely affect plants depends strongly on the species. For example, cadmium concentrations of 4-640 $\mu\text{g/g}$ soil reduced yield by 25% among 15 crop species (Page et al. 1981).

Birds and mammals are comparatively resistant to the biocidal properties of cadmium. For example, adult drake mallards fed up to 200 mg/kg body weight showed no ill effects; the lowest oral doses producing death in rats and guinea pigs ranged from 150 to 250 mg/kg body weight (Eisler 1985b). Sublethal effects of cadmium exposure in birds include growth retardation, anemia, and testicular damage (Eisler 1985b). Dietary concentrations of 4-20 mg/kg body weight resulted in altered blood chemistry, mild to severe kidney lesions, and hyperresponsiveness in ducks (Cain et al. 1983; Heinz and Haseltine 1983). In small laboratory mammals, dietary cadmium concentrations of 1.8 mg/kg body weight depressed hematocrit and hemoglobin values; altered other blood chemistry factors; and produced teratogenic, mutagenic, and carcinogenic effects (Eisler 1985b). Among mammals, evidence suggests cadmium may bioaccumulate at higher trophic levels (Eisler 1985b; Scanlon 1987).

In freshwater biota, ambient cadmium concentrations of $>10 \mu\text{g/L}$ are associated with high mortality, reduced growth, inhibited reproduction, and other adverse effects (Eisler 1985b); concentrations of 0.8-9.9 $\mu\text{g/L}$ produced significant mortality in several species of invertebrates and fishes. Freshwater organisms bioaccumulate cadmium to a greater extent than does terrestrial wildlife. Bioconcentration factors in freshwaters range from 164 to 4,190 for algae and invertebrates and from 3 to 7,440 for fishes (Eisler 1985b; EPA 1986). The AWQC for cadmium for the protection of aquatic life are 3.9 and 1.1 $\mu\text{g/L}$ (at a hardness of 200) for acute and chronic exposure, respectively (EPA 1986).

4.1.5 Chromium

Chromium concentrations range from 5 to 300 mg/kg in soils and 1 to 10 µg/L in uncontaminated rivers and lakes (Eisler 1986b). Sheppard and Evenden (1990) reported a mean chromium concentration of 38 µg/g for soil collected from 64 sites throughout Canada, and the World Health Organization (WHO 1988) reported an average concentration of 53 mg/kg for 863 samples collected in the United States. Regional concentrations of chromium in soils near APG range from 5.3 to 70.8 mg/kg; regional surface water concentrations range from 5 to 31.4 µg/L (ICF Kaiser Engineers 1995). Chromium is most frequently encountered in the trivalent (III) or hexavalent (VI) oxidation states; the hexavalent form is more toxic because it has a higher oxidation potential and can easily penetrate biological membranes (Eisler 1986b).

A variety of plants take up and accumulate chromium. Adverse effects include decreased growth and leaf necrosis (Peterson and Girling 1981). Treatment of plants with nutrient solutions containing chromium (VI) concentrations of 5 mg/L or less resulted in decreased chlorophyll concentration, inhibition of seed germination and growth, and decreased root uptake of nutrients (WHO 1988). The high chromium concentrations reported in many plants may represent a significant pathway of chromium transport to herbivorous biota. Adverse effects of chromium on sensitive wildlife species have been reported at concentrations of 5.1 and 10.0 mg/kg of diet for chromium (VI) and chromium (III), respectively (Eisler 1986b). Documented effects in birds include limb deformities, everted viscera, and stunting. In mammals, chromium exposure has resulted in altered blood chemistry, skin ulcerations, bronchial carcinomas, kidney and liver lesions, and teratogenic effects (Eisler 1986b).

In aquatic systems, exposure to 10 µg/L of chromium (VI) inhibited growth in algae; frond growth in common duckweed; and survival and fecundity in *Daphnia* (Eisler 1986b). For chromium (VI), acute toxicity values range from 23.07 µg/L for a cladoceran to 1,870,000 µg/L for a stonefly; chronic values range from <2.5 µg/L for a daphnid to 1,987 µg/L for fathead minnows (EPA 1986). Acute values for chromium (III) range from 2,221 µg/L for a mayfly to 71,060 µg/L for a caddisfly; chronic values range from 66 µg/L for *Daphnia* to 1,025 µg/L for fathead minnows (EPA 1986). For fish, chromium (VI) concentrations of 16-21 µg/L resulted in reduced growth; altered plasma cortisol metabolism; altered enzyme activities; chromosomal aberrations; and morphological changes in gill, stomach, and kidney tissues. The AWQC for chromium (VI) for the protection of freshwater biota are 16 and 11 µg/L for acute and chronic exposure, respectively (EPA 1986). The AWQC for chromium (III) is hardness dependent. At a hardness of 200, the AWQC are 3,100 and 370 µg/L for acute and chronic exposure, respectively.

4.1.6 Cobalt

Total cobalt soil concentrations typically range from 1 to 100 mg/kg soil (Peterson and Girling 1981); Sheppard and Evenden (1990) reported a mean concentration of 11 µg/g for Canadian soils. Regional soil concentrations at APG range from 1.1 to 25.6 mg/kg (ICF Kaiser Engineers 1995). Many plant species take up cobalt; the swamp black gum was reported to bioaccumulate up to 845 mg/kg plant (DW). Reported plant-soil concentration ratios range from 0.27 to 0.87 (Peterson and Girling 1981). The effects of cobalt on plants depend on the species. For example, cobalt-accumulating plants with tissue concentrations up to 3,300 mg/kg (ash weight) showed no signs of cobalt toxicity, although cobalt-sensitive plants with leaf-tissue cobalt concentrations of only 11 mg/kg exhibited marked growth depression and chlorosis (Peterson and Girling 1981). No information was found in the literature regarding adverse effects of cobalt on aquatic biota or terrestrial wildlife.

4.1.7 Copper

Copper causes lethal and sublethal effects in aquatic systems, including reduced primary productivity and decreased growth, increased mortality, inhibited spawning, and altered foraging behavior in fish (Benoit 1975; Harrison 1986; Sandheinrich and Atchison 1989). Copper toxicity in aquatic systems decreases with increased hardness, alkalinity, and total organic carbon (EPA 1986). At a hardness of 50, acute values for 41 genera of freshwater organisms ranged from 16.74 µg/L for *Ptychocheilus* to 10,240 µg/L for the stonefly *Acroneuria*. Chronic toxicity values at a hardness of 50 for 15 freshwater species ranged from 3.873 µg/L for brook trout to 60.36 µg/L for northern pike (EPA 1986). The AWQC for copper are hardness dependent. At a hardness of 200, the AWQC for copper for the protection of aquatic biota are 34 and 21.4 µg/L for acute and chronic exposures, respectively (EPA 1986).

Soil copper concentrations range from 9.3 to 159.4 µg/g soil (average 38.3 µg/g) in forests of the northeastern United States (Herrick and Friedland 1990) and from 29.2 to 129.8 µg/g soil in an urban forest in southwestern Ohio (Tong and Farrell 1991). Sheppard and Evenden (1990) reported a mean soil copper concentration of 14 µg/g soil at 64 sites throughout Canada. At APG, regional soil concentrations range from 3.0 to 33.2 µg/g (ICF Kaiser Engineers 1995). In terrestrial systems, soil copper concentrations of <500 mg/kg induce a wide range of adverse impacts, such as reduced microbial and fungal abundance and biomass, and decreased species diversity, density, and biomass in invertebrates. Soil concentrations of 50 to 100 µg/g have been reported to be toxic to nontolerant plants (Tyler et al. 1989).

4.1.8 Iron

Iron is an essential trace element for plant and wildlife (EPA 1986). In surface and marine water, iron precipitates have smothered bottom-dwelling organisms and fish eggs, coated fish gills, and inhibited oxygen uptake (EPA 1976). Iron concentrations of 900-1,000 $\mu\text{g/L}$ have been reported to be toxic to carp (*Cyprinus carpio*) and resulted in the elimination of trout from a Colorado mountain stream.

In birds, dietary iron concentrations up to 440 ppm caused no adverse effects in turkeys (NAS 1980). In livestock, toxic iron concentrations interfere with phosphorus metabolism (EPA 1976), and dietary concentrations of 1,677 $\mu\text{g/g}$ significantly reduced growth rates (EPA 1985). Dietary doses of 200 mg ferric chloride/kg resulted in 50% mortality in mice, and rabbits experienced hepatic congestion and death within 24-48 hours at a dose of 750 mg ferrous sulfate/kg body weight (NAS 1980).

Little information was found on the effects of iron on terrestrial plants. Iron is considered an essential plant nutrient (Devlin 1975). Iron availability to plants is controlled by soil pH. Iron dissolves in soil solution and becomes available to plants in acidic soils. In neutral or alkaline soils, iron is less soluble and less available. Precipitated iron can complex with phosphorus and molybdenum and make these nutrients less available for plant uptake (USATHAMA 1991).

4.1.9 Lead

Lead concentrations have been reported as 26 $\mu\text{g/g}$ of soil at 64 sites through Canada (Sheppard and Evenden 1990), 69.4-180.8 $\mu\text{g/g}$ of soil (average 115.3 $\mu\text{g/g}$) in montane forests of the northeastern United States (Herrick and Friedland 1990), and 160.7-196.3 $\mu\text{g/g}$ of soil (average 178.5 $\mu\text{g/g}$) among urban maple and maple-pine forest sites in southeastern Ohio (Tong and Farrell 1991). Regional soil concentrations for APG range from 3,190 to 23,500 $\mu\text{g/g}$ (ICF Kaiser Engineers 1995). In the United States, lead concentrations are generally <2 $\mu\text{g/L}$ in lakes, but the average lead concentration in major rivers has been reported as 23 $\mu\text{g/L}$ (Biddinger and Gloss 1984). Regional surface water concentrations for APG range from 1.5 to 56.1 $\mu\text{g/L}$ (ICF Kaiser Engineers 1995).

Plants readily take up lead (under certain soil conditions such as low pH and low organic matter levels) via absorption in ionic solution through the roots. Lead can also enter plants across vegetative surfaces following aerosol deposition; little translocation occurs after uptake (Koeppel 1981; Eisler 1988b; Xian and Shokohifard 1989). Elevated lead levels generally cause negligible damage to plants, depending on species. Very high concentrations (several hundred milligrams per kilogram or more), however, have inhibited growth and reduced photosynthesis, water absorption, and mitosis (Demayo et al. 1982). Elevated levels of particulate lead may occur on plant surfaces as a result of aerosol deposition. This topical lead coating typically does not affect the plant but may

represent a significant route of lead entry into higher trophic levels via food chain transfer to herbivores (Koeppel 1981; Eisler 1988b).

Soil invertebrate communities exposed to soil lead levels as low as 34 mg/kg soil exhibited a significant decrease in species diversity, while exposure to lead soil levels of 34-4,800 mg/kg soil significantly altered biomass, density, species number, and vertical distributions in individual soil groups, such as earthworms, ants, and spiders (Tyler et al. 1989). Terrestrial invertebrates take up and accumulate lead, and some taxa (e.g., woodlice and spiders) have been proposed for use as environmental monitors of lead concentrations in soil and litter.

Elevated levels of lead (up to 270 mg/kg body [DW]) have been reported in amphibians and reptiles collected near lead mines and smelters. Lead in tadpoles may contribute to the lead levels observed in wildlife that prey on tadpoles (Eisler 1988b). Lead poisoning in frogs may result in sloughing of the integument; sluggishness; decreases in red and white blood cells, neutrophils, and monocytes; and death. Death has been reported in frogs at lead concentrations of 25 mg/L and in salamanders at 1.4 mg/L (Eisler 1988b).

Lead concentrations in birds tend to be highest in specimens collected from urban areas and near lead mining and smelting facilities (Eisler 1988b). Lead poisoning in birds has been extensively documented. Its effects include loss of appetite; impaired locomotion, balance, and depth perception; microscopic lesions in brain, kidney, muscle, and bone tissues; and altered blood composition and chemistry and immune system (Eisler 1988b). Birds of prey may be exposed to lead by feeding on dead or dying game animals that contain lead shot or by consuming prey (such as waterfowl and small mammals) that contain high levels of biologically incorporated lead (Eisler 1988b). Ingestion of lead-contaminated prey may represent a significant source of mortality in golden and bald eagles (Frenzel and Anthony 1989; Craig 1990).

The highest body burdens of lead in mammals have been reported for specimens collected from urban areas and near lead mining and smelting facilities (Eisler 1988b). The lead exposure route for mammals is via diet; species high on the food chain are apparently more susceptible to lead contamination (Scanlon 1987; Eisler 1988b). Reported effects of lead poisoning in mammals include altered structure and function in kidneys, bone, and the hematopoietic and central nervous systems, as well as biochemical, histopathological, teratogenic, and reproductive effects. The effects are species specific; younger developmental stages are the most sensitive; and organolead compounds are more toxic than inorganic ones (Eisler 1988b). Little is known about the toxic and sublethal effects of lead on mammalian wildlife. In laboratory and domestic mammals, adverse effects have been observed with lead doses ranging from 0.05 mg lead/kg body weight (mice) to 5 mg lead/kg body weight (rats and dogs) (Eisler 1988b).

Lead is toxic to all phyla of aquatic organisms. Its effects are determined by species and physical and chemical factors. Dissolved waterborne lead is more toxic than total lead; organic lead

forms are more toxic than inorganic ones; toxicity decreases with increasing hardness; and toxic effects generally increase under conditions of rapid growth (EPA 1986; Eisler 1988b). Although lead is concentrated by aquatic biota, little evidence of biomagnification exists (Demayo et al. 1982; Eisler 1988b). In fishes, toxic and sublethal effects of lead include increased mucus production, which interferes with the respiratory and ion-exchange functions of gills; spinal curvature; anemia; destruction of spinal neurons; reduced swimming ability; growth inhibition; altered blood chemistry; and death (Holcombe et al. 1976; Demayo et al. 1982; Eisler 1988b).

Reduced survival, impaired reproduction, and reduced growth have been reported in aquatic organisms at lead concentrations of 1.0-5.1 $\mu\text{g/L}$ (Eisler 1988b); lead concentrations of $>10 \mu\text{g/L}$ are expected to cause increasingly severe long-term effects on aquatic biota (Demayo et al. 1982). At a hardness level of 200, the AWQC for lead for the protection of freshwater life are 200 and 7.7 $\mu\text{g/L}$ for acute and chronic exposure, respectively (EPA 1986).

4.1.10 Magnesium

No wildlife toxicity data were found for magnesium. Sax and Lewis (1989) reported an oral LD_{50} ¹ of 230 mg/kg body weight for dogs.

4.1.11 Manganese

Manganese is an abundant element present in soils at an average concentration of 600 mg/kg soil; Sheppard and Evenden (1990) reported an average manganese concentration of 400 $\mu\text{g/g}$ among 64 Canadian locations, and Neilsen et al. (1990) reported mean total manganese soil concentrations of 514-1,230 mg/kg among 34 British Columbia orchards. Regional soil concentrations for APG range from 4.9 to 1,140 mg/kg (ICF Kaiser Engineers 1995).

Manganese is an important plant nutrient. Although algae have been reported to concentrate manganese some 60,000 times, plants typically have levels similar to or less than those in the soil. Limited information was found regarding adverse effects of manganese on plants. Reported effects of manganese toxicity include internal bark necrosis; discoloration of the stem, petioles, and leaflets; increased stem length; fewer roots; and lower fresh weight yields (Marsh and Peterson 1990; Neilsen et al. 1990). Reported toxic leaf manganese concentrations range from $>60 \mu\text{g/g}$ ash DW (Neilsen et al. 1990) to 5,000 $\mu\text{g/g}$ DW (Marsh and Peterson 1990).

No data were found for manganese toxicity in wildlife. In domestic and laboratory animals, high levels of manganese interfered with iron metabolism and hemoglobin regeneration and

¹ LD_{50} = dose that is lethal to 50% of the exposed test population.

produced neurotoxic effects (Mena 1980). Toxicity data for freshwater biota show tolerance values ranging from 1.5 to >1,000 mg/L (EPA 1986). Because manganese ions are rarely present at levels above 1 mg/L, manganese is not considered a problem in freshwater systems, and no AWQC have been developed for the protection of freshwater aquatic life.

4.1.12 Mercury

Mercury and its compounds have no known normal biological function, and the presence of mercury in living cells is undesirable and potentially hazardous (NAS 1978). Mercury exists in three oxidation states: elemental mercury, mercurous ion (Hg_2^{+2}), and mercuric ion (Hg^{+2}). All mercury compounds interfere with thiol metabolism. Chemical speciation is probably the most important factor affecting the ecotoxicology of mercury (Boudou and Ribeyre 1983).

In general, organic forms of mercury are more readily absorbed than inorganic forms. Organic mercury compounds are also more soluble in organic solvents and lipids, pass more readily through biological membranes, and are slower to be excreted (Eisler 1987a). In aquatic systems, low-toxicity forms of mercury may become methylated by biological or chemical processes. Methylmercury is the most hazardous mercury species owing to its high stability, high lipid solubility, and high ability to penetrate biological membranes (Eisler 1987a; Hobson 1988).

Total mercury concentrations range from about 0.001 to 0.05 $\mu\text{g/L}$ in uncontaminated natural waters and are typically <1.0 mg/kg in uncontaminated sediments (Eisler 1987a). For APG, regional concentrations are <0.2 $\mu\text{g/L}$ in surface water and 0.12-0.48 mg/kg in sediments (ICF Kaiser Engineers 1995). In aquatic systems, sediments act as mercury sinks, while methylation tends to release mercury from sediments into the ecosystem (Hobson 1988). Mercury levels are usually <1 mg/kg (fresh weight) in biota from uncontaminated areas and >1 mg/kg in biota from areas that have received mercury from anthropogenic sources. Mercury can bioconcentrate in biota and biomagnify through food chains (Eisler 1987a).

Early developmental stages are most sensitive to the effects of mercury, and organomercury compounds are more toxic than inorganic forms. In addition to its lethal effects, mercury is a mutagen, teratogen, and carcinogen. Lethal concentrations of total mercury range from 0.1 to 200 $\mu\text{g/L}$ in aquatic biota; 2.2 to 31 mg/kg body weight (acute oral dose) and 4.0 to 40 mg/kg (dietary) for birds; and 0.1 to 0.5 mg/kg body weight (daily dose) and 1.0 to 5.0 mg/kg (dietary) for mammals (Eisler 1987a). Sublethal effects of mercury have been observed at concentrations of 0.03 to 0.1 $\mu\text{g/L}$ for aquatic species, 604 $\mu\text{g/kg}$ body weight (daily dose) and 50 to 500 $\mu\text{g/kg}$ (dietary) for birds, and 250 $\mu\text{g/kg}$ body weight (daily dose) and 1,100 $\mu\text{g/kg}$ (dietary) for mammals (Eisler 1987a).

No information was found regarding the effects of mercury on terrestrial vegetation. Mercury poisoning in fish can result in increased respiratory movements, loss of equilibrium, emaciation, brain lesions, inability to capture food, abnormal motor coordination, and death. Sublethal effects can include inhibited reproduction; reduced growth; and altered behavior, metabolism, blood chemistry, and osmoregulation (Eisler 1987a). The AWQC for mercury for the protection of freshwater biota are 2.4 and 0.012 $\mu\text{g/L}$ for acute and chronic exposure, respectively. However, the AWQC of 2.4 $\mu\text{g/L}$ for acute exposure is above the mercury concentration of 0.03-0.1 $\mu\text{g/L}$ reported to produce sublethal effects and also above the lower limit (0.1 $\mu\text{g/L}$) reported to be fatal to sensitive aquatic biota. On the basis of these data, the U.S. Fish and Wildlife Service considers the acute mercury AWQC to provide no significant protection for freshwater aquatic biota (Eisler 1987a).

Mercury poisoning produces muscular incoordination, falling, slowness, and death in birds. Sublethal effects in birds include decreased growth, developmental abnormalities, inhibited reproduction, altered blood chemistry and composition, altered metabolism, and behavioral modifications (Eisler 1987a). Mercury bioaccumulation and biomagnification has been observed in birds, and young are more sensitive than older individuals. In mammals, methylmercury affects the central nervous system and the kidneys. Toxic effects include convulsions, widespread brain damage, kidney damage, and increased stillbirths. Sublethal effects include reduced fertility, increased anomalous fetuses, behavioral changes, visual disturbances, tremors, and motor incoordination (Eisler 1987a).

4.1.13 Nickel

Nickel concentrations in soils range from 5 to 500 mg/kg, with an average of about 100 mg/kg (Hutchinson 1981). Reported nickel concentrations in surface waters from the major U.S. river and lake basins range from 3 $\mu\text{g/L}$ in the western gulf to 56 $\mu\text{g/L}$ in Lake Erie (Snodgrass 1980). For APG, regional concentrations range from 1.7 to 24.3 mg/kg in soil and 10 to 72.9 $\mu\text{g/L}$ in surface water (ICF Kaiser Engineers 1995).

Nickel concentrations in plants grown in uncontaminated soils are typically <10 mg/kg. The bioavailability and uptake of nickel by plants depend on the soil type and plant species (Hutchinson 1981). Plants collected near nickel smelters had nickel concentrations ranging from 2 to 40 mg/kg DW (Hutchinson 1981), while concentrations ranged from 0.2 to 4.5 $\mu\text{g/g}$ for nearly 2,000 specimens of field crops and natural vegetation in the United States (Brooks 1980). The effects of nickel toxicity in plants include induced iron-deficiency chlorosis, foliar necrosis, stunted root and shoot growth, deformation, leaf and stem spotting, abnormal starch accumulation, and accumulation of apolar soluble phenolics (Hutchinson 1981).

Nickel accumulation has been reported for only a few wildlife species. Nickel concentrations were <3.67 $\mu\text{g/g}$ (wet weight) in liver, heart, and kidney tissues collected from

white-tailed deer, gray and red squirrels, and cottontail rabbit (Jenkins 1980). Scanlon (1989) measured heavy-metal concentrations in several species of small mammals living in roadside environments and reported average body burdens of nickel ranging from 0.23 $\mu\text{g/g}$ (DW) in the house mouse to 4.19 $\mu\text{g/g}$ in the masked shrew. Scanlon (1989) suggested that small mammals at higher trophic levels are more vulnerable to heavy-metal contamination. Reported nickel levels in kidney tissues collected from the ruffed grouse and the American robin were 4.96 and 1.66 $\mu\text{g/g}$ (wet weight), respectively (Jenkins 1980).

No information was found regarding nickel toxicity in wildlife. In laboratory animals, reported effects of nickel include inhibition of enzyme systems, elevated ATPase levels, inhibition of RNA synthesis, significant increases in serum glucose, loss of ATPase activity in brain capillaries, interference with spermatogenesis, reduced litter size, and enhanced neonatal mortality (Mushak 1980). Oral intake of nickel is associated with the lowest level of toxicological response; dogs and cats that received daily oral doses of 12 mg/kg for more than 6 months exhibited no adverse effects (Mushak 1980).

In freshwater systems, nickel toxicity decreases with increasing hardness (EPA 1986). Nickel results in a variety of adverse effects in freshwater biota. Adverse effects on algae exposed to nickel concentrations of 1.0–45 mg/L included reduced growth, inhibition of flagellar movement, decreased capacity for phototaxis and geotaxis, and changes in community structure and species diversity (Spencer 1980). In aquatic invertebrates, nickel adversely affected locomotion, reproduction, development, and growth. In fish, exposure to nickel reduced fecundity and egg hatchability, increased embryo and larvae mortality, and increased incidence of abnormal larvae (Birge and Black 1980).

Acute toxicity values for 21 freshwater species ranged from 1,101 $\mu\text{g/L}$ for a cladoceran to 43,240 $\mu\text{g/L}$ for fish. Chronic toxicity values for two invertebrates and two fish in freshwaters ranged from 14.77 $\mu\text{g/L}$ for *Daphnia magna* in soft water to 526.7 $\mu\text{g/L}$ for the fathead minnow in hard water (EPA 1986). Reported bioconcentration factors range from 0.8 for fish to 193 for a cladoceran. The AWQC for nickel for the protection of freshwater biota are 2,500 and 280 $\mu\text{g/L}$ (hardness of 200) for acute and chronic exposure, respectively (EPA 1986).

4.1.14 Silver

Concentrations of silver in soils are typically <1 mg/kg, with normal ranges from <0.01 to 5 mg/kg; freshwater silver concentrations average 0.2 $\mu\text{g/L}$ (Peterson and Girling 1981). At APG, regional concentrations range from 0.57 to 0.71 mg/kg for soils and 0.3 to 5.0 $\mu\text{g/L}$ for surface water (ICF Kaiser Engineers 1995). Silver concentrations in fruits and vegetables range from 0.02 to 0.1 mg/kg (DW), with higher levels in fruits, nuts, and seeds than in vegetative portions of plants.

Silver is one of the most toxic of the heavy metals, but because it is easily reduced and has a low solubility, it is not readily available to biota (Peterson and Girling 1981; Biddinger and Gloss 1984). The toxic actions of silver include enzyme inhibition, complexation with nitrogenous bases in DNA, inhibition of DNA synthesis and transcription, reduced yields in plants, and reduced germination of fungal spores. A tissue concentration of 180 mg/kg (DW) reduced root growth in maize and barley seedlings; significant reductions in shoot growth were evident at tissue concentrations >60 mg/kg (DW) (Peterson and Girling 1981).

No data were found regarding the effects of silver on wildlife. In aquatic systems, silver can bioaccumulate, but there is no evidence of biomagnification (Biddinger and Gloss 1984). The AWQC for the protection of freshwater biota for acute silver exposure are hardness dependent (EPA 1986). At a hardness of 200, the AWQC are 13 µg/L for acute exposure and 0.12 µg/L for chronic exposure (EPA 1986).

4.1.15 Zinc

Soil levels of zinc typically range from 10 to 300 mg/kg (Collins 1981); Sheppard and Evenden (1990) reported an average zinc concentration of 80 µg/g for 64 Canadian sites, and Herrick and Friedland (1990) reported zinc concentrations of 56.5-207.4 µg/g in montane forest soils of the northeastern United States. For APG, regional concentrations range from 4.89 to 242 mg/kg in soils and 5.0 to 180 µg/L in surface water (ICF Kaiser Engineers 1995).

In plants, zinc is actively taken up by the roots and can be translocated throughout the plant (Collins 1981). Zinc concentrations of 18 mg/L in soil moisture (as measured in lysimeter solutions) resulted in appreciable damage to coniferous forest understory plants. Nutrient concentrations of 0.02-0.1 mg/L caused cytological changes, reduced root elongation, and decreased growth in some plants (Tyler et al. 1989). The symptoms of zinc toxicity include retardation of growth and chlorosis of older leaves; zinc may also inhibit CO₂ fixation, inhibit photosynthesis and respiration, disrupt electron transport, and restrict phloem translocation (Collins 1981).

Zinc concentration of >170 mg/kg in soils reduced density, biomass, species diversity, and vertical distributions of soil invertebrates (Tyler et al. 1989). Zinc concentrations in small mammals living in roadside environments ranged from 50.94 to 146.18 µg/g, with higher levels found in species at higher trophic levels (Scanlon 1987).

In aquatic systems, zinc damages gill surfaces in fishes and invertebrates, affecting ion regulation and gas exchange (de March 1988). Zinc is bioaccumulated but does not appear to biomagnify in aquatic food chains (Biddinger and Gloss 1984). Acute toxicity in freshwater varies with hardness. At a hardness of 50, acute sensitivities for eight species ranged from 50.7 µg/L for *Ceriodaphnia reticulata* to 88,960 µg/L for a damselfly (EPA 1986). For invertebrates, chronic

toxicity values were 46.73 µg/L for *Daphnia magna* and >5,243 µg/L for a caddisfly. Among seven fish species, chronic toxicity values ranged from 36.41 µg/L for the flagfish to 854.7 µg/L for the brook trout (EPA 1986). Freshwater plants are more sensitive than are animals; a zinc concentration of 30 µg/L inhibited growth of the alga *Selenastrum capricornutum* (EPA 1986). In freshwater, zinc bioaccumulates in animal tissues 51-1,130 times the ambient water concentration. The AWQC for zinc for the protection of aquatic life are 210 and 190 µg/L for acute and chronic exposure, respectively (EPA 1986).

4.2 POLYCHLORINATED BIPHENYLS

The following discussion on the biological hazards of polychlorinated biphenyls (PCBs) is summarized from a review by Eisler (1986b). Polychlorinated biphenyls, a group of 209 synthetic halogenated aromatic hydrocarbons, elicit a variety of biological and toxic effects and tend to bioaccumulate in food chains. The toxicology of PCBs primarily depends on the partition coefficient based on solubility in N-octanol/water (K_{ow}) and steric properties resulting from different patterns of chlorine substitution. PCBs with high K_{ow} and high numbers of substituted chlorines in adjacent positions pose the greatest environmental concern.

Concentrations of PCB of <0.014 µg/L water pose little hazard to aquatic life, although some filter-feeding shellfish have been adversely affected by concentrations as low as 0.006 µg/L. Significant impacts on teleost fish were detected at total PCB concentrations of >500 µg/kg (wet weight) in diets, 400 µg/kg in total body, and 300 µg/kg in eggs. Concentrations at these levels and higher constitute "significant PCB contamination" (Eisler 1986b).

In Great Lakes lake trout, PCB concentrations increase with length of the food chain (Rasmussen et al. 1990). In lake trout and sunfish, PCB concentrations increase with tissue lipid content (Rasmussen et al. 1990; Southworth 1990). Rasmussen et al. (1990) showed a biomagnification factor of 3.5 with each higher trophic level. The PCB levels of Great Lakes lake trout declined with greater distance from urban-industrial centers, although even fish from remote lakes contained PCB levels >2 µg/g, which are higher than the guidelines for human consumption (Rasmussen et al. 1990).

The AWQC for PCBs for the protection of freshwater biota is 0.014 µg/L for chronic exposure (EPA 1986). However, the EPA states that this value is probably too high because it is based on bioconcentration factors derived in the laboratory, and field-derived bioconcentration factors are typically at least 10 times higher for fish. For acute exposure, the AWQC is 2.0 µg/L.

Of major concern are PCB concentrations in raptors, particularly threatened and endangered species feeding at the top of the food chain. Bald eagles, for example, feed extensively on fish, birds, and carrion, all of which could carry considerable PCB levels. Bald eagle eggs contained

4.2-15.6 mg/kg (wet weight) in the Atlantic region of North America and 17.3-20.4 mg/kg in Ontario (Noble and Elliot 1990). It is unknown at what levels mortality and reproductive effects might occur; however, reproductive problems in Forster's terns have been noted at PCB levels of >50 mg/kg (Noble and Elliot 1990). Peakall et al. (1990) estimated critical PCB levels of >300 mg/kg in brain tissue for mortality in peregrine falcons. For reproductive effects, the critical value is estimated to be >40 mg/kg in eggs.

Eisler (1986b) proposed that for most birds, concentrations of >3,000 µg/kg in diet, 16,000 µg/kg in eggs, and 54,000 µg/kg in brain tissue will be associated with PCB poisoning. He provides data for common birds (red-winged blackbirds, common grackles, and brown-headed cowbirds) that suggest an LC_{50}^2 of 54-301 mg/kg in brain tissue.

Very little information is available on toxic and sublethal effects of PCBs on vegetation (Eisler 1986b). Ostrich ferns growing on sediments with PCB levels of 26 mg/kg showed evidence of a fivefold increase in somatic mutations when compared with ferns from control areas.

4.3 POLYCYCLIC AROMATIC HYDROCARBONS

The following discussion summarizes a recent review of the effects of polycyclic aromatic hydrocarbons (PAHs) on fish, wildlife, and invertebrates published by the U.S. Fish and Wildlife Service (Eisler 1987b). PAHs are ubiquitous in the environment. PAH levels are typically elevated in nonbiological materials in industrial areas because of anthropogenic sources; human activities release approximately 43,000 metric tons of PAHs into the atmosphere and 230,000 metric tons into aquatic environments each year. Most PAHs released to the atmosphere eventually reach surface soils and waters by direct deposition.

Terrestrial vegetation and invertebrates can accumulate significant levels of PAHs. Plants can assimilate PAHs deposited on leaf surfaces as well as take up PAHs through the roots. Translocation of PAHs occurs, and concentrations are usually greater on plant surfaces than in internal tissues. Aboveground vegetation typically has higher PAH levels than do the roots. Reported plant PAH concentrations range from 20 to 1,000 µg/kg (fresh weight) in vegetation from nonpolluted areas, and up to 25,000 µg/kg (fresh weight) in polluted areas. Phytotoxic effects of PAHs are rare. The biomagnification potential of PAHs in vegetation in terrestrial and aquatic food chains has not been adequately investigated.

Concentrations of PAHs in fish do not appear to be elevated. Reported values range from 3 µg/kg (fresh weight) for fish muscle from specimens collected in Lake Ontario to >15,000 µg/kg (fresh weight) in fish muscle from specimens collected near a wastewater treatment plant in

² LC_{50} = concentration that is lethal to 50% of the exposed test population.

Michigan. In aquatic systems, the PAH toxicity generally increases with increased molecular weight and increased alkyl substitution on the aromatic ring. Toxicity is most pronounced among crustaceans and least pronounced among fish. Most aquatic organisms appear to bioconcentrate PAHs rapidly, and uptake is highly species-specific. Bioconcentration factors for whole organisms and tissues are affected by biotic and abiotic factors and range from 0.02 to >82,000. The many effects of PAHs on aquatic biota depend on the form of the PAH and the exposed taxon. Mutagenic, carcinogenic, and cytotoxic effects, as well as inhibited reproduction, inhibited respiration, and inhibited photosynthesis, have been reported among various biota.

Little information is available on the effects of PAHs on terrestrial wildlife, but significant concentrations that could cause adverse effects are unlikely. Reported LD₅₀ acute oral doses for laboratory rodents range from 50 to 2,000 mg/kg body weight. Adverse effects observed in laboratory mammals include carcinomas, testicular damage, oocyte and follicle destruction, and altered blood serum chemistry and nephrotoxicity.

4.4 NITROAROMATIC COMPOUNDS — 2,4-DINITROTOLUENE

Little information was found regarding the effects of 2,4-dinitrotoluene on vegetation and terrestrial wildlife. Dinitrotoluene is a carcinogen in rodents (Rosenblatt et al. 1991) and has caused neurological effects in dogs (Ellis et al. 1979). Other adverse effects reported for laboratory animals include testicular atrophy and decreased spermatogenesis. A no-observed-adverse-effects level (NOAEL) of 0.2 mg/kg/d has been reported for dogs (Ellis et al. 1979).

For *Daphnia magna*, 48-hour EC₅₀³ 2,4-dinitrotoluene concentrations ranged from 29.5 to 99.7 mg/L (mean 47.5) (Liu et al. 1983). For the fathead minnow, 96-hour LC₅₀ values ranged from 27 to 38 mg/L (mean 32.8) (Bailey and Spanggord 1983; Liu et al. 1983). The AWQC for dinitrotoluene for the protection of freshwater biota, based only on lowest-observed-effect-levels, are 330 and 230 µg/L for acute and chronic exposure, respectively (EPA 1986). Bioconcentration factors have been reported as 31.83 for both compounds (Liu et al. 1983).

4.5 ORGANOSULFUR COMPOUNDS

4.5.1 1,1-Oxathiane

No toxicity data were found in the literature for 1,1-oxathiane.

³ EC₅₀ = concentration at which effects are observed in 50% of the exposed test population.

4.5.2 1,4-Oxathiane

No ecological toxicity data were found in the literature for 1,4-oxathiane, which is moderately toxic by ingestion and mildly toxic by inhalation. It is also a skin and eye irritant. The oral LD₅₀ for rats is 2,830 mg/kg (Sax and Lewis 1989).

4.5.3 Dithiane

No toxicity data were found for dithiane.

4.6 VOLATILE ORGANIC COMPOUNDS

4.6.1 1,1,2,2-Tetrachloroethane

No wildlife toxicity data were found in the literature for 1,1,2,2-tetrachloroethane. In experimental animals, short-term inhalation or ingestion of 1,1,2,2-tetrachloroethane produced hepatic effects, including congestion, fatty degeneration, histological changes, alterations in levels of enzymes, and increased DNA synthesis. Rats ingesting subchronic concentrations of 100 mg/kg body weight/day or 3.2-50 mg/kg body weight/day had decreased body weight gain and histopathological damage in the liver, kidney, testicles, and thyroid glands. Mice exposed to time-weighted average daily doses of 142 or 284 mg/kg body weight/day of 1,1,2,2-tetrachloroethane in corn oil by gavage for 78 weeks had increased hepatocellular carcinomas. The compound 1,1,2,2-tetrachloroethane has bound to nucleic acids and proteins of several organs in rodents. At concentrations of 200 ppm for 6 hours, acute or short-term exposure to 1,1,2,2-tetrachloroethane has produced neurotoxic effects (Hughes et al. 1994a).

4.6.2 1,1-Dichloroethene

1,1-Dichloroethene, also called vinylidene chloride, does not accumulate much in fish or birds. Animals that breathed or ingested high levels of 1,1-dichloroethene suffered liver, kidney, and lung damage. Offspring of some animals that breathed high levels of 1,1-dichloroethene showed increased birth defects (ATSDR 1994a).

4.6.3 1,4-Dichlorobenzene

Plants and fish take up and retain 1,4-dichlorobenzene. Animals that breathed or ate 1,4-dichlorobenzene experienced adverse effects on the liver, kidneys, and blood. Very high amounts of 1,4-dichlorobenzene in water can cause liver and kidney tumors in animals (ATSDR 1993a).

4.6.4 2-Butanone

2-Butanone is not expected to concentrate in fish or increase in animal tissues higher in the food chain. It causes serious health effects in animals only at very high concentrations. Inhalation of high levels of 2-butanone can lead to birth defects, loss of consciousness, and death. In rats, ingestion of 2-butanone produced nervous system effects, including drooping eyelids and uncoordinated muscle movements; reproduction was unaffected. In mice, breathing low levels of 2-butanone for a short time produced temporary behavioral effects. In animals that drank low levels of 2-butanone for a short time, mild kidney damage was observed. No long-term studies have been conducted with animals breathing or drinking 2-butanone. (ATSDR 1992a).

4.6.5 2-Hexanone

Breathing toxic concentrations of 2-hexanone can adversely affect the nervous system and the reproductive system in animals. Pregnant rats that breathed 2-hexanone did not gain as much weight during pregnancy and had smaller, less active babies than did unexposed rats. Animals that ingested high levels of 2-hexanone also experienced adverse effects on reproduction and the nervous system, as well as decreased body weight (ATSDR 1992b). In water and soil, 2-hexanone does not attach to soil or sediments and can usually be broken down by microorganisms (ATSDR 1992b).

4.6.6 Acetone

Chronic exposure to acetone can cause liver and nerve damage, birth defects, and impaired reproduction (in males only) in animals. Acetone does not cause skin cancer when applied dermally. It is unknown whether ingesting or inhaling acetone can cause cancer (ATSDR 1994b).

4.6.7 Benzene

High levels (50,000 times the average levels) of benzene in the air can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Chronically breathing lower levels can damage blood cells and bone marrow, causing anemia, excessive

bleeding, or leukemia (ATSDR 1993b,c). Oral exposure to high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, coma, and death (ATSDR 1993b,c).

Benzene can produce hematological, neurological, and behavioral effects (Hughes et al. 1994b) and adversely affect genes and reproductive capability in animals (ATSDR 1993b,c). Rats exposed to benzene concentrations of 10 ppm (32 mg/m³) for 6 days developed immunological effects (Hughes et al. 1994b).

4.6.8 Carbon Disulfide

No ecological toxicity data were found for carbon disulfide. Carbon disulfide mainly affects the central nervous system. At acutely poisonous levels, carbon disulfide is a narcotic and anesthetic and leads to respiratory failure and death. Chronic doses damage the central and peripheral nervous system. Carbon disulfide also produces developmental and other reproductive effects. The lowest published toxic concentration for humans is 14 mg/kg body weight. In rabbits, 350 mg/kg body weight adversely affected reproduction (Sax and Lewis 1989).

4.6.9 Chloroethane

Chloroethane is mildly toxic by inhalation; irritates skin, eyes, and mucous membranes; and can cause narcosis. The lowest published lethal concentration by inhalation in guinea pigs was 40,000 ppm for 45 minutes (Sax and Lewis 1989).

4.6.10 Chloroform

Animal reproduction is impaired by 300 ppm chloroform. Male mice had abnormal sperm. Exposure of female rats and mice to chloroform during pregnancy resulted in aborted fetuses or increased birth defects (ATSDR 1993d). Chloroform is a carcinogen, neoplastigen, tumorigen, and teratogen in experimental animals. Prolonged inhalation causes paralysis, cardiac respiratory failure, and death. Prolonged, light chloroform anesthesia produces hepatitis in dogs. Prolonged chloroform anesthesia can also damage the heart and kidneys (Sax and Lewis 1989).

4.6.11 cis-1,2-Dichloroethene

Cis-1,2-dichloroethene is mildly toxic by ingestion and inhalation and is irritating and narcotic at high concentrations. Laboratory animals exposed to cis-1,2-dichloroethene had liver and

kidney damage. The lowest published lethal dose for mice inhaling cis-1,2-dichloroethene was 65,000 mg/m³ for 2 hours (Sax and Lewis 1989).

4.6.12 Hexachlorobenzene

In laboratory animals, adverse impacts of consuming hexachlorobenzene included effects on the liver, kidneys, ovaries, skin, and nervous system and decreased fetal weight. Chronic exposure to high doses produced cancer in laboratory animals (EPA 1990a). The offspring of mink exposed to dietary concentrations of 1 ppm (approximately 0.16 mg/kg body weight/day) for 47 weeks had lower weights and increased mortality (Newhook and Meek 1994).

4.6.13 trans-1,2-Dichloroethene

In experimental animals, trans-1,2-dichloroethene is mildly toxic by inhalation or intraperitoneal exposure. The lowest published lethal dose for cats inhaling trans-1,2-dichloroethene was 43,000 mg/m³ for 6 hours (Sax and Lewis 1989).

4.6.14 Trichloroethene

Breathing moderate levels of trichloroethene can cause headaches or dizziness. Skin contact with high trichloroethene levels can cause a rash. Animals chronically exposed to moderate levels of trichloroethene had enlarged livers. Those exposed to higher levels had liver and kidney damage (ATSDR 1993f,g). In addition, trichloroethene causes adverse reproductive effects and is a carcinogen, tumorigen, and teratogen in experimental animals (Sax and Lewis 1989).

4.6.15 Vinyl Chloride

People exposed to vinyl chloride in the workplace have suffered liver, nervous system, and immune system damage (ATSDR 1993h). In experimental animals, vinyl chloride is a carcinogen, tumorigen, and teratogen. For rats, the oral LD₅₀ is 500 mg/kg body weight (Sax and Lewis 1989).

4.6.16 Xylenes

Repeated short-term exposure to moderate to high xylene concentrations can cause cardiovascular, hepatic, and neurological effects. In mice, xylene exposure of 2.58 mg/kg/d or greater

significantly reduced fetal weights and increased the incidence of fetal malformities, and a dose of 2.06 mg/kg-d has been identified as a chronic NOAEL for this test organism (Marks et al. 1982).

4.7 SEMIVOLATILE ORGANIC COMPOUNDS

4.7.1 2,4,6-Trichloroaniline

Toxicity data for 2,4,6-trichloroaniline are limited. Increased mortality has been observed in fathead minnow (*Pimephales promelas*) at concentrations as low as 1,000 µg/L. At 135 µg/L, fathead minnow mortality was not affected (Barnhart and Campbell 1972). A water flea (*Daphnia magna*) locomotor activity was affected at 6,000 µg/L, and the EC10 concentration for green algae population growth was >12,000 (Knie et al. 1983).

In experimental animals, 2,4,6-trichloroaniline is a carcinogen. The oral LD₅₀ for mice is 5,800 mg/kg body weight (Sax and Lewis 1989).

4.7.2 2-Methylphenol and 4-Methylphenol

No wildlife toxicity data were found in the literature for 2-methylphenol or 4-methylphenol. In experimental animals, 2-methylphenol and 4-methylphenol are neoplastigens. They are toxic by ingestion; inhalation; and subcutaneous, intravenous, and intraperitoneal exposure. They are also severe eye and skin irritants. The oral LD₅₀s for rats are 121 mg/kg body weight for 2-methylphenol and 207 mg/kg for 4-methylphenol (Sax and Lewis 1989).

4.7.3 Di-n-Butyl Phthalate

Di-n-butyl phthalate can adversely affect reproduction, development, weight gain, liver, and kidneys in mammals (Chan and Meek 1994). The lowest oral concentration affecting the reproductive system of male rats was 8,400 µg/kg body weight (Sax and Lewis 1989). The lowest dietary concentration that was not embryotoxic or teratogenic in mice was 62.5 mg/kg body weight/day (Chan and Meek 1994).

4.7.4 Diethyl Phthalate

No wildlife toxicity data for diethyl phthalate were found in the literature. The oral LD₅₀ for rats is 8,600 mg/kg body weight (Sax and Lewis 1989). Diethyl phthalate is poisonous by an intravenous route and moderately toxic by ingestion, subcutaneous, and intraperitoneal routes.

4.7.5 Diisopropyl Methyl Phosphonate

No wildlife toxicity data were found in the literature for diisopropyl methyl phosphonate (DIMP). The oral LD₅₀s are 826 mg/kg body weight for rats and 1,490 mg/kg body weight for ducks (Sax and Lewis 1989). DIMP is moderately toxic by ingestion.

4.7.6 Nitroglycerin

Fathead minnows chronically exposed to 0.2 mg/L of nitroglycerin were adversely affected (Bentley et al. 1978). The oral LD₅₀s for rats and mice were 500-900 and 500-1200 mg/kg, respectively (Smith 1986). In humans, nitroglycerin can produce severe headaches and adverse cardiovascular effects (Rosenblatt et al. 1991)

4.7.7 N-Nitrosodiphenylamine

Chronically high dietary levels of N-nitrosodiphenylamine can produce swelling and cancer of the bladder and change body weight in experimental animals (ATSDR 1993e).

5 EXPOSURE ASSESSMENT

5.1 TISSUE RESIDUE ANALYSES

Selected plant and animal receptor species from J-Field were collected and analyzed for PCOECs to provide insight into contaminant uptake by biota at the site and for use in uptake models. Organisms analyzed for tissue (plants) or whole-body (animals) chemical residues included common reed (*Phragmites australis*), grasshoppers and crickets (Orthoptera), golden shiners (*Notemigonis crysoleucas*), banded killifish (*Fundulus diaphanus*), frogs (*Rana* spp.), and white-footed mice (*Peromyscus leucopus*). Table 5.1 shows the AOCs from which various organisms were collected and types of analyses performed. The organisms sampled from each AOC reflected the availability of specimens, the type of habitat present, and the size of the AOC relative to a species' territory or home range.

5.1.1 Toxic Burning Pits

Vegetation, insects, fish, and mice were collected from the TBP AOC and analyzed for chemical contaminants.

5.1.1.1 Vegetation

Nine samples of aboveground tissues of common reed were collected from eight locations in the marsh surrounding the TBP AOC (Figure 5.1) in July 1994. Analyses were conducted for SVOCs, pesticides and PCBs, and TAL metals. Table 5.2 presents the results of the analyses. The concentrations of PCBs, most pesticides, and SVOCs were below detection limits. The only SVOCs detected were 2-methylphenol and bis(2-ethylhexyl)phthalate, at mean concentrations of 883 and 683 $\mu\text{g/kg}$, respectively. However, bis(2-ethylhexyl)phthalate was also detected in the associated laboratory blank, and the reported tissue concentration is probably a result of laboratory contamination. The only pesticide detected, beta-BHC, was found in two of the nine plant samples, with a calculated mean concentration of 1.7 $\mu\text{g/kg}$.

Metals were also analyzed in plant samples (common reed stems, leaves, shoots, rhizomes, and roots) collected from marsh and upland locations in the TBP AOC for a bioremediation study (Jastrow 1995). Low levels of several inorganic analytes were detected, including aluminum, arsenic, and lead. The lead concentrations in these plant tissues were positively correlated with the available (DTPA-extractable) lead concentrations in the soil, but not significantly correlated with the total

TABLE 5.1 Species and Chemical Analyses Used in Evaluating Body Burdens of Contaminants in Organisms from Areas of Concern at J-Field

Organism	Area of Concern								
	TBP	RCP	SBT	RPDG	RPTS	PB	SBDG	WPP	Other
Common reed (<i>Phragmites australis</i>)	Metals, SVOCs, pesticides, PCBs	Metals, SVOCs, pesticides, PCBs	- ^a	-	-	-	-	-	-
Insects: grasshoppers and crickets (Orthoptera)	Metals, SVOCs, pesticides, PCBs	Metals, SVOCs, pesticides, PCBs	-	-	-	Metals, SVOCs, pesticides, PCBs	-	-	-
Fish: golden shiner and banded killifish (<i>Notemigonus crysoleucas</i> and <i>Fundulus diaphanus</i>)	Metals, SVOCs, pesticides, PCBs	-	-	-	-	-	-	-	-
Amphibians ^b (<i>Rana</i> spp.)	Metals, pesticides, PCBs, explosives	-	-	Metals, pesticides, PCBs, explosives	Metals, pesticides, PCBs, explosives	-	Metals, pesticides, PCBs, explosives	Metals, pesticides, PCBs, explosives	Metals, pesticides, PCBs, explosives
Mammals: white-footed mouse ^c (<i>Peromyscus leucopus</i>)	Metals, pesticides, PCBs	Metals, pesticides, PCBs	-	Metals, pesticides, PCBs	-	-	-	-	-

^a - = no analysis conducted.

^b Amphibians collected by Johnson (1995).

^c Mice collected and analyzed by analysis of chemical residues by Whaley (1996).

FIGURE 5.1 Approximate Locations from which Common Reed Was Collected for Analyses of Chemical Residues

TABLE 5.2 Results of Chemical Analyses of Aboveground Tissues of Common Reed Collected from the Marsh Surrounding the Toxic Burning Pits Area

Analyte ^a	Frequency of Detection	Minimum	Maximum	Mean	Standard Deviation	95% UCL ^b
<i>SVOCs (µg/kg)</i>						
2-methylphenol	9/9	460	1,500	883	399	1,126
bis(2-ethylhexyl)phthalate ^c	9/9	600	850	683	118	755
<i>Pesticides/PCBs (µg/kg)</i>						
beta-BHC	2/9	1.1	3.8	1.7	1	2.3
<i>Inorganics (mg/kg)</i>						
Aluminum	8/9	1.3	16.2	5.1	4.3	7.7
Arsenic	2/9	0.05	0.16	0.1	0.04	0.12
Barium	9/9	0.88	6.2	3.5	2.1	4.7
Calcium	9/9	302	1,160	679	265	841
Chromium	8/9	0.23	1	0.75	0.26	0.91
Cobalt	1/9	0.32	0.7	0.37	0.21	0.5
Copper	9/9	1.3	3.8	2.6	0.9	3.1
Iron	9/9	15.5	25.5	19.7	3.7	22.0
Lead	9/9	0.1	0.96	0.4	0.29	0.58
Magnesium	9/9	205	620	423	141	509
Manganese	9/9	12.2	65.9	30.2	15.2	39.5
Nickel	3/9	0.6	1.4	0.8	0.4	1.0
Potassium	9/9	4,730	7,590	5,780	964	6,369
Selenium	1/9	0.05	0.1	0.1	0.02	0.11
Sodium	9/9	250	1,020	490	291	668
Zinc	9/9	10.7	35.4	21.6	8.6	26.9

^a Analytes not detected in any sample from the TBP AOC are not shown. If an analyte was detected, the statistics were derived by using the reported results for samples that exceeded the detection limit and one-half of the detection limit for samples where the analyte was not detected. This procedure follows EPA guidance for determining exposure point concentrations (Davis 1994).

^b UCL = upper confidence limit.

^c Also detected in the associated laboratory blank.

soil lead concentration. Most of the lead in the plant samples was found in belowground tissues (roots and rhizomes), and only a small portion of the total lead was translocated to aboveground tissues. Because most organisms likely to consume substantial quantities of vegetation eat primarily aboveground tissues, it is believed that aboveground concentrations of contaminants are the most representative of the exposure point concentrations for use in uptake models that include the ingestion of vegetation.

5.1.1.2 Insects

Grasshoppers and crickets collected from the TBP AOC were analyzed for SVOCs, pesticides, PCBs, and metals (Table 5.3). No SVOCs were detected, but the pesticide dieldrin was detected in one sample (27 µg/kg). Ten inorganic analytes, including seven heavy metals, were

TABLE 5.3 Chemical Residue Analyses of Insects Collected from the Toxic Burning Pits Area

Analyte ^a	Frequency of Detection	Minimum	Maximum	Mean	Standard Deviation	95% UCL
<i>Pesticides/PCBs (µg/kg)</i>						
Dieldrin	1/2	3.3	27	15.15	16.76	90.0 ^b
<i>Inorganics (mg/kg)</i>						
Cadmium	1/2	0.9	4.6	2.7	2.6	14.3 ^b
Calcium	2/2	926	1,850	1,388	653	4,305.2 ^b
Copper	2/2	40.00	43.80	41.90	2.69	53.91 ^b
Iron	2/2	76.5	145.0	110.8	48.4	326.9 ^b
Lead	2/2	1.40	9.88	5.64	6.00	32.43 ^b
Magnesium	2/2	1,070	1,110	1,090	28	1,215 ^b
Manganese	2/2	13.6	46.9	30.3	23.6	135.7 ^b
Potassium	2/2	11,100	14,600	12,850	2,475	23,900 ^b
Sodium	2/2	1,330	3,800	2,565	1,747	10,364 ^b
Zinc	2/2	166.0	242.0	204.0	53.7	443.7 ^b

^a Analytes not detected in any samples from the TBP AOC are not shown. If an analyte was detected, the statistics were derived by using the reported results for samples that exceeded the detection limit and one-half of the detection limit for samples where the analyte was not detected. This procedure follows EPA guidance for determining exposure point concentrations (Davis 1994).

^b The 95% UCL exceeds the maximum reported value; therefore, the maximum reported value was used as the exposure point concentration in the uptake models.

detected in the insect samples. The maximum heavy-metal concentrations ranged from 4.6 mg/kg for cadmium to 1,110 mg/kg for magnesium.

5.1.1.3 Fish

Four samples of fish collected from the pond in the marsh southeast of the TBP AOC were analyzed for whole-body chemical residues; Table 5.4 presents the results of those analyses. Only three pesticides (4,4'-DDD, 4,4'-DDE, and heptachlor) were detected, at maximum tissue concentrations of 61.0, 136.0, and 23.5 µg/kg, respectively. Heptachlor was detected in only one of four samples. Ten inorganic analytes, including seven metals, were also detected. The metals detected included lead, selenium, and zinc. No SVOCs were detected in the fish.

TABLE 5.4 Chemical Residue Analyses of Fish Collected from the Toxic Burning Pits Area

Analyte ^a	Frequency of Detection	Minimum	Maximum	Mean	Standard Deviation	95% UCL
<i>Pesticides/PCBs (µg/kg)</i>						
4,4'-DDD	3/4	23.0	61.0	38.0	17.8	58.9
4,4'-DDE	4/4	9.9	136.0	77.7	55.2	142.7 ^b
Heptachlor	1/4	2.3	23.5	12.2	8.7	22.4
<i>Inorganics (mg/kg)</i>						
Barium	1/4	6.3	13.3	8.1	3.5	12.2
Calcium	4/4	53,500	94,100	69,775	17,214	90,028
Iron	4/4	69.5	151.0	126.9	38.5	172.2 ^b
Lead	3/4	0.14	1.19	0.72	0.47	1.28 ^b
Magnesium	4/4	1,760	2,450	2,060	289	2,400
Manganese	4/4	25.5	66.8	38.4	19.2	61.1
Potassium	4/4	10,700	11,200	10,975	263	11,284 ^b
Selenium	4/4	0.95	2.06	1.39	0.49	1.96
Sodium	4/4	4,340	5,280	4,848	396	5,313 ^b
Zinc	4/4	137.00	273.00	226.50	61.26	298.57 ^b

^a Analytes not detected in any samples from the TBP AOC are not shown. If an analyte was detected, the statistics were derived by using the reported results for samples that exceeded the detection limit and one-half of the detection limit for samples where the analyte was not detected. This procedure follows EPA guidance for determining exposure point concentrations (Davis 1994).

^b The 95% UCL exceeds the maximum reported value; therefore, the maximum reported value was used as the exposure point concentration in the uptake models.

5.1.1.4 Amphibians

A single frog was collected from a crater southwest of the main TBP AOC as part of a larger evaluation of J-Field craters (Johnson 1995). Section 5.1.9.3 presents information on the overall analyses of amphibian whole-body chemical residues for the craters. Table 5.5 presents the results for the frog from the TBP crater. The only analytes detected were the pesticide p,p'-DDE (9 µg/kg) and barium (7.93 mg/kg).

TABLE 5.5 Contaminants Detected in a Frog from a Crater in the Toxic Burning Pits Area

Analyte ^a	Concentration
<i>Pesticides/PCBs (µg/kg)</i>	
p,p'-DDE	9
<i>Metals (mg/kg)</i>	
Barium	7.93

^a Only detected analytes are included.

Source: Johnson (1995).

5.1.1.5 Small Mammals

Ten white-footed mice were collected from the TBP AOC. They were analyzed for metals, pesticides, and PCBs (Whaley 1996). Table 5.6 presents the results of the analyses. The only

TABLE 5.6 Chemical Residue Analyses of Mice Collected from the Toxic Burning Pits Area

Analyte ^a	Frequency of Detection	Minimum	Maximum	Mean	Standard Deviation	95% UCL
<i>Pesticides/PCBs (µg/kg)</i>						
Aroclor 1260	1/10	25.00 ^b	50	28	8	32.64
<i>Metals (mg/kg)</i>						
Arsenic	10/10	0.346	1.548	1.058	0.509	1.35
Barium	10/10	1.398	5.055	3.033	1.237	3.75
Cadmium	10/10	0.02	0.41	0.13	0.172	0.23
Chromium	10/10	0.408	2.667	1.454	0.855	1.95
Lead	10/10	0.041	1.433	0.44	0.464	0.71

^a Analytes not detected in any samples from the TBP AOC are not shown. If an analyte was detected, the statistics were derived by using the reported results for samples that exceeded or met the detection limit and one-half of the detection limit for samples where the analyte was not detected. This procedure follows EPA guidance for determining exposure point concentrations (Davis 1994).

^b This value is one-half of the method detection limit.

Source: Whaley (1996).

pesticide or PCB detected was the PCB Aroclor 1260, which was present in only one mouse at a concentration of 50.0 µg/kg. Five metals were also detected: arsenic, barium, cadmium, chromium, and lead. These metals were present at low concentrations, and none was present at concentrations significantly greater than those in mice collected from an off-site reference location (Whaley 1996). In fact, cadmium concentrations in mice from the TBP AOC were significantly lower than those in mice from reference sites (Whaley 1996).

5.1.2 White Phosphorus Burning Pits

Two frogs were collected from the WPP AOC for analyses of chemical residues (Johnson 1995). They were analyzed for pesticides, PCBs, explosives, and metals (arsenic, barium, cadmium, chromium, lead, and mercury). The only contaminant detected was chromium, which was present at a maximum concentration of 14.37 mg/kg.

5.1.3 Riot Control Pit

Vegetation, insects, and mice collected from the RCP AOC were analyzed for chemical contaminants.

5.1.3.1 Vegetation

A single composite sample of aboveground tissues of common reed was collected from the main pit at the RCP AOC. It was analyzed for SVOCs, pesticides, PCBs, and TAL metals; Table 5.7 presents the results. Two SVOCs were present: bis(2-ethylhexyl)phthalate and 2-methylphenol. The former compound was also present in the laboratory blank, suggesting that laboratory contamination may have affected the analysis results. Thirteen inorganic materials were present above the method detection limits. No pesticides or PCBs were detected.

TABLE 5.7 Contaminants Detected in Common Reed Collected from the Riot Control Pit Area

Analyte ^a	Concentration
<i>SVOCs (µg/kg)</i>	
2-Methylphenol	960
bis(2-Ethylhexyl)phthalate ^b	770
<i>Inorganics (mg/kg)</i>	
Aluminum	4.1
Barium	6.4
Calcium	1,270
Chromium	0.97
Cobalt	0.82
Copper	3.7
Iron	17.1
Lead	0.18
Magnesium	317
Manganese	70.2
Potassium	6,500
Sodium	46
Zinc	21.1

^a Only detected analytes are reported.

^b Also detected in the associated laboratory blank.

5.1.3.2 Insects

A single composite sample of insects (grasshoppers) was collected from the RCP AOC. It was analyzed for SVOCs, pesticides, PCBs, and TAL metals; Table 5.8 presents the results. No SVOCs, pesticides, or PCBs were detected. Nine inorganic analytes were detected, including copper, lead, and zinc.

5.1.3.3 Small Mammals

Twelve white-footed mice were collected from the RCP AOC. They were analyzed for heavy metals, pesticides, and PCBs (Whaley 1996). Table 5.9 summarizes the results of the analyses. The PCB Aroclor 1260 was detected in two mice, and the pesticide p,p'-DDE was detected in one mouse. Maximum concentrations were 130.0 and 25.0 µg/kg, respectively. Low levels of arsenic, barium, cadmium, chromium, and lead were detected. The barium and cadmium concentrations were significantly lower than those in mice collected from an off-site reference site, and concentrations of other metals were not significantly different from those in mice from the reference site (Whaley 1996).

TABLE 5.8 Contaminants Detected in Insects Collected from the Riot Control Pit Area

Analyte ^a	Concentration (mg/kg)
Calcium	1,300
Copper	46
Iron	37.5
Lead	1.3
Magnesium	950
Manganese	21.9
Potassium	10,800
Sodium	731
Zinc	253

^a Only detected analytes are reported.

5.1.4 South Beach Trench

Because of the small size of the trench and limited evidence that there was any chemical contamination, no biota samples from the SBT AOC were analyzed for chemical residues.

5.1.5 South Beach Demolition Ground

A single frog, collected from the large onshore crater north of the SBDG AOC as part of a larger effort to evaluate risks from craters, was analyzed for pesticides, PCBs, heavy metals, and explosives residues. Table 5.10 presents the results. The only analytes present above detection limits were p,p'-DDE (6.0 µg/kg) and chromium (15.73 mg/kg).

TABLE 5.9 Chemical Residue Analyses of Mice Tissues Collected from the Riot Control Pit Area

Analyte ^a	Frequency of Detection	Minimum	Maximum	Mean	Standard Deviation	95% UCL
<i>Pesticides/PCBs (µg/kg)</i>						
Aroclor 1260	2/12	25.00 ^b	130	38.33	32.91	55.39
p,p'-DDE	1/12	6.00 ^b	25	23.42	5.48	26.26 ^c
<i>Metals (mg/kg)</i>						
Arsenic	12/12	0.04	1.5	1.05	0.53	1.32
Barium	12/12	0.52	2.25	1.36	0.53	1.63
Cadmium	12/12	0.02	0.1	0.04	0.02	0.05
Chromium	12/12	0.39	5.25	2.81	1.47	3.57
Lead	12/12	0.07	0.51	0.19	0.12	0.25

^a Analytes not detected in any samples from the TBP AOC are not shown. If an analyte was detected, the statistics were derived by using the reported results and one-half of the detection limit for samples where the analyte was not detected. This procedure follows EPA guidance for determining exposure point concentrations (Davis 1994).

^b One-half of the method detection limit.

^c The 95% UCL exceeds the maximum reported concentration.

Source: Whaley (1996).

5.1.6 Robins Point Demolition Ground

Amphibians (frogs) and mice were obtained from the RPDG AOC and analyzed for chemical contaminants.

5.1.6.1 Amphibians

Seven frogs collected from craters in the inactive portion of the RPDG were analyzed for pesticides, PCBs, heavy metals, and explosives residues (Johnson 1995). Table 5.11 summarizes the results of the analyses. Low levels of one pesticide (p,p'-DDE), two heavy metals (arsenic and barium), and three explosives-breakdown products (2,4,6-trinitrotoluene, 4-amino-2,6-dinitrotoluene, and 2-amino-4,6-dinitrotoluene) were detected.

TABLE 5.10 Contaminants Detected in a Frog Collected from the Crater in the South Beach Demolition Ground Area

Analyte ^a	Concentration
<i>Pesticides/PCBs (µg/kg)</i>	
p,p'-DDE	6
<i>Metals (mg/kg)</i>	
Chromium	15.73

^a Only detected analytes are reported.

Source: Johnson (1995).

TABLE 5.11 Residue Analyses of Frogs Collected from the Robins Point Demolition Ground Area

Analyte ^a	Frequency of Detection	Minimum	Maximum	Mean	Standard Deviation	95% UCL
<i>Pesticides/PCBs (µg/kg)</i>						
p,p'-DDE	3/7	5	7	5	1	5.73
<i>Explosives (µg/kg)</i>						
2,4,6-Trinitrotoluene	1/7	10.0	18.0	11.1	3.0	13.30
4-Amino-2,6-dinitrotoluene	1/7	5.0	11.0	5.9	2.3	7.59
2-Amino-4,6-dinitrotoluene	1/7	5.0	19.0	7.0	5.3	10.89
<i>Metals (mg/kg)</i>						
Arsenic	1/7	4.00	11.11	5.02	2.69	7.00
Barium	1/7	3.50	13.20	4.89	3.67	7.59

^a Analytes not detected in any samples from the RPDG AOC are not shown. If an analyte was detected, the statistics were derived by using the reported results for samples that exceeded the detection limit and one-half of the detection limit for samples where the analyte was not detected. This procedure follows EPA guidance for determining exposure point concentrations (Davis 1994).

Source: Johnson (1995).

5.1.6.2 Small Mammals

Body burdens of pesticides, PCBs, and heavy metals were determined for 11 white-footed mice from the RPDG AOC (Whaley 1996). Table 5.12 presents the results of these analyses. Aroclor 1260 and p,p'-DDE were detected in two different mice. The p,p'-DDE concentration measured for the RPDG AOC (10 µg/kg) was similar to that detected in mice collected from the reference site (6 µg/kg); no measurable levels of Aroclor were reported for the reference site (Whaley 1996). Low levels of heavy metals were detected, including arsenic, barium, cadmium, chromium, and lead. The arsenic, chromium, and lead levels in mice from the RPDG were not significantly different from those in mice from a reference site, whereas the barium and cadmium levels in RPDG mice were significantly lower than those in mice from the reference site (Whaley 1996).

5.1.7 Robins Point Tower Site

A single frog, captured from a crater in the RPTS AOC, was analyzed for pesticides, PCBs, explosives, and heavy metals. No detectable levels of any analytes were found.

TABLE 5.12 Residue Analyses of Mice Collected from the Robins Point Demolition Ground Area

Analyte ^a	Frequency of Detection	Minimum	Maximum	Mean	Standard Deviation	95% UCL
<i>Pesticides/PCBs (µg/kg)</i>						
Aroclor 1260	1/11	25	50	27	8	31.37
p,p'-DDE	1/11	3	10	3.7	3	5.64
<i>Metals (mg/kg)</i>						
Arsenic	11/11	0.54	1.50	1.2	0.28	1.35
Barium	11/11	0.84	3.10	1.46	0.69	1.83
Cadmium	11/11	0.02	0.02	0.02	0.002	0.02
Chromium	11/11	0.38	4.23	2.51	1.26	3.20
Lead	11/11	0.05	2.62	0.53	0.72	0.93

^a Analytes not detected in any samples from the RPDG AOC are not shown. If an analyte was detected, the statistics were derived by using the reported results for samples that exceeded or met the detection limit and one-half of the detection limit for samples where the analyte was not detected. This procedure follows EPA guidance for determining exposure point concentrations (Davis 1994).

Source: Whaley (1996).

5.1.8 Prototype Building

Only insects (grasshoppers) were collected from the PB AOC; a single composite sample was analyzed for SVOCs, pesticides, PCBs, and TAL metals. Table 5.13 presents the results of the analyses. No pesticides, PCBs, or SVOCs were present at levels above detection limits. Several inorganic analytes were measured at concentrations above the detection limit. These concentrations were comparable to those measured in insects from the TBP and RCP AOCs (Tables 5.3 and 5.8).

5.1.9 Potential Areas of Concern

Chemical residues were also analyzed for amphibians collected from craters in the Ruins Site and Area D PAOCs (Johnson 1995).

TABLE 5.13 Chemical Residues Detected in a Composite Insect Sample Collected from the Prototype Building Area

Analyte ^a	Concentration (mg/kg)
Calcium	843.0
Copper	37.2
Iron	71.6
Magnesium	911.0
Manganese	11.6
Potassium	10,700.0
Sodium	771.0
Zinc	188.0

^a Only detected analytes are reported.

The results of these analyses, along with other data, were used in evaluating ecological risk to amphibians in craters at J-Field as well as for evaluating possible exposures to amphibians in particular AOCs and PAOCs.

5.1.9.1 Ruins Site

A single frog was collected from a crater in the Ruins Site PAOC. It was analyzed for pesticides, PCBs, explosives, and heavy metals (Johnson 1995). The only analyte detected was barium (9.23 mg/kg).

5.1.9.2 Area D

The Area D PAOC contains several relict craters that hold water for at least some part of the year, and amphibians and other aquatic organisms may be associated with these habitats. Seven frogs collected from these craters were analyzed for pesticides, PCBs, heavy metals, and explosives residues (Johnson 1995). Table 5.14 summarizes the results of these analyses. Two pesticides (o,p'-DE and p,p'-DDE) and two heavy metals (barium and lead) were detected in frogs. Generally, these analytes were detected at low levels, although one frog contained a lead concentration of more than 86 mg/kg, which was more than six times the lead concentration detected in any other frog collected at Area D or elsewhere on J-Field (Johnson 1995). A total of 22 frogs were collected from J-Field for analysis of chemical residues. More than 80% of the frogs with detectable lead concentrations were collected from a single crater in the Area D PAOC. No explosives residues were detected in any frogs sampled from Area D.

5.1.9.3 Craters

Twenty of the 22 frogs collected from J-Field were obtained from 10 craters. These 20 frogs were analyzed for pesticides, PCBs, heavy metals, and explosives (Johnson 1995). Table 5.15 presents the results. Two pesticides, three explosive compounds, and four metals were detected. However, arsenic, chromium, o,p'-DDE, and the three explosive compounds were detected only once each among all the samples. The explosives were all detected in a single animal from a crater in the RPDG AOC. Most of the samples containing detectable lead levels were collected from the Area D PAOC, as discussed in Section 5.1.9.2.

TABLE 5.14 Residue Analyses of Frogs Collected from Area D

Analyte ^a	Frequency of Detection	Minimum	Maximum	Mean	Standard Deviation	95% UCL
<i>Pesticides/PCBs (µg/kg)</i>						
o,p'-DDE	1/7	2.5	5	2.86	0.94	3.55
p,p'-DDE	2/7	2.5	10	3.93	2.83	6.01
<i>Metals (mg/kg)</i>						
Barium	2/7	3.5	9.15	5.04	2.64	6.98
Lead	4/7	1	86.14	16.29	31.22	39.22

^a Analytes not detected in any samples from the Area D PAOC are not shown. If an analyte was detected, the statistics were derived by using the reported results for samples that exceeded or met the detection limit and one-half of the detection limit for samples where the analyte was not detected. This procedure follows EPA guidance for determining exposure point concentrations (Davis 1994).

Source: Johnson (1995).

TABLE 5.15 Residue Analyses of Frogs Collected from Craters at J-Field

Analyte ^a	Frequency of Detection	Minimum	Maximum	Mean	Standard Deviation	95% UCL
<i>Pesticides/PCBs (µg/kg)</i>						
o,p'-DDE	1/20	2.5	5.0	2.6	0.55	3.39
p,p'-DDE	7/20	2.5	10.0	4.0	2.40	4.77
<i>Explosives (µg/kg)</i>						
2,4,6-Trinitrotoluene	1/19	10.0	18.0	10.4	1.84	10.77
4-Amino-2,6-dinitrotoluene	1/19	5.0	11.0	5.3	1.38	5.39
2-Amino-4,6-dinitrotoluene	1/19	5.0	19.0	5.7	3.21	7.16
<i>Metals (mg/kg)</i>						
Arsenic	1/20	4.00	11.11	4.36	1.59	4.77
Barium	7/20	3.50	13.20	5.56	3.04	7.16
Chromium	1/20	3.50	15.73	6.01	2.29	6.77
Lead	5/20	1.00	86.14	6.42	19.05	13.35

^a Analytes not detected in any samples from the craters are not shown. If an analyte was detected, the statistics were derived by using the reported results for samples that exceeded or met the detection limit and one-half of the detection limit for samples where the analyte was not detected. This procedure follows EPA guidance for determining exposure point concentrations (Davis 1994).

Source: Johnson (1995).

5.2 CONTAMINANT UPTAKE MODELING

In addition to the direct analyses of contaminants in biota conducted for the J-Field samples (Section 5.1), exposure of biota at the J-Field site was assessed by modeling contaminant uptake for selected ecological receptors. This approach was necessary because residue analysis requires the capture and typically destructive sampling of biota, and such sampling is not possible for certain species found at J-Field. The large size of species such as the white-tailed deer and great blue heron makes specimen collection difficult, costly, and impractical. The following sections describe the modeling approach used for estimating contaminant uptake by ecological receptors at J-Field.

5.2.1 Exposure Point Concentrations

The exposure point concentration represents the environmental concentration of a contaminant in a particular medium to which an ecological receptor at that site would be exposed. For this ERA, the exposure point concentration was estimated as the 95% upper confidence limit (UCL) of the arithmetic mean of the concentrations reported for a specific AOC. Use of the 95% UCL as the exposure point concentration is consistent with EPA Region III guidance for conducting ecological risk assessments (Davis 1994). The same general approach is also used in determining the exposure point concentration in human health risk assessments (EPA 1989b). The calculated 95% UCL serves as an estimate of the reasonable maximum exposure (RME), which is defined as the maximum exposure reasonably expected to occur at a site (EPA 1989b).

If the set of data values for an individual contaminant in a particular medium was determined to be normally distributed, the 95% UCL for the contaminant was calculated on the basis of data collected during the RI (Yuen et al. 1999), by using the following equation (Davis 1994):

$$95\% \text{ UCL} = \bar{X} + t(s/\sqrt{n}),$$

where

$\bar{X}$ = arithmetic mean of the characterization data;

t = one-tailed t -statistic value with $n-1$ degrees of freedom and a significance level of $P < 0.05$;

s = arithmetic standard deviation of the characterization data; and

n = sample size.

If the set of data values for an individual contaminant in a particular medium was determined to be lognormally distributed, the 95% UCL was calculated using the following equation (Davis 1994):

$$95\% \text{ UCL} = e^{\frac{(X_{\ln} + V/2) + (S_{\ln} * H)}{\sqrt{n-1}}},$$

where

$X_{\ln}$ = arithmetic mean of the log-transformed characterization data;

V = the variance of the log-transformed characterization data;

$S_{\ln}$ = the standard deviation of the log-transformed characterization data;

H = the value of the H -statistic, dependent on $S_{\ln}$, the sample size (n), and the selected level of statistical significance (95%); and

n = sample size.

Data used to estimate the 95% UCL met all protocols, procedures, and QA/QC requirements established in the QAPjP (Prasad et al. 1995) and discussed in Section 3.3.1. The calculated 95% UCL was then used as the RME exposure point concentration for modeling contaminant uptake with two exceptions. The exceptions were that if the calculated 95% UCL either exceeded the maximum reported concentration or was less than 80% of the maximum concentration, the maximum reported concentration was used as the RME exposure point concentration. Thus, the RME concentration of each PCOEC at each AOC was estimated for each medium by using either the 95% UCL or the maximum reported concentration of the PCOEC. The RME concentrations used for modeling contaminant uptake are presented in Tables 5.16 through 5.20.

5.2.2 Exposure Routes

Conceptual models depicting contaminant sources, exposure pathways, and ecological receptors are presented in Section 3. However, the conceptual models depict only general exposure pathways at each AOC. Because of the diversity of life histories among the various ecological receptor species, the distribution of the receptors among the AOCs, and the different media of concern among the AOCs, species-specific exposure routes were developed for each receptor species at each AOC. These routes represent the most likely exposure pathways for the ecological receptors at each AOC, and the routes govern the development of the uptake models.

TABLE 5.16 Exposure Point Concentrations of Contaminants of Ecological Concern for the Toxic Burning Pits Area

Contaminant	Exposure Point Concentration (Maximum Value)		
	Surface Water (µg/L)	Sediment (µg/kg)	Soil (µg/kg)
<i>Inorganics</i>			
Aluminum	18,000 ^a	26.9×10^6 ^a	22.6×10^6
Arsenic	36.3 ^a	14,100 ^a	1.4×10^6
Barium	559	927,000 ^a	1.6×10^6
Cadmium	13.4 ^a	7,040 ^a	35,500
Chromium	64.8 ^a	80,200 ^a	878,000
Copper	525	515,000 ^a	4.32×10^6
Iron	181,100	35.6×10^6 ^a	154×10^6
Lead	1,590 ^a	1.8×10^6 ^a	94.2×10^6
Magnesium	228,000	5.1×10^6 ^a	3.9×10^6
Manganese	3,700	160,000 ^a	633,000 ^a
Mercury	1.7 ^a	1,710 ^a	3,600
Nickel	116 ^a	35,200 ^a	84,500
Potassium	38,700 ^a	1.6×10^6 ^a	1.5×10^6
Sodium	958,000	1.8×10^6 ^a	521,000
Zinc	4,040	3.4×10^6 ^a	17.8×10^6
<i>VOCs and SVOCs</i>			
1,1,2,2-Tetrachloroethane	4,348.0	23.0	2,500.0
1,1-Dichloroethene	- ^b	-	100.0
1,4-Dichlorobenzene	-	332.3 ^c	-
12DCE	1,700	72.0	170 ^a
2-Methylnaphthalene	-	-	1,250
2,4,6-Trichloroaniline	-	-	7,900
2-Hexanone	125.0	16.0 ^a	-
2-Methylphenol	-	-	1,250
2-Butanone	-	200.0	37.0
2,4-Dinitrotoluene	-	2,110	-
4-Methylphenol	-	-	1,250
Acetone	32 ^a	200.0	20.0
Benzene	-	-	100
Benzo(b)fluoranthene	-	-	1,250
Benzo(k)fluoranthene	-	-	1,250
Chloroethane	125	-	-
Chloroform	-	-	50.0
cis-12DCE	1,809	-	-
Diethyl phthalate	-	-	2,000

TABLE 5.16 (Cont.)

Contaminant	Exposure Point Concentration (Maximum Value)		
	Surface Water (µg/L)	Sediment (µg/kg)	Soil (µg/kg)
DIMP	0.4 ^c	-	-
Fluoranthene	-	362.1 ^c	-
Hexachlorobenzene	-	360.5 ^c	3,100
m&p-Xylene	-	-	50.0
N-Nitrosodiphenylamine	-	-	1,250
Pyrene	-	361.9	1,250 ^a
TRCLE	3,615	29 ^a	2,800 ^a
trans-12DCE	239.0	- ^b	-
Vinyl chloride	125.0	54 ^a	-
<i>Pesticides/PCBs</i>			
4,4'-DDD	-	5.9 ^c	-
Aroclor 1248	-	-	570.0
<i>Chemical Warfare Agents and Degradation Products</i>			
1,4-Oxathiane	9.7 ^c	-	-
1,1-Oxathiane	12.2	-	-
Dithiane	3.6	-	-
Nitroglycerin	-	-	15,300
<i>Other</i>			
Carbon disulfide	-	-	38.0

^a Not a PCOEC for the indicated medium.

^b - = the contaminant was not detected in the medium.

^c Exposure point concentration is the 95% UCL.

Source: Yuen et al. (1999).

TABLE 5.17 Exposure Point Concentrations of Contaminants of Ecological Concern for the White Phosphorus Burning Pits Area

Contaminant	Exposure Point Concentration (Maximum Value)	
	Surface Water (µg/L)	Soil (µg/kg)
<i>Metals</i>		
Arsenic	3.2 ^a	8,200
Cobalt	20.5	6,980 ^a
Copper	52.3	67,300
Iron	28,400	37.2 × 10 ⁶ ^a
Lead	76.1	231,000 ^a
Zinc	411.0	588,000
<i>VOCs and SVOCs</i>		
bis(2-ethylhexyl)phthalate	ND ^b	323.7 ^c

^a Not a PCOEC for the indicated medium.

^b ND = not detected.

^c Exposure point concentrations is the 95% UCL.

Source: Yuen et al. (1999).

TABLE 5.18 Exposure Point Concentrations of Contaminants of Ecological Concern for the Riot Control Pit Area

Contaminant	Exposure Point Concentration (Maximum Value)	
	Surface Water (µg/L)	Soil (µg/kg)
Arsenic	ND ^a	7,400
Copper	24.6 ^b	1.8 × 10 ⁶
Zinc	34.2 ^b	385,000

^a ND = contaminant below detection limit.

^b Not a PCOEC for the indicated medium.

Source: Yuen et al. (1999).

TABLE 5.19 Exposure Point Concentrations of Contaminants of Ecological Concern for the South Beach Trench and Prototype Building Areas, Area A, Ruins Site, and Craters

Contaminant	Exposure Point Concentration (Maximum Value)		
	Surface Water (µg/L)	Sediment (µg/kg)	Soil (µg/kg)
<i>South Beach Trench AOC</i>			
Cadmium	ND ^a	ND	3,300
<i>Prototype Building AOC</i>			
4,4'-DDD	ND	- ^b	6.2
4,4'-DDT	ND	-	16.0
Acetone	ND	-	6.7 ^c
Cadmium	ND	-	3,500
Copper	ND	-	74,900
Endrin aldehyde	ND	-	7.5
Zinc	27.3 ^d	-	190,000
<i>Area A PAOC</i>			
Acetone	-	67	-
<i>Crater PAOC</i>			
Cadmium	-	2,540	-

^a ND = contaminant below detection limit.

^b - = contaminant not measured.

^c Exposure point concentration is the 95% UCL.

^d Not a PCOEC for the indicated medium.

Source: Yuen et al. (1999).

TABLE 5.20 Exposure Point Concentrations of Contaminants of Ecological Concern for the Robins Point Tower Site and Robins Point Demolition Ground Areas

Contaminant	Exposure Point Concentration		
	Surface Water (µg/L)	Sediment (µg/kg)	Soil (µg/kg)
<i>RPTS AOC</i>			
Zinc	3,860	- ^a	ND ^b
<i>RPDG AOC</i>			
Aluminum	30,300	10.1×10^6 ^c	8.5×10^6 ^c
Barium	275	48,200 ^c	37,891 ^c
Cobalt	39.2	ND	4,234 ^c
Copper	75.1	30,000 ^c	13,299
Iron	191,000	11.1×10^6 ^c	13.9×10^6 ^c
Lead	228.0	56,700 ^c	30,801 ^c
Manganese	5,260	48,500 ^c	115,000 ^c
Silver	1.76	1,810	10,300 ^c

^a - = contaminant not measured.

^b ND = contaminant below detection limit.

^c Not a PCOEC for the indicated medium.

Source: Yuen et al. (1999).

For terrestrial biota, the most likely exposure route is assumed to be ingestion of contaminated food and incidental ingestion of contaminated media. For aquatic and semi-aquatic biota, the dominant exposure route is assumed to be direct absorption of contaminants from the media and ingestion of contaminated sediment. Root uptake is the dominant exposure route for rooted vegetation. It is more likely, however, that a receptor would be exposed via more than one exposure route and medium at a given exposure point. For example, a mallard duck in the TBP AOC would be exposed to contaminants in surface water, sediment, and soil by direct and indirect ingestion. Table 5.21 identifies the exposure routes for the J-Field ecological receptors. These routes were modeled mathematically following the approach described in Section 5.2.3.

TABLE 5.21 Exposure Routes Evaluated for Ecological Receptors at J-Field

Receptor	Medium	Exposure Route
Grasses	Soil	Soil → root uptake → grass
Common reed	Sediment	Sediment → root uptake → common reed
Deciduous trees	Soil	Soil → root uptake → trees
Golden shiner	Surface water	Surface water → direct absorption → golden shiner
Red-spotted newt	Surface water (breeding adults only)	Surface water → direct absorption → newt
	Soil (nonbreeding adults only)	Soil → invertebrates → ingestion → newt Soil → incidental ingestion → newt Soil → dermal absorption → newt
Leopard frog	Surface water	Surface water → direct absorption → frog
Mallard duck	Surface water	Surface water → invertebrates → ingestion → duck Surface water → ingestion → duck
	Sediment	Sediment → invertebrates → ingestion → duck Sediment → incidental ingestion → duck
	Soil	Soil → vegetation → ingestion → duck Soil → incidental ingestion → duck
Great blue heron	Surface water	Surface water → fish → ingestion → heron Surface water → amphibians → ingestion → heron Surface water → ingestion → heron
Red-tailed hawk	Soil	Soil → vegetation → mammals → ingestion → hawk Soil → vegetation → bird → ingestion → hawk Soil → invertebrates → bird → ingestion → hawk Soil → vegetation and invertebrates → bird → ingestion → hawk Soil → vegetation → mammal → snake → ingestion → hawk Soil → invertebrate → snake → ingestion → hawk
	Surface water	Surface water → ingestion → hawk
American kestrel	Soil	Soil → invertebrates → ingestion → kestrel Soil → invertebrates → snake → ingestion → kestrel Soil → vegetation and invertebrates → mammal → snake → ingestion → kestrel Soil → vegetation → mammal → ingestion → kestrel Soil → vegetation → bird → ingestion → kestrel Soil → invertebrates → bird → ingestion → kestrel Soil → vegetation and invertebrates → bird → ingestion → kestrel
	Surface water	Surface water → ingestion → kestrel
American robin	Soil	Soil → invertebrates → ingestion → robin Soil → vegetation → ingestion → robin Soil → incidental ingestion → robin
	Surface water	Surface water → ingestion → robin
Tree swallow	Soil	Soil → invertebrates → ingestion → swallow
	Surface water	Surface water → ingestion → swallow

TABLE 5.21 (Cont.)

Receptor	Medium	Exposure Route
Muskrat	Surface water	Surface water → vegetation → muskrat Surface water → ingestion → muskrat
	Sediment	Sediment → vegetation → ingestion → muskrat Sediment → incidental ingestion → muskrat
Deer mouse	Soil	Soil → vegetation → ingestion → mouse Soil → invertebrates → ingestion → mouse Soil → incidental ingestion → mouse
	Surface water	Surface water → ingestion → mouse
Eastern cottontail	Soil	Soil → vegetation → ingestion → rabbit Soil → incidental ingestion → rabbit
	Surface water	Surface water → ingestion → rabbit
Red fox	Soil	Soil → vegetation → mouse → ingestion → fox Soil → vegetation → invertebrate → bird → ingestion → fox Soil → vegetation → bird → ingestion → fox Soil → invertebrate/vegetation → bird → ingestion → fox Soil → invertebrate → ingestion → fox Soil → vegetation → ingestion → fox Soil → incidental ingestion → fox
	Surface water	Surface water → ingestion → fox
White-tailed deer	Soil	Soil → vegetation → ingestion → deer Soil → incidental ingestion → deer
	Surface water	Surface water → ingestion → deer

5.2.3 Estimation of Applied Daily Dose

For each receptor, a conceptual food chain model was developed that identified contaminant sources, exposure routes, and food chain (or web) relationships. Mathematical equations to predict contaminant uptake, expressed as an applied daily dose (ADD), were then developed according to EPA (1993b) guidance and/or mathematical approaches published in the scientific literature (reviewed by Hope [1995]). Each uptake model incorporated species-specific information on diet composition, body weight, home range, food and water ingestion rates, and incidental ingestion rates of environmental media, as available. The principal uptake routes in the models were as follows: (1) root uptake from contaminated soils and sediments; (2) incidental ingestion of soil and sediment; (3) ingestion of food and water; (4) direct absorption from surface water and sediments (aquatic biota only); and (5) direct absorption from dermal exposure (aquatic biota only). The following sections describe the methods used to model contaminant uptake.

5.2.3.1 Receptor Exposure Factors and Model Assumptions

5.2.3.1.1 Exposure Factors. Exposure factors are the species-specific physiological and life history parameters that directly affect contaminant uptake. Physiological parameters include body weight; surface area; metabolic rate; assimilation efficiency; and rates of food, water, soil, and sediment ingestion. Life history parameters include home range, diet composition, and seasonal activity. These parameters are analogous to the standard exposure factors used to model contaminant uptake in human health risk assessments.

Several data sources were used to obtain species-specific exposure factors, particularly the *Wildlife Exposure Factors Handbook* (EPA 1993b) and the references cited therein. Other sources included the scientific literature (*Journal of Mammalogy*, *Auk*, *Journal of Wildlife Management*, *Transactions of the American Fisheries Society*, and *Journal of Herpetology*). Tables 5.22 through 5.34 present the species-specific exposure factors used to estimate contaminant uptake in this ERA. When species-specific exposure factors were unavailable, factors estimated by using empirically derived allometric equations (EPA 1993b) or from closely related species were used.

5.2.3.1.2 Model Assumptions. Because of the limited availability of species-specific data, several assumptions were made in modeling contaminant uptake:

- For AOC-specific evaluations, the home range of each modeled receptor was centered on the AOC.
- Consistent with EPA (1993b) guidance, the home range included both daily activity and foraging ranges.
- All foraging activities of each receptor were constant and uniformly distributed over the receptor's entire home range.
- Contaminant uptake by biota would not significantly affect the environmental concentration of contaminants.
- Contaminant assimilation was assumed to equal metabolizable energy assimilation efficiency; if the metabolizable energy assimilation efficiency was unknown, complete (100%) contaminant assimilation was assumed between trophic levels.

TABLE 5.22 Exposure Factors for the Red-Spotted Newt^a

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	2.24	New York	Gillis and Breuer (1984)
Surface area (cm ²)	14.74		Estimated ^b
Food ingestion rate (g/g-d)	- ^c		
Water ingestion rate (g/g-d)	0 ^d		
Home range (ha)	0.0087	Massachusetts	Healy (1975)
Seasonality factor ^e	0.92		
Diet composition (%)		New York	MacNamara (1977)
Invertebrates	100		

^a All exposure factors use eastern newt surrogate data.

^b Estimated with allometric equation: Surface Area = $8.42W^{0.694}$, where W is weight (2.24 g) (EPA 1993b).

^c Data not available.

^d Water requirement is assumed to be met by dermal absorption rather than direct ingestion.

^e The newts were assumed to be terrestrial (non-breeding), 11 months of year.

TABLE 5.23 Exposure Factors for the Leopard Frog^a

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	49.1	New Brunswick	McAlpine and Dilworth (1989)
Surface area (cm ²)	15.95		Estimated ^b
Food ingestion rate (g/g-d)	- ^c		
Water ingestion rate (g/g-d)	0 ^d		
Home range (ha)	0.0065	Michigan	Martof (1953)
Seasonality factor	1.0		
Burrow factor (%)	58	Michigan	Martof (1956) ^e
Diet composition (%)		New York	Stewart and Sandison (1973)
Vegetation	11		
Invertebrates	89		

^a All exposure factors use green frog surrogate data.

^b Estimated with allometric equation: Surface Area = $0.997W^{0.712}$, where W is weight (49.1 g) (EPA 1993b).

^c Data not available.

^d Water requirement is assumed to be met by dermal absorption rather than direct ingestion.

^e Estimated as fraction of year spent in hibernation.

TABLE 5.24 Exposure Factors for the Mallard Duck

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	1,134	North America	Nelson and Martin (1953)
Food ingestion rate (g/g-d)	0.18		Estimated ^a
Water ingestion rate (g/g-d)	0.057		Estimated ^b
Sediment diet fraction (% diet)	<2%		EPA (1993b)
Home range (ha)	580	Minnesota	Kirby et al. (1985)
Seasonality factor	1.0		
Diet composition (%)		North Dakota	Swanson et al. (1985)
Invertebrates	75		
Vegetation	25		

^a The dry food ingestion rate was estimated as 0.06 g/g-d with allometric equation: Food Ingestion Rate (g/d) = $0.648W^{0.651}$, where W is weight (1,134 g); Food Ingestion Rate (g/g-d) = Food Ingestion Rate (g/d)/ W (g) (EPA 1993b). This value was converted to a wet food ingestion rate using estimates of water content of 71% for aquatic invertebrates and 79% for vegetation.

^b Estimated with allometric equations: Water Ingestion (L/d) = $0.059W^{0.67}$, where W is weight (1.134 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

TABLE 5.25 Exposure Factors for the Great Blue Heron

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	2,229	Eastern North America	Quinney (1982)
Food ingestion rate (g/g-d)	0.18		Kushlan (1978)
Water ingestion rate (g/g-d)	0.045		Estimated ^a
Home range (ha)	200		Estimated ^b
Seasonality factor	1.0		
Diet composition (%)		Lower Michigan	Alexander (1977)
Fish	98		
Amphibians	2		

^a Estimated with allometric equations: Water Ingestion (L/d) = $0.059W^{0.67}$, where W is weight (2.229 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

^b Estimated from foraging distance from colony reported in EPA (1993b).

TABLE 5.26 Exposure Factors for the Red-Tailed Hawk

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	1,219	Ohio	Springer and Osborne (1983)
Food ingestion rate (g/g-d)	0.099	Michigan	Craighead and Craighead (1956)
Water ingestion rate (g/g-d)	0.057		Estimated ^a
Home range (ha)	697	Michigan	Craighead and Craighead (1956)
Seasonality factor	1.0		
Diet composition (%)		Oregon	Janes (1984)
Mammals ^b	78.5		
Birds ^c	8.5		
Reptiles	13		

^a Estimated with allometric equations: Water Ingestion (L/d) = $0.059W^{0.67}$, where W is weight (1.219 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

^b Mammal component was subdivided into 13.1% eastern cottontail and 65.4% mice based on Janes (1984).

^c Bird component is assumed to be equally composed of insectivorous, herbivorous, and omnivorous species.

TABLE 5.27 Exposure Factors for the American Kestrel

Factor Exposure	Mean	Geographic Location	Source
Body weight (g)	121	Utah	Gessaman and Haggas (1987)
Food ingestion rate (g/g-d)	0.31	Ohio	Barret and Mackay (1975)
Water ingestion rate (g/g-d)	0.118		Estimated ^a
Home range (ha)	131	Michigan	Craighead and Craighead (1956)
Seasonality factor	1.0		
Diet composition (%)		California	Meyer and Balgooyen (1987)
Invertebrates	32.6		
Herpetofauna	5.4		
Birds ^b	30.3		
Mammals	31.7		

^a Estimated with allometric equations: Water Ingestion (L/d) = $0.059W^{0.67}$, where W is weight (0.121 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

^b Bird component is assumed to be equally composed of insectivorous, herbivorous, and omnivorous species.

TABLE 5.28 Exposure Factors for the American Robin

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	77	Pennsylvania	Clench and Leberman (1978)
Food ingestion rate (g/g-d)	1.52	Kansas	Hazelton et al. (1984)
Water ingestion rate (g/g-d)	0.14		Estimated ^a
Soil diet fraction (%)	4.0		Assumed ^b
Home range (ha)	0.81	Ontario	Weatherhead and McRae (1990)
Seasonality factor	1.0		
Diet composition (%)		Eastern United States	Wheelwright (1986) ^c
Invertebrates	40		
Vegetation	60		

^a Estimated with allometric equations: Water Ingestion (L/d) = $0.059W^{0.67}$, where W is weight (0.077 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

^b No data available for soil diet fraction. A default value of 10% (personal communication, EPA) is used and applied only to the invertebrate portion of the diet.

^c Estimated from seasonal diet compositions reported in Wheelwright (1986).

TABLE 5.29 Exposure Factors for the Tree Swallow

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	21 ^a	Alberta	Dunn and Hannon (1992)
Food ingestion rate (g/g-d)	0.81		Estimated ^b
Water ingestion rate (g/g-d)	0.21		Estimated ^c
Home range (ha)	28	Alberta	Dunn and Hannon (1992) ^d
Seasonality factor	1.0		
Diet composition (%)		Alberta	Dunn and Hannon (1992)
Invertebrates	100		

^a Mean for incubating females.

^b Dry food ingestion rate of 0.25 g/g-d estimated with allometric equation: Food Ingestion Rate (g/d) = $0.398W^{0.850}$, where W is weight (21 g) (EPA 1993b); Food Ingestion Rate (g/g-d) = Food Ingestion Rate (g/d)/ W (g). The dry food ingestion rate was converted to a wet weight ingestion rate using an estimate of 69% water content in insects (EPA 1993b).

^c Estimated with allometric equations: Water Ingestion (L/d) = $0.059W^{0.67}$, where W is weight (0.021 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

^d Derived from 300-m foraging distance from nest reported in Dunn and Hannon (1992).

TABLE 5.30 Exposure Factors for the Muskrat

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	1,415	New York	Dozier (1950)
Food ingestion rate (g/g-d)	0.34	Louisiana	Svihla and Svihla (1931)
Water ingestion rate (g/g-d)	0.096		Estimated ^a
Sediment diet fraction (%)	5.0		Assumption
Home range (ha)	0.17	Ontario	Proulx and Gilbert (1983)
Seasonality factor	1.0		
Diet composition (%)		Maryland	Willner et al. (1975)
Vegetation	100		

^a Estimated with allometric equations: Water Ingestion (L/d) = $0.099W^{0.90}$, where W is weight (1.415 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

TABLE 5.31 Exposure Factors for the White-Footed Mouse

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	21	North America	Millar (1989)
Food ingestion rate (g/g-d)	0.45	Manitoba	Millar (1989) ^a
Water ingestion rate (g/g-d)	0.146		Estimated ^b
Soil diet fraction (%)	< 2.0		EPA (1993b)
Home range (ha)	0.06	Virginia	Wolff (1985)
Seasonality factor	1.0		
Diet composition (%)		Virginia	Wolff et al. (1985)
Invertebrates	58		
Vegetation	42		

^a Value for lactating female deer mouse.

^b Estimated with allometric equations: Water Ingestion (L/d) = $0.099W^{0.90}$, where W is weight (0.021 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

TABLE 5.32 Exposure Factors for the Eastern Cottontail Rabbit

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	1,189	Western Maryland, West Virginia	Chapman and Morgan (1973)
Food ingestion rate (g/g-d)	0.40		Estimated ^a
Water ingestion rate (g/g-d)	0.097		Estimated ^b
Soil diet fraction (%)	6.3 ^c		EPA (1993b)
Home range (ha)	3.8 ^d	Pennsylvania	Althoff and Storm (1989)
Seasonality factor	1.0		
Diet composition (%)		Maryland	Spencer and Chapman (1986)
Vegetation	100		

^a Dry food ingestion rate was estimated as 0.34 g/g-d with allometric equation: Food Ingestion Rate (g/d) = $0.577W^{0.727}$, where W is weight (1,189 g); Food Ingestion Rate (g/g-d) = Food Ingestion Rate(g/d)/ W (g) (EPA 1993b). This value was converted to a wet weight ingestion rate using an estimated water concentration of 79% for vegetation (EPA 1993b).

^b Estimated with allometric equations: Water Ingestion (L/d) = $0.099W^{0.90}$, where W is weight (1.189 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

^c Value based on estimated % soil in diet for the jackrabbit.

^d Estimated from seasonal home range values reported for males and females in Althoff and Storm (1989).

TABLE 5.33 Exposure Factors for the Red Fox

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	4,690	Illinois	Storm et al. (1976)
Food ingestion rate (g/g-d)	0.16	North Dakota	Sargeant (1978)
Water ingestion rate (g/g-d)	0.085		Estimated ^a
Soil diet fraction (%)	2.8	Maryland	Beyer et al. (1994)
Home range (ha)	699	Minnesota	Sargeant (1972)
Seasonality factor	1.0		
Diet Composition (%)		Illinois	Knable (1974) ^b
Mammals	64.4		
Birds ^c	13.9		
Invertebrates	4.4		
Vegetation	17.3		

^a Estimated with allometric equations: Water Ingestion (L/d) = $0.099W^{0.90}$, where W is weight (4.69 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

^b Estimated from seasonal diet compositions reported in Knable (1974).

^c Bird component is assumed to be equally composed of insectivorous, herbivorous, and omnivorous species.

TABLE 5.34 Exposure Factors for the White-Tailed Deer

Exposure Factor	Mean	Geographic Location	Source
Body weight (g)	49,333	New England	Forest Service (1986)
Food ingestion rate (g/g-d)	0.05	Pennsylvania	Hesselton and Hesselton (1982)
Water ingestion rate (g/g-d)	0.07		Estimated ^a
Home range (ha)	16.2	New England	Forest Service (1986)
Seasonality factor	1.0		
Diet composition (%)		New England	Forest Service (1986)
Vegetation	100		

^a Estimated with allometric equations: Water Ingestion (L/d) = $0.099W^{0.90}$, where W is weight (49.33 kg); and Water Ingestion (g/g-d) = (Water Ingestion [L/d]) ÷ W (kg) (EPA 1993b).

5.2.3.2 Equations for Exposure to Soil Contaminants

Contaminant uptake from soil could occur via (1) root uptake for plants, (2) incidental ingestion of contaminated soil, or (3) direct absorption via dermal contact. The equations used to predict contaminant uptake via these mechanisms are described in the following sections.

5.2.3.2.1 Root Uptake by Plants. Information on contaminant concentrations in vegetation is important for two reasons: (1) to evaluate potential impacts on plants and (2) to take into account that vegetation is the principal food for herbivorous species and the base of the food chain for omnivorous and predatory terrestrial species. Contaminant concentrations in aboveground plant tissue at J-Field were measured directly by tissue analyses (Section 5.1). The measured tissue concentrations were used in uptake models that included a plant ingestion pathway. If measured tissue data were unavailable, the aboveground plant tissue concentration was modeled by the following equation:

$$C_p = C_s \times SPTF$$

where

C_p = concentration of contaminant in plant tissue (mg/kg dry weight [DW]),

C_s = exposure point concentration of contaminant in soil, and

$SPTF$ = soil-to-plant transfer factor for contaminant from soil (unitless).

This approach considers root uptake as the principal uptake pathway for terrestrial vegetation. The soil-to-plant transfer factor is expressed as the ratio of the contaminant concentration in milligrams per kilogram in aboveground plant tissue to the contaminant concentration in milligrams per kilogram in dry soil. When available, soil-to-plant transfer factors from the database in Streng and Peterson (1989) were used. Alternately, the soil-to-plant transfer factor was estimated by following the approach in McKone (1993):

$$SPTF_i = 7.7 \times K_{ow}^{-0.58},$$

where K_{ow} is the contaminant-specific octanol-water partition coefficient (unitless). This approach applies only to organic contaminants and was not used to estimate uptake of inorganic contaminants.

5.2.3.2.2 Incidental Ingestion of Soil. No methods estimate soil ingestion rates without determining insoluble ash weights of gastrointestinal contents, food items, soils, and scats. The *Wildlife Exposure Factors Handbook* (EPA 1993b) provides estimates of the percent of soil in the diets of bird, mammal, and reptile species. For species for which no soil ingestion information was available, a default value of 2% of the total food ingestion was used. These values were used in the following equation to estimate contaminant uptake from incidental soil ingestion:

$$ADD_{si} = (C \times FS \times IR_{total} \times FR) / BW,$$

where

ADD_{si} = applied daily dose from incidental ingestion of soil (mg/kg-d),

C = exposure point concentration for soil at the AOC (mg/kg),

FS = fraction of soil in diet (as percentage of diet on DW basis; unitless),

IR_{total} = food ingestion rate on DW basis (kg/d),

FR = fraction of total food intake from AOC, and

BW = body weight of receptor (kg).

Species-specific ingestion rates were obtained from the *Wildlife Exposure Factors Handbook* (EPA 1993b) or the scientific literature, or they were estimated with allometric equations developed by Nagy (1987) for predicting ingestion rates of some birds, mammals, and herpetofauna as a function of body weight (in grams).

The equations used for birds were as follows:

$$IR = 0.398 BW^{0.850} \text{ for passerines, and}$$

$$IR = 0.301 BW^{0.751} \text{ for nonpasserines.}$$

The equations used for mammals were as follows:

$$IR = 0.621 BW^{0.564} \text{ for rodents,}$$

$$IR = 0.577 BW^{0.727} \text{ for nonrodent herbivores, and}$$

$$IR = 0.235 BW^{0.822} \text{ for omnivorous (nonrodent) and} \\ \text{carnivorous mammals.}$$

For herpetofauna, food ingestion allometric equations were available only for iguanid lizards, and these were used for all herpetofauna, as necessary. The equations were as follows:

$$IR = 0.019 BW^{0.841} \text{ for herbivores, and}$$

$$IR = 0.013 BW^{0.773} \text{ for insectivores.}$$

These allometric equations provide an estimate of dry food ingestion rate. Dry food ingestion rates were converted to wet food ingestion rates using methods presented by Sample et al. (1997) and water contents of food items presented in EPA (1993b).

5.2.3.2.3 Dermal Absorption from Direct Contact with Soil. Estimating contaminant uptake via dermal absorption for ecological resources is problematic, primarily because many of the required parameters have not been measured for terrestrial biota (EPA 1993b). Hope (1995) discusses two approaches for estimating dermal uptake; the following equation was used for estimating dermal uptake of contaminants by the red-spotted newt (nonbreeding adults) in the J-Field ERA:

$$ADD_{dc} = ([SA \times CD \times P_c \times C_s \times CF \times r_s \times \partial]/BW) \times q \times y,$$

where

ADD_{dc} = ADD from dermal contact (mg/kg-d);

SA = surface area of ecological receptor (cm^2);

CD = contact depth (1 cm), constant;

P_c = fraction of receptor surface area in contact with soil;

C_s = exposure point concentration (mg/kg);

CF = conversion factor (1×10^{-6} kg/mg);

r_s = bulk soil density (mg/ cm^3);

∂ = contaminant-specific dermal absorption factor (unitless);

BW = body weight (kg);

q = site-use factor, ratio of the AOC area to the home range or foraging area of the receptor; and

y = seasonality factor, percentage of time per year receptor occurs at AOC.

The surface areas of receptors were estimated by using the surface-area-to-body-weight allometric equations in the *Wildlife Exposure Factors Handbook* (EPA 1993b). Body weights were obtained either from field-measured weights or from the *Wildlife Exposure Factors Handbook* (EPA 1993b). Because contaminant-specific dermal absorption factors for wildlife were not available, a default value of 1.00 was assumed for all receptors.

5.2.3.3 Equations for Exposure to Surface Water Contaminants

Uptake of contaminants from surface water can occur via two routes: ingestion of drinking water and absorption from direct contact. Equations used to predict uptake from each of these pathways are described in the following sections.

5.2.3.3.1 Ingestion of Drinking Water. Contaminant uptake from the ingestion of contaminated drinking water was estimated with the following equation (EPA 1993b):

$$ADD_{dw} = C_{dw} \times FR \times IR_{dw} / BW ,$$

where

ADD_{dw} = ADD from drinking water (mg/kg-d),

C_{dw} = exposure point concentration at drinking water supply (mg/L),

FR = fraction of total water ingestion from contaminated source,

IR_{dw} = ingestion rate of drinking water (g/d), and

BW = body weight (g).

This equation predicts contaminant uptake from a single contaminated water supply. For wide-ranging species, ADD_{dw} values were predicted for each contaminated water source likely to be visited by the receptor. These values were then summed across all appropriate AOCs to provide a single ADD value for the drinking water pathway. Drinking water ingestion rates and body weights were obtained from the *Wildlife Exposure Factors Handbook* (EPA 1993b) and the scientific literature. Body weights were obtained from either weights taken from organisms at J-Field or the *Wildlife Exposure Factors Handbook* (EPA 1993b). At each AOC, the fraction of total water ingestion from a contaminated source was estimated by centering the receptor's home range on the AOC, identifying all surface waters within the home range, and determining the degree of overlap between the contaminated water source and the animal's home range.

5.2.3.3.2 Absorption From Direct Contact. Direct contaminant uptake from surface water is limited primarily to aquatic biota, such as fish, amphibians, and aquatic invertebrates. The contaminant concentrations in aquatic receptors were assumed to be in equilibrium with the contaminants in the water column. Contaminant concentration in a receptor was estimated with the following equation:

$$C_{ar} = C_{sw} \times BCF ,$$

where

C_{ar} = contaminant body burden in the aquatic receptor (mg/kg),

C_{sw} = exposure point concentration in the surface water (mg/L), and

BCF = contaminant-specific bioconcentration factor.

Note that C_{ar} does not represent an ADD value, but rather a tissue concentration. Site-specific BCF values were determined by using the results of tissue analyses of aquatic invertebrates and fish (Section 5.1), and additional BCF values were obtained from the scientific literature (Eisler 1986a; Jorgensen et al. 1991). If published values were not available, the octanol-water partitioning coefficient (K_{ow}) was used as an estimate of the BCF with the following equation (Lyman et al. 1990):

$$\log BCF = 0.76 \times \log K_{ow} - 0.23 .$$

5.2.3.4 Equations for Exposure to Sediment Contaminants

Contaminant uptake from sediments occurs along the same three pathways identified for contaminant uptake from contaminated soils: (1) incidental ingestion, (2) direct absorption from dermal contact, and (3) root uptake. The contaminant uptake from sediments was estimated by the same methods used for estimating uptake from soils (Section 5.2.3.2).

5.2.3.5 Equations for Ingestion of Food

Contaminant uptake via ingestion of contaminated food is probably the principal exposure pathway for terrestrial wildlife receptors at J-Field. Contaminant transport from environmental media to herbivorous receptor species is relatively straightforward, because contaminated vegetation would be the only contaminated food source. For higher trophic level receptors, complex food chains and webs are typical, and modeling contaminant uptake from environmental media to the receptor becomes more complex. Contaminant uptake from ingestion of food was estimated consistent with EPA (1993b) guidance and used the following equation:

$$ADD_{fi} = \sum_{k=1}^m (C_k \times Df_k \times SU \times NIR_k) ,$$

where

ADD_{fi} = ADD from ingestion of contaminated food (mg/kg-d);

m = number of food items in the diet of the receptor species (unitless);

C_k = contaminant concentration in food item k (mg/kg);

Df_k = fraction of the total diet represented by food item k (unitless);

SU = site-use factor, calculated as the ratio of the area of contamination to the home range area (unitless); and

NIR_k = normalized ingestion rate of food item k = [non-normalized ingestion rate (IR) (g/d)] $\div$ [body weight (BW) (g)].

The site-use factor was used to estimate the fraction of the diet obtained from a contaminated area, and this fraction of the diet was considered contaminated. Contaminant concentrations in food items (C_k) were based either on actual tissue concentrations measured for selected biota at J-Field (Section 5.1) or modeled concentrations. For the latter approach, the contaminant concentration in a lower trophic level food item is estimated as follows:

$$C_k = \sum_1^N ADD_k \times AE ,$$

where

C_k = contaminant concentration (mg/kg) in food item k resulting from all appropriate uptake pathways,

N = number of appropriate uptake pathways,

ADD_k = ADD to food item k from all appropriate uptake pathways (mg/kg),
and

AE = assimilation efficiency (%).

The types and numbers of uptake pathways vary according to food item and may include root uptake, incidental ingestion of contaminated media, and ingestion of drinking water and food.

Because the ADD represents only the dose that a receptor would receive and provides no information on how much of the dose is actually incorporated and could be passed along to other

trophic levels, some measure of contaminant assimilation was necessary to more accurately predict contaminant concentration in food items. The assimilation efficiency (*AE*) reflects the amount of the ADD that is retained and incorporated into the food item. Contaminant assimilation was estimated by using the metabolizable energy assimilation efficiencies provided in the *Wildlife Exposure Factor Handbook* (EPA 1993b) and assuming that contaminant assimilation is directly proportional to the assimilation efficiency of metabolizable energy. A default *AE* value of 1.00 (100% assimilation) was assumed for food items for which no information was available regarding assimilation efficiencies of metabolizable energy.

5.2.3.6 Multiple Exposure Pathways

To estimate the total uptake of each PCOEC by a receptor from all media and pathways (Table 5.21) at a single AOC, the ADD estimates for all appropriate pathways were summed. For wide-ranging species such as the white-tailed deer, which may visit several AOCs, all appropriate AOC-specific ADD estimates were summed to provide a sitewide total ADD. For example, the sitewide ADD for the white-tailed deer was estimated as follows:

$$ADD_{sitewide} = ADD_{TBP} + ADD_{WPP} + ADD_{RCP} + ADD_{SBT} +$$

$$ADD_{SBDG} + ADD_{RPDG} + ADD_{RPT} + ADD_{PB}.$$

For some receptors, one or more of these terms will be zero because the receptor was not considered to use a particular AOC.

5.2.3.7 Model Uncertainties

The principal uncertainties associated with these model assumptions are related to (1) estimating contaminant transfer between and assimilation within trophic levels; (2) using a uniform foraging activity over the entire home range of a species; and (3) using exposure factor data from geographically different populations, allometric equations, or different species.

The transfer and assimilation of contaminants between and within trophic levels are affected by a variety of factors not addressed by the uptake models. These factors include, but are not limited to, the following: (1) contaminant solubility in biological fluids, (2) location of the contaminant in a food item relative to the portion of the food item eaten, (3) species metabolism, (4) contaminant biotransformation, and (5) depuration. For most biota, it is unlikely that the transfer or assimilation of a contaminant is 100% efficient. Thus, assuming 100% contaminant assimilation likely overestimates the true degree of contaminant movement and assimilation within food chains. Furthermore, it is not known whether the assimilation efficiency of metabolizable energy is directly

proportional to contaminant assimilation, and the use of the assimilation efficiency of metabolizable energy does not take into account contaminant depuration or detoxification.

The assumption that foraging activity is constant over the entire home range is probably inaccurate. Most biological resources, including food and water, are not distributed homogeneously but in a patchy, heterogeneous manner in the environment. Therefore, foraging activity would also occur in a patchy manner.

Estimating the contaminant uptake required the use of biological data from species that differed taxonomically from the receptor species, data from taxonomically identical species but geographically different populations, or data that were allometrically derived. When species-specific data were not available, exposure factors for surrogate species were used for uptake modeling. Because of differences in behavior, physiology, and genetics among taxa, this approach may overestimate or underestimate the ADD. This uncertainty is smallest when closely related species (e.g., same genus) are used, and it increases with a decreasing level of taxonomic similarity (e.g., same family but different genus).

Extrapolations within a particular taxon can also add uncertainty to the model results. Although exposure factor data were available for many of the species of concern, the data were typically from populations other than those found at J-Field. Physiological parameters (e.g., metabolic rate, body weight, ingestion rate) and life history variables (e.g., home range, diet composition, foraging habitat) may differ among populations inhabiting different portions of the total geographic range of the species (e.g., Florida and Wisconsin for the eastern cottontail). Thus, many of the exposure factor values used in this ERA may not accurately reflect the actual values for populations at J-Field.

Uncertainty also arises in extrapolating the outcome of contaminant uptake modeling to effects on populations and communities at the affected site. While contaminant uptake models provide an indication of the doses that individual organisms receive and can be used to evaluate risks to such individuals from contaminants, the link between exposure to individuals and population-level or community-level ecological effects can only be inferred, with a relatively high degree of uncertainty. However, because tools for evaluating population-level effects from contaminants in the field are limited, the contaminant uptake models were used as one line of evidence to evaluate the ecological risk at J-Field.

5.2.4 Applied Daily Dose Estimates

5.2.4.1 Toxic Burning Pits

Tables 5.35 and 5.36¹ present estimates of tissue PCOEC concentrations expected to result from contact with media in the TBP AOC for plants and aquatic animal receptors, respectively. These results were incorporated into the models used for estimating ADDs to organisms in higher trophic levels. Tables 5.37 through 5.48 present estimates of ADDs expected to occur through ingestion of water, incidental ingestion of soil or sediment, and ingestion of food and the total ADD from the TBP AOC for the receptors modeled.

5.2.4.2 White Phosphorus Burning Pits

Table 5.49 presents estimates of tissue concentrations of PCOECs expected to result from contact with media for plants and aquatic receptors in the WPP AOC. These results were incorporated into the models used for estimating ADDs to organisms in higher trophic levels at the WPP AOC. Table 5.50 presents estimates of ADDs of PCOECs expected through ingestion of water, incidental ingestion of soil, and ingestion of food and the total ADD from the WPP AOC for the receptors modeled.

5.2.4.3 Riot Control Pit

Table 5.51 presents the modeled estimates of tissue PCOEC concentrations that would result from exposure to contaminated media at the RCP AOC for maple trees, breeding red-spotted newts, and leopard frogs. Table 5.52 presents the estimates of ADDs from dermal absorption (nonbreeding red-spotted newts only), incidental soil ingestion, ingestion of surface water, and food ingestion, as well as the total ADD for various receptors.

5.2.4.4 South Beach Trench

Table 5.53 presents estimated concentrations of PCOECs in tissues of plant and aquatic amphibians (breeding phase of red-spotted newts and leopard frogs) from the SBT AOC. Table 5.54 presents the estimated ADDs for terrestrial amphibians (nonbreeding red-spotted newts), snakes, birds, and mammals. Because no contaminants were detected in surface water samples from the SBT AOC, the predominant pathway for uptake by organisms in this area was incidental ingestion of soil

¹ For the sake of readability, all the tables mentioned in Section 5.2.4 appear at the end of Section 5.

and absorption of contaminants through dermal contact with soil (terrestrial phase of red-spotted newts only).

5.2.4.5 Robins Point Demolition Ground

Table 5.55 presents estimated concentrations of PCOECs for terrestrial vegetation and the aquatic phase of red-spotted newts at the RPDG AOC. Table 5.56 presents ADDs for other receptors at the RPDG.

5.2.4.6 Robins Point Tower

Because no final PCOECs were identified for this AOC, uptake for receptors at this site was not modeled.

5.2.4.7 Prototype Building

Eight PCOECs were identified for the PB AOC. Table 5.57 presents the estimated tissue PCOEC concentrations in terrestrial vegetation at the PB AOC. Table 5.58 presents the modeled estimated ADD for nine receptors likely to be found at this AOC.

5.2.4.8 Craters

Uptake to receptors was not modeled for the Craters PAOC because only sediment and soil chemical data were collected, and the principal receptors would be affected by concentrations in surface water. However, potential effects to amphibians that use such areas as breeding habitats during wet portions of the year were evaluated by examining residuals data for frogs collected from the craters and evaluating the reproductive performance of amphibians (primarily red-spotted newts) that use these ephemeral habitats.

5.2.4.9 Sitewide ADD

The sitewide ADDs for the PCOECs were calculated by summing the ADDs for the tree swallow, American kestrel, red-tailed hawk, white-tailed deer, and red fox for individual AOCs that contained suitable habitat. Sitewide ADDs were calculated for these receptors because their home ranges or territories are large enough to encompass multiple AOCs. Tables 5.59 through 5.63 present the sitewide ADDs. The sitewide ADDs are < 0.01 mg/kg-d for many of the contaminants identified as final PCOECs.

TABLE 5.35 Estimated Concentrations (mg/kg) of Contaminants in Tissues of Plant Receptors at the Toxic Burning Pits

Contaminant	Organism		
	Common Reed	Grasses	Maple
1,1-Oxathiane	- ^a	-	-
1,1,2,2-Tetrachloroethane	0.009	1.008	1.008
1,1-Dichloroethene	-	0.084	0.084
1,4-Dichlorobenzene	0.003	-	-
1,4-Dithiane	-	-	-
1,4-Oxathiane	-	-	-
2,4,6-Trichloroaniline	-	7.900 ^b	7.900 ^b
2,4-Dinitrotoluene	1.426	-	-
2-Butanone	0.200 ^c	0.037 ^b	0.037 ^b
2-Methylnaphthalene	-	0.007	0.007
2-Methylphenol	1.126 ^d	0.88	0.88
4,4'-DDE	<0.001	-	-
4-Methylphenol	-	0.928	0.928
Acetone	2.660	0.266	0.266
Aluminum	7.70 ^d	4.07	4.07
Antimony	0.175	5.51	5.51
Aroclor 1248	-	0.003	0.003
Arsenic	0.12 ^d	14.4	14.4
Barium	4.70 ^d	237	237
Benzo(b)fluoranthene	-	0.004	0.004
Benzo(k)fluoranthene	-	0.004	0.004
Cadmium	3.872	19.53	19.53
Calcium	841 ^d	36,000 ^b	36,000 ^b
Carbon disulfide	-	0.03	0.03
Chloroethane	-	-	-
Chloroform	-	0.035	0.035
Chromium	0.91 ^d	6.58	6.58
Cobalt	0.50 ^d	1.10	1.10
Copper	3.1 ^d	561.6	561.6
Cyanide	-	1,620	1,620
Diethyl phthalate	-	0.734	0.734
DIMP	-	-	-
Dithiane	-	-	-

TABLE 5.35 (Cont.)

Contaminant	Organism		
	Common Reed	Grasses	Maple
Fluorene	-	0.05	0.05
Hexachlorobenzene	0.003	0.028	0.028
Hexachloroethane	-	0.027	0.027
Iron	22.0 ^d	616	616
Lead	0.58 ^d	6,405.6	6,405.6
Magnesium	509 ^d	504	504
Manganese	39.50 ^d	18.99	18.99
Mercury	0.650	1.368	1.368
N-Nitrosodiphenylamine	-	0.188	0.188
Nickel	1.0 ^d	5.1	5.1
Nitroglycerin	-	13.54	13.54
Phenol	-	1.74	1.74
Pyrene	0.003	0.010	0.010
Selenium	0.11 ^d	9.26	9.26
Silver	5.61	62.85	62.85
Sodium	668 ^d	26	26
Tetrachloroethene	-	0.30	0.30
Thallium	-	4.83	4.83
Trichloroethene	0.012	1.142	1.142
Vinyl chloride	0.083	-	-
Zinc	26.9 ^d	7,120	7,120

^a - = not detected in source medium (soil or sediment). Resulting concentration in plant tissues was assumed to be zero for modeling contaminant uptake by ecological receptors.

^b Since no information on soil-to-plant transfer factors was available, the soil exposure point concentration was used as the plant tissue concentration.

^c Since no information on soil-to-plant transfer factors was available, the sediment exposure point concentration was used as the plant tissue concentration.

^d Value based on information from residuals analysis of aboveground tissues of common reed collected from the TBP AOC.

TABLE 5.36 Estimated Concentrations (mg/kg) of Contaminants in Tissues of Aquatic Animal Receptors at the Toxic Burning Pits Area

Contaminant	Organism	
	Fish	Leopard Frog
1,1-Oxathiane	0.012 ^a	0.012 ^a
1,1,2,2-Tetrachloroethane	4.35	4.35
1,1-Dichloroethene	- ^b	-
1,4-Dichlorobenzene	-	-
1,4-Dithiane	0.002 ^a	0.002 ^a
1,4-Oxathiane	0.010 ^a	0.010 ^a
2,4,6-Trichloroaniline	-	-
2,4-Dinitrotoluene	-	-
2-Butanone	-	-
2-Methylnaphthalene	-	-
2-Methylphenol	-	-
4,4'-DDE	0.136 ^c	-
4-Methylphenol	-	-
Acetone	0.022	0.022
Aluminum	30.3 ^d	4,158
Antimony	<0.001	<0.001
Aroclor 1248	-	-
Arsenic	0.44 ^d	0.15
Barium	12.2 ^c	4.47
Benzo(b)fluoranthene	-	-
Benzo(k)fluoranthene	-	-
Cadmium	1.16 ^d	0.1
Calcium	90,028 ^c	205 ^a
Carbon disulfide	-	-
Chloroethane	0.07	0.07
Chloroform	-	-
Chromium	2.32 ^d	0.22
Cobalt	3.25 ^d	4.16
Copper	5.58 ^d	2.63
Cyanide	-	-
Diethyl phthalate	-	-
DIMP	<0.001 ^a	<0.001 ^a
Dithiane	0.004 ^a	0.004 ^a

TABLE 5.36 (Cont.)

Contaminant	Organism	
	Fish	Leopard Frog
Fluorene	-	-
Hexachlorobenzene	-	-
Hexachloroethane	-	-
Iron	151 ^c	1,355
Lead	1.19 ^c	159
Magnesium	2,400 ^c	1,706
Manganese	61.1 ^c	85.1
Mercury	0.11 ^d	0.27
N-Nitrosodiphenylamine	-	-
Nickel	6.28 ^d	9.86
Nitroglycerin	-	-
Phenol	-	-
Pyrene	-	-
Selenium	1.96 ^c	1.60
Silver	0.24 ^d	1.14
Sodium	5,280 ^c	7,168
Tetrachloroethene	-	-
Thallium	-	-
Trichloroethene	137.0	137.0
Vinyl chloride	0.82	0.82
Zinc	273 ^c	921

^a Because no information on bioconcentration factor was available, the surface water exposure point concentration was used as the estimated fish or amphibian tissue concentration.

^b - = not detected in source medium (surface water).
Resulting concentration in organism tissues was assumed to be zero for modeling contaminant uptake to predators.

^c Value based on results of residuals analysis of fish tissues collected from the TBP AOC (Table 5.4).

^d Not detected during residuals analysis of fish tissues.
Value used is one-half the detection limit for the analysis.

TABLE 5.37 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for Black Racers at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	0.001	- ^a	<0.001	0.001
1,1,2,2-Tetrachloroethane	0.277	<0.001	0.264	0.304
1,1-Dichloroethene	-	<0.001	0.001	0.001
1,4-Dichlorobenzene	-	-	-	-
1,4-Dithiane	<0.001	-	<0.001	<0.001
1,4-Oxathiane	0.001	-	<0.001	0.001
2,4,6-Trichloroaniline	-	0.002	0.047	0.049
2,4-Dinitrotoluene	-	-	-	-
2-Butanone	-	<0.001	<0.001	<0.001
2-Methylnaphthalene	-	<0.001	<0.001	<0.001
2-Methylphenol	-	<0.001	0.005	0.006
4,4'-DDE	-	-	-	-
4-Methylphenol	-	<0.001	0.006	0.006
Acetone	0.002	<0.001	0.002	0.004
Aluminum	1.147	5.537	17.842	24.526
Antimony	0.002	0.123	0.051	0.176
Aroclor 1248	-	<0.001	<0.001	<0.001
Arsenic	0.002	0.353	0.009	0.364
Barium	0.036	0.387	0.042	0.465
Benzo(b)fluoranthene	-	<0.001	<0.001	<0.001
Benzo(k)fluoranthene	-	<0.001	<0.001	<0.001
Cadmium	0.001	0.009	0.288	0.298
Calcium	13.059	8.820	39.587	61.466
Carbon disulfide	-	<0.001	<0.001	<0.001
Chloroethane	0.008	-	<0.001	0.008
Chloroform	-	<0.001	<0.001	<0.001
Chromium	0.004	0.215	0.022	0.242
Cobalt	0.007	0.026	0.027	0.060
Copper	0.033	1.058	0.829	1.920
Cyanide	-	0.029	9.595	9.625
Diethyl phthalate	-	<0.001	0.004	0.005

TABLE 5.37 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
DIMP	<0.001	-	<0.001	<0.001
Dithiane	<0.001	-	<0.001	<0.001
Fluorene	-	<0.001	<0.001	0.001
Hexachlorobenzene	-	<0.001	<0.001	0.001
Hexachloroethane	-	<0.001	<0.001	0.001
Iron	11.536	37.730	12.521	61.787
Lead	0.101	23.079	0.695	23.876
Magnesium	14.524	0.951	13.348	28.822
Manganese	0.236	0.155	0.629	1.020
Mercury	<0.001	0.001	0.002	0.003
N-Nitrosodiphenylamine	-	<0.001	0.001	0.001
Nickel	0.007	0.021	0.073	0.102
Nitroglycerin	-	0.004	0.081	0.084
Phenol	-	<0.001	0.010	0.011
Pyrene	-	<0.001	<0.001	<0.001
Selenium	<0.001	0.002	0.062	0.064
Silver	<0.001	0.010	0.378	0.389
Sodium	61.025	0.128	49.440	110.59
Tetrachloroethane	-	<0.001	0.002	<0.002
Thallium	-	0.005	0.029	0.034
Trichloroethene	0.230	<0.001	0.568	0.799
Vinyl chloride	0.008	-	0.003	0.011
Zinc	0.257	4.361	11.158	15.776

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. Consequently, this value is assumed to be zero.

TABLE 5.38 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for Mallards at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Incidental Sediment Ingestion	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	<0.001	- ^a	-	<0.001	<0.001
1,1,2,2-Tetrachloroethane	0.002	<0.001	<0.001	<0.001	0.003
1,1-Dichloroethene	-	-	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	-	<0.001	-	<0.001	<0.001
1,4-Dithiane	<0.001	-	-	<0.001	<0.001
1,4-Oxathiane	<0.001	-	-	<0.001	<0.001
2,4,6-Trichloroaniline	-	-	<0.001	0.003	0.004
2,4-Dinitrotoluene	-	<0.001	-	0.001	<0.001
2-Butanone	-	<0.001	<0.001	<0.001	<0.001
2-Methylnaphthalene	-	-	<0.001	<0.001	<0.001
2-Methylphenol	-	-	0.010	0.087	0.10
4,4'-DDE	-	<0.001	-	<0.001	<0.001
4-Methylphenol	-	-	<0.001	<0.001	<0.001
Acetone	<0.001	<0.001	<0.001	<0.001	<0.001
Aluminum	0.009	0.895	0.752	17.534	19.190
Antimony	<0.001	0.001	0.017	0.012	0.029
Aroclor 1248	-	-	<0.001	<0.001	<0.001
Arsenic	<0.001	<0.001	0.048	0.015	0.063
Barium	<0.001	0.031	0.053	0.679	0.763
Benzo(b)fluoranthene	-	-	<0.001	<0.001	<0.001
Benzo(k)fluoranthene	-	-	<0.001	<0.001	<0.001
Cadmium	<0.001	<0.001	0.001	0.027	0.038
Calcium	0.108	0.190	1.198	18.576	20.072
Carbon disulfide	-	-	<0.001	<0.001	<0.001
Chloroethane	<0.001	-	-	<0.001	<0.001
Chloroform	-	-	<0.001	<0.001	<0.001
Chromium	<0.001	0.003	0.029	0.555	0.087
Cobalt	<0.001	<0.001	0.004	0.006	0.010
Copper	<0.001	0.017	0.144	0.555	0.176
Cyanide	-	-	0.004	0.674	0.678
Diethyl phthalate	-	-	<0.001	<0.001	<0.001
DIMP	<0.001	-	-	<0.001	<0.001
Dithiane	<0.001	-	-	<0.001	<0.001

TABLE 5.38 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Incidental Sediment Ingestion	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
Fluorene	-	-	<0.001	<0.001	<0.001
Hexachlorobenzene	-	<0.001	<0.001	<0.001	<0.001
Hexachloroethane	-	-	<0.001	<0.001	<0.001
Iron	0.095	1.184	5.123	22.496	28.899
Lead	<0.001	0.059	3.134	3.779	6.973
Magnesium	0.120	0.170	0.129	3.439	3.858
Manganese	0.002	0.005	0.021	0.108	0.137
Mercury	<0.001	<0.001	<0.001	0.009	0.009
N-Nitrosodiphenylamine	-	-	<0.001	<0.001	<0.001
Nickel	<0.001	0.001	0.003	0.026	0.030
Nitroglycerin	-	-	0.001	0.006	0.006
Phenol	-	-	<0.001	0.001	0.001
Pyrene	-	<0.001	<0.001	<0.001	<0.001
Selenium	<0.001	<0.001	<0.001	0.023	0.023
Silver	<0.001	<0.001	<0.001	0.028	0.030
Sodium	0.505	0.059	0.017	1.295	1.876
Tetrachloroethene	-	-	<0.001	<0.001	<0.001
Thallium	-	-	0.001	0.003	0.003
Trichloroethene	0.002	<0.001	<0.001	0.029	0.029
Vinyl chloride	<0.001	<0.001	-	<0.001	<0.001
Zinc	0.002	0.113	0.592	78.178	78.885

^a "-" denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the uptake modeling.

TABLE 5.39 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for Great Blue Herons at the Toxic Burning Pits Area

Contaminant	ADD from Water Ingestion	ADD from Incidental Sediment Ingestion	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	<0.001	- ^a	<0.001	<0.001
1,1,2,2-Tetrachloroethane	0.004	<0.001	0.014	0.018
1,1-Dichloroethene	-	-	-	-
1,4-Dichlorobenzene	-	<0.001	-	<0.001
1,4-Dithiane	<0.001	-	<0.001	<0.001
1,4-Oxathiane	<0.001	-	<0.001	<0.001
2,4,6-Trichloroaniline	-	-	-	-
2,4-Dinitrotoluene	-	<0.001	-	<0.001
2-Butanone	-	<0.001	-	<0.001
2-Methylnaphthalene	-	-	-	-
2-Methylphenol	-	-	-	-
4,4'-DDE	-	<0.001	<0.001	<0.001
4-Methylphenol	-	-	-	-
Acetone	<0.001	<0.001	<0.001	<0.001
Aluminum	0.015	1.762	0.340	2.147
Antimony	<0.001	0.001	<0.001	0.001
Aroclor 1248	-	-	-	-
Arsenic	<0.001	0.001	0.001	0.002
Barium	<0.001	0.061	0.039	0.101
Benzo(b)fluoranthene	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-
Cadmium	<0.001	<0.001	0.008	0.009
Calcium	0.168	0.375	289.05	289.59
Carbon disulfide	-	-	-	-
Chloroethane	<0.001	-	<0.001	<0.001
Chloroform	-	-	-	-
Chromium	<0.001	0.005	0.007	0.013
Cobalt	<0.001	<0.001	0.011	0.011
Copper	<0.001	0.034	0.018	0.052
Cyanide	-	-	-	-
Diethyl phthalate	-	-	-	-
DIMP	<0.001	-	<0.001	<0.001
Dithiane	<0.001	-	<0.001	<0.001

TABLE 5.39 (Cont.)

Contaminant	ADD from Water Ingestion	ADD from Incidental Sediment Ingestion	ADD from Food Ingestion	Total ADD
Fluorene	-	-	-	-
Hexachlorobenzene	-	<0.001	-	-
Hexachloroethane	-	-	-	-
Iron	0.148	2.333	0.574	3.054
Lead	0.001	0.117	0.014	0.132
Magnesium	0.187	0.335	7.817	8.338
Manganese	0.003	0.010	0.202	0.215
Mercury	<0.001	<0.001	<0.001	<0.001
N-Nitrosodiphenylamine	-	-	-	-
Nickel	<0.001	0.002	0.021	0.023
Nitroglycerin	-	-	-	-
Phenol	-	-	-	-
Pyrene	-	<0.001	-	<0.001
Selenium	<0.001	<0.001	0.006	0.007
Silver	<0.001	<0.001	<0.001	0.001
Sodium	0.785	0.117	17.421	18.322
Tetrachloroethene	-	-	-	-
Thallium	-	-	-	-
Trichloroethene	0.003	<0.001	0.449	0.452
Vinyl chloride	<0.001	<0.001	0.003	0.003
Zinc	0.003	0.223	0.937	1.164

^a "-" denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the uptake modeling.

TABLE 5.40 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for American Robins at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	0.002	- ^a	-	0.002
1,1,2,2-Tetrachloroethane	0.609	0.152	1.531	2.292
1,1-Dichloroethene	-	0.006	0.127	0.133
1,4-Dichlorobenzene	-	-	-	-
1,4-Dithiane	<0.001	-	-	<0.001
1,4-Oxathiane	0.001	-	-	0.001
2,4,6-Trichloroaniline	-	0.480	12.008	12.488
2,4-Dinitrotoluene	-	-	-	-
2-Butanone	-	0.002	0.056	0.058
2-Methylnaphthalene	-	0.076	0.011	0.087
2-Methylphenol	-	0.076	1.338	1.414
4,4'-DDE	-	-	-	-
4-Methylphenol	-	0.076	1.410	1.486
Acetone	0.004	0.001	0.404	0.410
Aluminum	2.520	1,374.0	6.183	1,382.8
Antimony	0.005	30.461	8.377	38.842
Aroclor 1248	-	0.035	0.004	0.039
Arsenic	0.005	87.552	13.437	100.99
Barium	0.078	96.064	22.055	118.20
Benzo(b)fluoranthene	-	0.076	0.006	0.082
Benzo(k)fluoranthene	-	0.076	0.006	0.082
Cadmium	0.002	2.158	20.585	22.745
Calcium	28.700	2,188.8	33,956	36,174
Carbon disulfide	-	0.002	0.039	0.041
Chloroethane	0.018	-	-	0.018
Chloroform	-	0.003	0.054	0.057
Chromium	0.009	53.382	7.646	61.037
Cobalt	0.015	6.566	1.543	8.124
Copper	0.074	262.65	538.81	801.54
Cyanide	-	7.296	2,462.4	2,469.7
Diethyl phthalate	-	0.122	1.116	1.237
DIMP	<0.001	-	-	<0.001
Dithiane	<0.001	-	-	<0.001

TABLE 5.40 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
Fluorene	-	0.076	0.069	0.145
Hexachlorobenzene	-	0.188	0.043	0.232
Hexachloroethane	-	0.076	0.040	0.116
Iron	25.354	9,363.2	649.95	10,039
Lead	0.223	5,726.4	5,847.9	11,575
Magnesium	31.920	235.90	1,134.9	1,402.7
Manganese	0.518	38.486	45.834	84.838
Mercury	<0.001	0.0219	1.249	1.468
N-Nitrosodiphenylamine	-	0.076	0.285	0.361
Nickel	0.016	5.138	7.706	12.860
Nitroglycerin	-	0.930	20.582	21.512
Phenol	-	0.076	2.641	2.717
Pyrene	-	0.076	0.015	0.091
Selenium	<0.001	0.433	14.069	14.502
Silver	0.001	2.548	95.532	98.081
Sodium	134.12	31.677	2,334.2	2,500.0
Tetrachloroethene	-	0.061	0.462	0.523
Thallium	-	1.173	7.334	8.507
Trichloroethene	0.506	0.170	1.736	2.413
Vinyl chloride	0.018	-	-	0.018
Zinc	0.566	1,082.2	6,640.6	7,723.4

^a "-" denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the uptake modeling.

TABLE 5.41 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for Tree Swallows at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	<0.001	- ^a	<0.001
1,1,2,2-Tetrachloroethane	0.048	0.043	0.091
1,1-Dichloroethene	-	0.004	0.004
1,4-Dichlorobenzene	-	-	-
1,4-Dithiane	<0.001	-	<0.001
1,4-Oxathiane	<0.001	-	<0.001
2,4,6-Trichloroaniline	-	0.334	0.334
2,4-Dinitrotoluene	-	-	-
2-Butanone	-	0.002	0.002
2-Methylnaphthalene	-	<0.001	0.001
2-Methylphenol	-	0.037	0.037
4,4'-DDE	-	-	-
4-Methylphenol	-	0.039	0.039
Acetone	<0.001	0.011	0.012
Aluminum	0.198	0.172	0.371
Antimony	<0.001	0.233	0.234
Aroclor 1248	-	<0.001	<0.001
Arsenic	<0.001	0.021	0.022
Barium	0.006	0.031	0.037
Benzo(b)fluoranthene	-	<0.001	<0.001
Benzo(k)fluoranthene	-	<0.001	<0.001
Cadmium	<0.001	0.193	0.194
Calcium	2.260	78.327	80.587
Carbon disulfide	-	0.001	0.001
Chloroethane	0.001	-	0.001
Chloroform	-	0.001	0.001
Chromium	0.001	0.114	0.115
Cobalt	0.001	0.043	0.044
Copper	0.006	1.854	1.860
Cyanide	-	68.589	68.589
Diethyl phthalate	-	0.031	0.031
DIMP	<0.001	-	<0.001
Dithiane	<0.001	-	<0.001

TABLE 5.41 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Food Ingestion	Total ADD
Fluorene	-	0.002	0.002
Hexachlorobenzene	-	0.001	0.001
Hexachloroethane	-	0.001	0.001
Iron	1.997	6.139	8.136
Lead	0.018	0.418	0.436
Magnesium	2.514	46.996	49.510
Manganese	0.041	1.986	2.026
Mercury	<0.001	<0.001	<0.001
N-Nitrosodiphenylamine	-	0.008	0.008
Nickel	0.001	0.215	0.216
Nitroglycerin	-	0.573	0.573
Phenol	-	0.074	0.074
Pyrene	-	<0.001	<0.001
Selenium	<0.001	0.392	0.392
Silver	<0.001	2.661	2.661
Sodium	10.562	160.89	171.45
Tetrachloroethene	-	0.013	0.013
Thallium	-	0.204	0.204
Trichloroethene	0.040	0.048	0.088
Vinyl chloride	0.001	-	0.001
Zinc	0.045	10.246	10.291

^a "-" denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the uptake modeling.

TABLE 5.42 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for American Kestrels at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	<0.001	<0.001	<0.001
1,1,2,2-Tetrachloroethane	0.006	0.004	0.010
1,1-Dichloroethene	- ^a	<0.001	0.001
1,4-Dichlorobenzene	-	-	-
1,4-Dithiane	<0.001	<0.001	<0.001
1,4-Oxathiane	<0.001	<0.001	<0.001
2,4,6-Trichloroaniline	-	0.022	0.022
2,4-Dinitrotoluene	-	-	-
2-Butanone	-	<0.001	<0.001
2-Methylnaphthalene	-	<0.001	<0.001
2-Methylphenol	-	0.002	0.002
4,4'-DDE	-	-	-
4-Methylphenol	-	0.003	0.003
Acetone	<0.001	0.001	0.001
Aluminum	0.024	0.824	0.848
Antimony	<0.001	0.033	0.033
Aroclor 1248	-	<0.001	<0.001
Arsenic	<0.001	0.052	0.052
Barium	0.001	0.067	0.068
Benzo(b)fluoranthene	-	<0.001	<0.001
Benzo(k)fluoranthene	-	<0.001	<0.001
Cadmium	<0.001	0.024	0.024
Calcium	0.271	42.662	42.934
Carbon disulfide	-	<0.001	<0.001
Chloroethane	<0.001	<0.001	<0.001
Chloroform	-	<0.001	<0.001
Chromium	<0.001	0.035	0.035
Cobalt	<0.001	0.007	0.007
Copper	0.001	0.823	0.824
Cyanide	-	4.401	4.401
Diethyl phthalate	-	0.002	0.002
DIMP	<0.001	<0.001	<0.001
Dithiane	<0.001	<0.001	<0.001

TABLE 5.42 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Food Ingestion	Total ADD
Fluorene	-	<0.001	<0.001
Hexachlorobenzene	-	<0.001	<0.001
Hexachloroethane	-	<0.001	<0.001
Iron	0.240	6.429	6.669
Lead	0.002	7.908	7.910
Magnesium	0.302	2.571	2.873
Manganese	0.005	0.121	0.126
Mercury	<0.001	0.002	0.002
N-Nitrosodiphenylamine	-	0.001	0.001
Nickel	<0.001	0.017	0.017
Nitroglycerin	-	0.037	0.037
Phenol	-	0.005	0.005
Pyrene	-	<0.001	<0.001
Selenium	<0.001	0.025	0.025
Silver	<0.001	0.172	0.172
Sodium	1.269	6.590	7.859
Tetrachloroethene	-	0.001	0.001
Thallium	-	0.014	0.014
Trichloroethene	0.005	0.004	0.009
Vinyl chloride	<0.001	<0.001	0.001
Zinc	0.005	8.604	8.609

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the uptake modeling.

TABLE 5.43 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for Red-Tailed Hawks at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	<0.001	<0.001	<0.001
1,1,2,2-Tetrachloroethane	0.001	<0.001	0.001
1,1-Dichloroethene	-	<0.001	<0.001
1,4-Dichlorobenzene	-	-	-
1,4-Dithiane	<0.001	<0.001	<0.001
1,4-Oxathiane	<0.001	<0.001	<0.001
2,4,6-Trichloroaniline	-	0.001	0.001
2,4-Dinitrotoluene	-	-	-
2-Butanone	-	<0.001	<0.001
2-Methylnaphthalene	-	0.001	<0.001
2-Methylphenol	-	<0.001	<0.001
4,4'-DDE	-	-	-
4-Methylphenol	-	<0.001	<0.001
Acetone	<0.001	<0.001	<0.001
Aluminum	0.002	0.045	0.047
Antimony	<0.001	0.001	0.001
Aroclor 1248	-	<0.001	<0.001
Arsenic	<0.001	0.001	0.001
Barium	<0.001	0.002	0.002
Benzo(b)fluoranthene	-	<0.001	<0.001
Benzo(k)fluoranthene	-	<0.001	<0.001
Cadmium	<0.001	<0.212	<0.001
Calcium	0.025	1.747	1.771
Carbon disulfide	-	<0.001	<0.001
Chloroethane	<0.001	<0.001	<0.001
Chloroform	-	<0.001	<0.001
Chromium	<0.001	0.001	0.001
Cobalt	<0.001	<0.001	<0.001
Copper	<0.001	0.035	0.035
Cyanide	-	0.136	0.136
Diethyl phthalate	-	<0.001	<0.001
DIMP	<0.001	<0.001	<0.001
Dithiane	<0.001	<0.001	<0.001

TABLE 5.43 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Food Ingestion	Total ADD
Fluorene	-	<0.001	<0.001
Hexachlorobenzene	-	<0.001	<0.001
Hexachloroethane	-	<0.001	<0.001
Iron	0.022	0.335	0.357
Lead	<0.001	0.185	0.186
Magnesium	0.027	0.080	0.107
Manganese	0.001	0.004	0.004
Mercury	<0.001	<0.001	<0.001
N-Nitrosodiphenylamine	-	<0.001	<0.001
Nickel	<0.001	0.001	0.001
Nitroglycerin	-	0.001	0.001
Phenol	-	<0.001	<0.001
Pyrene	-	<0.001	<0.001
Selenium	<0.001	0.001	0.001
Silver	<0.001	0.005	0.005
Sodium	0.115	0.177	0.292
Tetrachloroethene	-	<0.001	<0.001
Thallium	-	<0.001	<0.001
Trichloroethene	<0.001	<0.001	<0.001
Vinyl chloride	<0.001	<0.001	<0.001
Zinc	0.001	0.360	0.361

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the uptake modeling.

TABLE 5.44 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for Muskrats at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Incidental Sediment Ingestion	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	0.001	- ^a	0.002	0.003
1,1,2,2-Tetrachloroethane	0.417	<0.001	2.433	2.851
1,1-Dichloroethene	-	-	-	-
1,4-Dichlorobenzene	-	0.006	<0.001	0.006
1,4-Dithiane	<0.001	-	<0.001	0.001
1,4-Oxathiane	0.001	-	0.002	0.003
2,4,6-Trichloroaniline	-	-	-	-
2,4-Dinitrotoluene	-	0.036	0.242	0.278
2-Butanone	-	0.003	0.034	0.037
2-Methylnaphthalene	-	-	-	-
2-Methylphenol	-	-	0.191	0.191
4,4'-DDE	-	<0.001	<0.001	<0.001
4-Methylphenol	-	-	-	-
Acetone	0.003	0.003	0.458	0.465
Aluminum	1.728	475.30	24.204	483.23
Antimony	0.003	0.270	0.072	0.345
Aroclor 1248	-	-	-	-
Arsenic	0.003	0.240	0.067	0.310
Barium	0.054	15.759	1.510	17.323
Benzo(b)fluoranthene	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-
Cadmium	0.001	0.120	0.675	0.796
Calcium	19.680	97.240	177.82	294.74
Carbon disulfide	-	-	-	-
Chloroethane	0.012	-	0.012	0.024
Chloroform	-	-	-	-
Chromium	0.006	1.363	0.237	1.607
Cobalt	0.010	0.153	0.217	0.380
Copper	0.050	8.755	1.195	10.000
Cyanide	-	-	<0.001	<0.001
Diethyl phthalate	-	-	-	-
DIMP	<0.001	-	<0.001	<0.001
Dithiane	<0.001	-	0.001	0.001

TABLE 5.44 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Incidental Sediment Ingestion	ADD from Food Ingestion	Total ADD
Fluorene	-	-	-	-
Hexachlorobenzene	<0.001	0.006	0.001	0.007
Hexachloroethane	-	-	-	-
Iron	17.386	605.20	234.09	856.67
Lead	0.153	30.260	2.121	32.534
Magnesium	21.888	86.870	376.53	485.29
Manganese	0.355	2.720	11.421	14.496
Mercury	<0.001	0.029	0.113	0.142
N-Nitrosodiphenylamine	-	-	-	-
Nickel	0.011	0.598	0.318	0.927
Nitroglycerin	-	-	-	-
Phenol	-	-	-	-
Pyrene	-	0.006	0.001	0.007
Selenium	<0.001	0.030	0.023	0.053
Silver	0.001	0.064	0.963	1.028
Sodium	91.968	30.260	1,332.1	1,454.3
Tetrachloroethene	-	-	-	-
Thallium	-	-	-	-
Trichloroethene	0.347	<0.001	0.238	0.585
Vinyl chloride	0.012	0.001	0.026	0.039
Zinc	0.388	57.970	9.712	68.069

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the uptake modeling.

TABLE 5.45 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for White-Footed Mice at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	0.002	- ^a	-	0.002
1,1,2,2-Tetrachloroethane	0.635	0.023	0.453	1.111
1,1-Dichloroethene	-	0.001	0.038	0.039
1,4-Dichlorobenzene	-	-	-	-
1,4-Dithiane	<0.001	-	-	<0.001
1,4-Oxathiane	0.001	-	-	0.001
2,4,6-Trichloroaniline	-	0.071	3.555	3.626
2,4-Dinitrotoluene	-	-	-	-
2-Butanone	-	<0.001	0.017	0.017
2-Methylnaphthalene	-	0.011	0.003	0.014
2-Methylphenol	-	0.011	0.396	0.407
4,4'-DDE	-	-	-	-
4-Methylphenol	-	0.011	0.417	0.429
Acetone	0.005	<0.001	0.120	0.125
Aluminum	2.628	203.40	1.831	207.86
Antimony	0.005	4.509	2.480	6.994
Aroclor 1248	-	0.005	0.001	0.006
Arsenic	0.005	12.960	2.852	15.817
Barium	0.082	14.220	4.669	18.970
Benzo(b)fluoranthene	-	0.011	0.002	0.013
Benzo(k)fluoranthene	-	0.011	0.002	0.013
Cadmium	0.002	0.320	4.883	5.204
Calcium	29.930	324.00	7,286.9	7,640.8
Carbon disulfide	-	<0.001	0.012	0.012
Chloroethane	0.018	-	-	0.018
Chloroform	-	<0.001	0.016	0.016
Chromium	0.009	7.902	1.949	9.860
Cobalt	0.015	0.972	0.457	1.444
Copper	0.077	38.880	117.57	156.53
Cyanide	-	1.080	729.00	730.08
Diethyl phthalate	-	0.018	0.330	0.348
DIMP	<0.001	-	-	<0.001
Dithiane	0.001	-	-	0.001

TABLE 5.45 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
Fluorene	-	0.011	0.020	0.032
Hexachlorobenzene	<0.001	0.028	0.013	0.041
Hexachloroethane	-	0.011	0.012	0.023
Iron	26.441	1,386.0	154.269	1,566.7
Lead	0.232	847.80	1,213.2	2,061.3
Magnesium	33.288	34.92	385.04	453.25
Manganese	0.540	5.697	15.830	22.067
Mercury	<0.001	0.032	0.259	0.292
N-Nitrosodiphenylamine	-	0.011	0.084	0.096
Nickel	0.017	0.761	2.282	3.059
Nitroglycerin	-	0.138	6.093	6.231
Phenol	-	0.011	0.782	0.793
Pyrene	-	0.011	0.005	0.016
Selenium	<0.001	0.064	4.165	4.230
Silver	0.001	0.377	28.283	28.661
Sodium	139.87	4.689	996.72	1,141.3
Tetrachloroethene	-	0.009	0.137	0.146
Thallium	-	0.174	2.171	2.345
Trichloroethene	0.528	0.025	0.514	1.067
Vinyl chloride	0.018	-	-	0.018
Zinc	0.590	160.20	1,408.8	1,569.6

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the uptake modeling.

TABLE 5.46 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for Eastern Cottontail at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	<0.001	- ^a	-	<0.001
1,1,2,2-Tetrachloroethane	0.163	0.024	0.155	0.342
1,1-Dichloroethene	-	0.001	0.013	0.014
1,4-Dichlorobenzene	-	-	-	-
1,4-Dithiane	<0.001	-	-	<0.001
1,4-Oxathiane	<0.001	-	-	<0.001
2,4,6-Trichloroaniline	-	0.077	1.215	1.292
2,4-Dinitrotoluene	-	-	-	-
2-Butanone	-	<0.001	0.006	0.006
2-Methylnaphthalene	-	0.012	0.001	0.013
2-Methylphenol	-	0.012	0.135	0.147
4,4'-DDE	-	-	-	-
4-Methylphenol	-	0.012	0.143	0.155
Acetone	0.001	<0.001	0.041	0.042
Aluminum	0.675	218.98	0.626	220.28
Antimony	0.001	4.854	0.848	5.703
Aroclor 1248	-	0.006	<0.001	0.006
Arsenic	0.001	13.952	2.215	16.169
Barium	0.021	15.309	3.645	18.975
Benzo(b)fluoranthene	-	0.012	0.001	0.013
Benzo(k)fluoranthene	-	0.012	0.001	0.013
Cadmium	0.001	0.344	3.003	3.347
Calcium	7.692	348.81	5,536.7	5,893.2
Carbon disulfide	-	<0.001	0.004	0.004
Chloroethane	0.005	-	-	0.005
Chloroform	-	<0.001	0.005	0.006
Chromium	0.002	8.507	1.013	9.522
Cobalt	0.004	1.046	0.156	1.206
Copper	0.020	41.857	86.373	128.25
Cyanide	-	1.163	249.15	250.31
Diethyl phthalate	-	0.019	0.113	0.132
DIMP	<0.001	-	-	<0.001
Dithiane	<0.001	-	-	<0.001

TABLE 5.46 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
Fluorene	-	0.012	0.007	0.019
Hexachlorobenzene	-	0.030	0.004	0.034
Hexachloroethane	-	0.012	0.004	0.016
Iron	6.796	1,492.1	97.739	1,593.7
Lead	0.060	912.73	985.16	1,897.9
Magnesium	8.555	37.594	77.575	123.73
Manganese	0.139	6.133	2.921	9.193
Mercury	<0.001	0.035	0.210	0.245
N-Nitrosodiphenylamine	-	0.012	0.029	0.041
Nickel	0.004	0.819	0.780	1.603
Nitroglycerin	-	0.148	2.082	2.231
Phenol	-	0.012	0.267	0.279
Pyrene	-	0.012	0.002	0.014
Selenium	<0.001	0.069	1.424	1.493
Silver	<0.001	0.406	9.666	10.072
Sodium	35.948	5.048	4.006	45.002
Tetrachloroethene	-	0.010	0.047	0.056
Thallium	-	0.187	0.742	0.929
Trichloroethene	0.136	0.027	0.176	0.338
Vinyl chloride	0.005	-	-	0.005
Zinc	0.152	172.47	1,095.0	1,267.7

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the uptake modeling.

TABLE 5.47 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for White-Tailed Deer at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	<0.001	- ^a	-	<0.001
1,1,2,2-Tetrachloroethane	0.007	<0.001	0.005	0.012
1,1-Dichloroethene	-	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	-	-	-	-
1,4-Dithiane	<0.001	-	-	<0.001
1,4-Oxathiane	<0.001	-	-	<0.001
2,4,6-Trichloroaniline	-	0.001	0.035	0.036
2,4-Dinitrotoluene	-	-	-	-
2-Butanone	-	<0.001	<0.001	<0.001
2-Methylnaphthalene	-	<0.001	<0.001	<0.001
2-Methylphenol	-	<0.001	0.004	0.004
4,4'-DDE	-	-	-	-
4-Methylphenol	-	<0.001	0.004	0.004
Acetone	<0.001	<0.001	0.001	0.001
Aluminum	0.028	2.022	0.018	2.068
Antimony	<0.001	0.045	0.025	0.070
Aroclor 1248	-	<0.001	<0.001	<0.001
Arsenic	<0.001	0.129	0.064	0.193
Barium	0.001	0.141	0.106	0.248
Benzo(b)fluoranthene	-	<0.001	<0.001	<0.001
Benzo(k)fluoranthene	-	<0.001	<0.001	<0.001
Cadmium	<0.001	0.003	0.087	0.091
Calcium	0.316	3.221	161.04	164.58
Carbon disulfide	-	<0.001	<0.001	<0.001
Chloroethane	<0.001	-	-	<0.001
Chloroform	-	<0.001	<0.001	<0.001
Chromium	<0.001	0.079	0.029	0.108
Cobalt	<0.001	0.010	0.005	0.015
Copper	0.001	0.387	2.512	2.900
Cyanide	-	0.011	7.247	7.258
Diethyl phthalate	-	<0.001	0.003	0.003
DIMP	<0.001	-	-	<0.001
Dithiane	<0.001	-	-	<0.001

TABLE 5.47 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
Fluorene	-	<0.001	<0.001	<0.001
Hexachlorobenzene	-	<0.001	<0.001	<0.001
Hexachloroethane	-	<0.001	<0.001	<0.001
Iron	0.279	13.778	2.756	16.813
Lead	0.002	8.428	28.656	37.086
Magnesium	0.352	0.347	2.256	2.955
Manganese	0.006	0.057	0.085	0.147
Mercury	<0.001	<0.001	0.006	0.006
N-Nitrosodiphenylamine	-	<0.001	0.001	0.001
Nickel	<0.001	0.008	0.023	0.030
Nitroglycerin	-	0.001	0.061	0.062
Phenol	-	<0.001	0.008	0.008
Pyrene	-	<0.001	<0.001	<0.001
Selenium	<0.001	0.001	0.041	0.042
Silver	<0.001	0.004	0.281	0.285
Sodium	1.478	0.047	0.117	1.641
Tetrachloroethene	-	<0.001	0.001	0.001
Thallium	-	0.002	0.022	0.023
Trichloroethene	0.006	<0.001	0.005	0.011
Vinyl chloride	<0.001	-	-	0.002
Zinc	0.006	1.593	31.851	33.450

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the contaminant uptake modeling.

TABLE 5.48 Estimated Applied Daily Dose (mg/kg-d) from Various Pathways for Red Fox at the Toxic Burning Pits Area

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
1,1-Oxathiane	<0.001	- ^a	<0.001	<0.001
1,1,2,2-Tetrachloroethane	0.001	<0.001	0.001	0.002
1,1-Dichloroethene	-	<0.001	<0.001	<0.001
1,4-Dichlorobenzene	-	-	-	-
1,4-Dithiane	<0.001	-	<0.001	<0.001
1,4-Oxathiane	<0.001	-	<0.001	<0.001
2,4,6-Trichloroaniline	-	<0.001	0.001	0.002
2,4-Dinitrotoluene	-	-	-	-
2-Butanone	-	<0.001	<0.001	<0.001
2-Methylnaphthalene	-	<0.001	<0.001	<0.001
2-Methylphenol	-	<0.001	<0.001	<0.001
4,4'-DDE	-	-	-	-
4-Methylphenol	-	<0.001	<0.001	<0.001
Acetone	<0.001	<0.001	<0.001	<0.001
Aluminum	0.003	0.213	0.072	0.289
Antimony	<0.001	0.005	0.003	0.007
Aroclor 1248	-	<0.001	<0.001	<0.001
Arsenic	<0.001	0.014	0.005	0.019
Barium	<0.001	0.015	0.007	0.022
Benzo(b)fluoranthene	-	<0.001	<0.001	<0.001
Benzo(k)fluoranthene	-	<0.001	<0.001	<0.001
Cadmium	<0.001	<0.001	0.002	0.003
Calcium	0.037	0.339	5.005	5.381
Carbon disulfide	-	<0.001	<0.001	<0.001
Chloroethane	<0.001	-	<0.001	<0.001
Chloroform	-	<0.001	<0.001	<0.001
Chromium	<0.001	0.008	0.003	0.011
Cobalt	<0.001	0.001	0.001	0.002
Copper	<0.001	0.041	0.091	0.131
Cyanide	-	0.001	0.302	0.303
Diethyl phthalate	-	<0.001	<0.001	<0.001
DIMP	<0.001	-	<0.001	<0.001
Dithiane	<0.001	-	<0.001	<0.001

TABLE 5.48 (Cont.)

Contaminant	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD
Fluorene	-	<0.001	<0.001	<0.001
Hexachlorobenzene	-	<0.001	<0.001	<0.001
Hexachloroethane	-	<0.001	<0.001	<0.001
Iron	0.032	1.451	0.580	2.063
Lead	<0.001	0.888	0.926	1.814
Magnesium	0.041	0.037	0.144	0.221
Manganese	0.001	0.006	0.007	0.014
Mercury	<0.001	<0.001	<0.001	<0.001
N-Nitrosodiphenylamine	-	<0.001	<0.001	<0.001
Nickel	<0.001	0.001	0.001	0.002
Nitroglycerin	-	<0.001	0.003	0.003
Phenol	-	<0.001	<0.001	<0.001
Pyrene	-	<0.001	<0.001	<0.001
Selenium	<0.001	<0.001	0.002	0.002
Silver	<0.001	<0.001	0.012	0.013
Sodium	0.171	0.005	0.230	0.407
Tetrachloroethene	-	<0.001	<0.001	<0.001
Thallium	-	<0.001	0.001	0.001
Trichloroethene	0.001	<0.001	<0.001	0.001
Vinyl chloride	<0.001	-	<0.001	<0.001
Zinc	0.001	0.168	1.016	1.184

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value is assumed to be zero for the contaminant uptake modeling.

TABLE 5.49 Estimated Concentrations (mg/kg) of Contaminants in Tissues of Plant and Aquatic Animal Receptors at the White Phosphorus Burning Pits Area

Contaminant	Organism			
	Grasses	Common Reed	Leopard Frog	Red-Spotted Newt (Breeding)
Aluminum	4.39	4.39	92.29	92.29
Antimony	0.03	0.03	0.01	0.01
Benzo[a]anthracene	0.00	0.00	0.00	0.00
Benzo[a]pyrene	0.00	0.00	0.00	0.00
Benzo[b]fluoranthene	0.00	0.00	0.00	0.00
Benzo[k]fluoranthene	0.00	0.00	0.00	0.00
bis(2-Ethylhexyl)phthalate	0.00	0.00	0.00	0.00
Cadmium	1.49	1.49	0.00	0.00
Chromium	0.27	0.27	14.37 ^a	0.16
Chrysene	0.00	0.00	0.00	0.00
Copper	8.75	8.75	2.62	2.62
Fluoranthene	0.00	0.00	0.00	0.00
Indeno(1,2,3-cd)pyrene	0.00	0.00	0.00	0.00
Iron	148.80	148.80	2,840.0	2,840.0
Lead	15.71	15.71	2.0 ^b	5.71
Magnesium	312.00	312.00	6,550.0	6,550.0
Mercury	0.05	0.05	0.2 ^b	0.31
Nickel	1.04	1.04	0.00	0.00
Pyrene	0.00	0.00	0.00	0.00
Sodium	29.95	29.95	112,000	112,000
Zinc	235.20	235.20	93.71	93.71

^a Value based on results of residuals analysis of frog tissues collected from the WPP AOC.

^b Value is the method detection limit for analysis of whole frog body burden for the contaminant. The contaminant was considered to be present at a level below the method detection limit (Johnson 1995).

TABLE 5.50 Estimated Applied Daily Doses (mg/kg-d) of Contaminants for Receptors at the White Phosphorus Burning Pits Area

Contaminant	Organism										
	Red-Spotted Newt (nonbreeding)	Black Racer	Mallard	American Robin	Tree Swallow	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
<i>ADD from Drinking Water</i>											
Aluminum	NA ^a	0.873	0.006	1.175	0.491	0.059	0.005	1.225	0.814	0.283	0.008
Antimony	NA	0.001	<0.001	0.001	0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Benzo(a)anthracene	NA	^b	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	NA	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	NA	-	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	NA	-	-	-	-	-	-	-	-	-	-
bis(2-ethylhexyl)phthalate	NA	-	-	-	-	-	-	-	-	-	-
Cadmium	NA	-	-	-	-	-	-	-	-	-	-
Chromium	NA	0.002	<0.001	0.002	0.001	<0.001	<0.001	0.002	0.002	0.001	<0.001
Chrysene	NA	-	-	-	-	-	-	-	-	-	-
Copper	NA	0.005	<0.001	0.007	0.003	<0.001	<0.001	0.008	0.005	0.002	<0.001
Fluoranthene	NA	-	-	-	-	-	-	-	-	-	-
Indeno(1,2,3-cd)pyrene	NA	-	-	-	-	-	-	-	-	-	-
Iron	NA	2.954	0.022	3.976	1.661	0.200	0.018	4.146	2.755	0.957	0.027
Lead	NA	0.008	<0.001	0.011	0.004	0.001	<0.001	0.011	0.007	0.003	<0.001
Magnesium	NA	13.624	0.100	18.340	7.664	0.920	0.084	19.126	12.707	4.415	0.124
Mercury	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	NA	-	-	-	-	-	-	-	-	-	-
Pyrene	NA	-	-	-	-	-	-	-	-	-	-
Sodium	NA	116.48	0.859	156.80	65.52	7.869	0.714	163.52	108.64	37.748	1.062
Zinc	NA	0.043	<0.001	0.058	0.024	0.003	<0.001	0.060	0.040	0.014	<0.001

TABLE 5.50 (Cont.)

Contaminant	Organism										
	Red-Spotted Newt (nonbreeding)	Black Racer	Mallard	American Robin	Tree Swallow	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
<i>ADD from Incidental Soil Ingestion</i>											
Aluminum	5,873.9 ^c	9.76	1.181	1,483.5	NA	NA	NA	219.60	611.15	11.584	1.220
Antimony	0.698 ^c	0.001	<0.001	0.176	NA	NA	NA	0.026	0.073	0.001	<0.001
Benzo(a)anthracene	0.063 ^c	<0.001	<0.001	0.016	NA	NA	NA	0.002	0.007	<0.001	<0.001
Benzo(a)pyrene	0.061 ^c	<0.001	<0.001	0.015	NA	NA	NA	0.002	0.006	<0.001	<0.001
Benzo(b)fluoranthene	0.081 ^c	<0.001	<0.001	0.021	NA	NA	NA	0.003	0.008	<0.001	<0.001
Benzo(k)fluoranthene	0.080 ^c	<0.001	<0.001	0.020	NA	NA	NA	0.003	0.008	<0.001	<0.001
bis(2-ethylhexyl)phthalate	0.078 ^c	<0.001	<0.001	0.020	NA	NA	NA	0.003	0.008	<0.001	<0.001
Cadmium	0.650 ^c	<0.001	<0.001	0.164	NA	NA	NA	0.024	0.068	0.001	<0.001
Chromium	8.715 ^c	0.014	0.002	2.201	NA	NA	NA	0.326	0.907	0.017	0.002
Chrysene	0.070 ^c	<0.001	<0.001	0.018	NA	NA	NA	0.003	0.007	<0.001	<0.001
Copper	16.201 ^c	0.027	0.003	4.092	NA	NA	NA	0.606	1.686	0.032	0.003
Fluoranthene	0.068 ^c	<0.001	<0.001	0.017	NA	NA	NA	0.003	0.007	<0.001	<0.001
Indeno(1,2,3-cd)pyrene	0.063 ^c	<0.001	<0.001	0.016	NA	NA	NA	0.002	0.007	<0.001	<0.001
Iron	8,955.3 ^c	14.880	1.801	2,261.8	NA	NA	NA	334.80	931.75	17.660	1.860
Lead	55.609 ^c	0.092	0.011	14.045	NA	NA	NA	2.079	5.786	0.110	0.012
Magnesium	577.76 ^c	0.960	0.116	145.92	NA	NA	NA	21.600	60.113	1.139	<0.001
Mercury	0.032 ^c	<0.001	<0.001	0.008	NA	NA	NA	0.001	0.003	<0.001	<0.001
Nickel	4.165 ^c	0.007	0.001	1.052	NA	NA	NA	0.156	0.433	0.008	0.001
Pyrene	0.062 ^c	<0.001	<0.001	0.016	NA	NA	NA	0.002	0.006	<0.001	<0.001
Sodium	144.20 ^c	0.240	0.029	36.419	NA	NA	NA	5.391	15.003	0.284	0.030
Zinc	141.55 ^c	0.235	0.028	35.750	NA	NA	NA	5.292	14.728	0.279	0.029

TABLE 5.50 (Cont.)

Contaminant	Organism										
	Red-Spotted Newt (nonbreeding)	Black Racer	Mallard	American Robin	Tree Swallow	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
<i>ADD from Food Ingestion</i>											
Aluminum	0.048	2.130	0.513	6.676	0.987	4.694	0.309	1.976	1.746	0.104	0.278
Antimony	<0.001	0.001	<0.001	0.048	0.007	0.001	<0.001	0.014	0.013	0.001	<0.001
Benzo(a)anthracene	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Benzo(a)pyrene	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(b)fluoranthene	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Benzo(k)fluoranthene	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
bis(2-ethylhexyl)phthalate	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004
Cadmium	0.016	0.015	0.001	2.257	0.334	0.022	0.001	0.668	0.590	0.035	0.002
Chromium	0.003	0.006	0.001	0.413	0.061	0.011	0.001	0.122	0.108	0.006	<0.001
Chrysene	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Copper	0.095	0.106	0.005	13.298	1.966	0.142	0.005	3.937	3.478	0.208	0.015
Fluoranthene	<0.001	<0.001	<0.001	0.006	<0.001	<0.001	<0.001	0.002	0.002	<0.001	<0.001
Indeno(1,2,3-cd)pyrene	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron	1.612	22.629	0.098	226.18	33.429	9.294	0.545	66.960	59.159	3.532	0.555
Lead	0.170	0.179	0.010	23.876	3.529	0.275	0.011	7.069	6.245	0.373	0.020
Magnesium	3.379	46.949	0.223	474.24	70.092	5.307	0.207	140.40	124.04	7.406	0.327
Mercury	0.001	0.002	0.001	0.076	0.011	0.001	<0.001	0.023	0.020	0.001	<0.001
Nickel	0.011	0.011	<0.001	1.578	0.233	0.019	0.001	0.467	0.413	0.025	0.018
Pyrene	<0.001	<0.001	0.001	0.003	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Sodium	0.324	748.01	0.313	45.524	6.278	3.080	0.293	13.478	11.907	0.711	0.159
Zinc	2.547	2.934	0.247	357.50	52.839	3.584	0.122	105.84	93.509	5.583	0.289

TABLE 5.50 (Cont.)

Contaminant	Organism										
	Red-Spotted Newt (nonbreeding)	Black Racer	Mallard	American Robin	Tree Swallow	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
Total ADD											
Aluminum	5,873.9	12.762	1.701	1,491.4	1.477	4.753	0.314	222.80	613.71	11.971	1.506
Antimony	0.746	0.003	<0.001	0.226	0.008	0.001	<0.001	0.042	0.086	0.002	<0.001
Benzo(a)anthracene	0.372	<0.001	<0.001	0.018	<0.001	<0.001	<0.001	0.003	0.007	<0.001	<0.001
Benzo(a)pyrene	0.061	<0.001	<0.001	0.017	<0.001	<0.001	<0.001	0.003	0.007	<0.001	<0.001
Benzo(b)fluoranthene	0.081	<0.001	<0.001	0.022	<0.001	<0.001	<0.001	0.004	0.009	<0.001	<0.001
Benzo(k)fluoranthene	0.080	<0.001	<0.001	0.022	<0.001	<0.001	<0.001	0.003	0.009	<0.001	<0.001
bis(2-ethylhexyl)phthalate	0.078	<0.001	<0.001	0.020	<0.001	<0.001	<0.001	0.003	0.008	<0.001	0.004
Cadmium	0.650	0.016	0.001	2.421	0.334	0.022	0.001	0.693	0.658	0.037	0.002
Chromium	126.76	0.022	0.001	2.616	0.062	0.011	0.001	0.450	1.016	0.024	0.004
Chrysene	0.073	<0.001	<0.001	0.020	<0.001	<0.001	<0.001	0.003	0.008	<0.001	<0.001
Copper	16.202	0.138	0.005	17.398	1.969	0.142	0.005	4.550	5.169	0.241	0.019
Fluoranthene	0.068	<0.001	<0.001	0.023	0.001	<0.001	<0.001	0.004	0.009	<0.001	<0.001
Indeno(1,2,3-cd)pyrene	0.063	<0.001	<0.001	0.017	<0.001	<0.001	<0.001	0.003	0.007	<0.001	<0.001
Iron	8,955.3	40.463	0.098	2,491.9	35.090	9.494	0.563	405.91	993.66	22.150	2.441
Lead	57.221	0.279	0.010	37.932	3.533	0.276	0.011	9.159	12.038	0.485	0.032
Magnesium	577.93	61.533	0.223	638.50	77.756	6.227	0.291	181.13	196.86	12.961	0.571
Mercury	0.130	0.002	0.001	0.084	0.011	0.001	<0.001	0.024	0.023	0.001	<0.001
Nickel	4.165	0.018	0.001	2.630	0.233	0.019	0.001	0.623	0.846	0.033	0.019
Pyrene	5.191	<0.001	<0.001	0.019	<0.001	<0.001	<0.001	0.003	0.007	<0.001	<0.001
Sodium	144.21	864.27	0.313	238.74	72.248	10.949	1.007	182.39	135.55	38.743	1.251
Zinc	141.55	3.212	0.247	393.31	52.863	3.584	0.122	111.19	108.28	5.876	0.319

See footnotes on next page.

Footnotes for Table 5.50

- ^a NA = not applicable. It was assumed that nonbreeding red-spotted newts obtained their daily water requirements directly from other sources (e.g., dermal uptake of ground moisture) and that there was a negligible level of incidental soil ingestion by tree swallows, American kestrels, and red-tailed hawks.
- ^b "-" denotes that the contaminant was not detected in media contributing to this exposure pathway. This value was assumed to be zero for the contaminant uptake modeling.
- ^c Combined ADD from incidental ingestion of soil and direct dermal absorption of contaminants from soil.

TABLE 5.51 Estimated Concentrations (mg/kg) of Contaminants in Tissues of Plant and Aquatic Animal Receptors at the Riot Control Pit Area

Contaminant	Organism		
	Vegetation	Leopard Frog	Red-Spotted Newt (breeding)
Aluminum	4.10 ^a	4.47	4.47
Antimony	0.02	- ^b	-
Cadmium	3.74	-	-
Chromium	0.97 ^a	-	-
Copper	3.70 ^a	1.23	1.23
Iron	17.10 ^a	154.00	154.00
Lead	0.18 ^a	0.10	0.10
Magnesium	317.00 ^a	8,500.0	8,500.0
Mercury	0.05	-	-
Nickel	1.20	-	-
Silver	13.52	-	-
Sodium	46.00 ^a	110,000	110,000
Zinc	21.10 ^a	0.26	0.26

^a Value based on residuals analysis of aboveground tissues of common reed collected from the RCP AOC (Table 5.7).

^b “-” denotes that this contaminant was not detected in media contributing to this exposure pathway. This value was considered to be zero for contaminant uptake modeling.

TABLE 5.52 Estimated Applied Daily Doses (mg/kg-d) of Contaminants for Receptors at the Riot Control Pit Area

Contaminant	Organism						
	Red-Spotted Newt (nonbreeding)	Black Racer	American Robin	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
<i>ADD from Drinking Water</i>							
Aluminum	NA ^a	0.042	0.057	0.059	0.027	0.005	<0.001
Antimony	NA	- ^b	-	-	-	-	-
Cadmium	NA	-	-	-	-	-	-
Chromium	NA	-	-	-	-	-	-
Copper	NA	0.003	0.003	0.004	0.002	<0.001	<0.001
Iron	NA	0.160	0.216	0.225	0.102	0.017	<0.001
Lead	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium	NA	17.680	23.800	24.820	11.283	1.910	0.054
Mercury	NA	-	-	-	-	-	-
Nickel	NA	-	-	-	-	-	-
Silver	NA	-	-	-	-	-	-
Sodium	NA	114.4	154.00	160.60	73.005	12.358	0.348
Zinc	NA	0.004	0.005	0.005	0.002	<0.001	<0.001
<i>ADD from Incidental Soil Ingestion</i>							
Aluminum	6,968.1 ^c	10.52	1,599.0	236.70	450.71	4.162	0.438
Antimony	0.586 ^c	0.001	0.134	0.020	0.038	<0.001	<0.001
Cadmium	1.802 ^c	0.003	0.413	0.061	0.117	0.001	<0.001
Chromium	50.605 ^c	0.076	11.613	1.719	3.273	0.030	0.003
Copper	468.960 ^c	0.708	107.62	15.930	30.333	0.280	0.029
Iron	5,034.036 ^c	7.600	1,155.2	171.00	325.61	3.007	0.317
Lead	283.496 ^c	0.428	65.056	9.630	18.337	0.169	0.018

TABLE 5.52 (Cont.)

Contaminant	Organism						
	Red-Spotted Newt (nonbreeding)	Black Racer	American Robin	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
Magnesium	506.05 ^c	0.764	116.13	17.190	32.732	0.302	0.032
Mercury	0.032 ^c	<0.001	0.007	0.001	0.002	<0.001	<0.001
Nickel	5.299 ^c	0.008	1.216	0.180	0.343	0.003	<0.001
Silver	2.387 ^c	0.004	0.548	0.081	0.154	0.001	<0.001
Sodium	171.95 ^c	0.260	39.459	5.841	11.122	0.103	0.011
Zinc	102.01 ^c	0.154	23.408	3.465	6.598	0.061	0.006
<i>ADD from Food Ingestion</i>							
Aluminum	0.044	1.648	6.232	1.845	1.115	0.032	0.186
Antimony	<0.001	<0.001	0.037	0.011	0.007	<0.001	<0.001
Cadmium	0.041	0.026	5.685	1.683	1.017	0.030	0.001
Chromium	0.011	0.041	1.474	0.437	0.264	0.008	0.002
Copper	0.498	0.506	31.342	12.705	1.006	0.029	0.018
Iron	0.406	2.505	38.395	13.019	4.652	0.135	0.141
Lead	0.014	0.013	0.955	0.373	0.049	0.001	0.006
Magnesium	10.289	65.326	866.70	307.86	86.231	2.508	0.194
Mercury	<0.001	<0.001	0.069	0.021	0.012	<0.001	<0.001
Nickel	0.013	0.013	1.824	0.540	0.326	0.009	0.001
Silver	0.146	0.131	20.543	6.082	3.676	0.107	0.005
Sodium	7.917	740.57	486.40	199.49	12.513	0.364	0.140
Zinc	2.740	2.228	173.07	70.021	5.740	0.167	0.032

TABLE 5.52 (Cont.)

Contaminant	Organism						
	Red-Spotted Newt (nonbreeding)	Black Racer	American Robin	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
Total ADD							
Aluminum	6,968.2	12.210	1,605.3	238.60	451.86	4.199	0.624
Antimony	0.586	0.001	0.171	0.031	0.044	<0.001	<0.001
Cadmium	1.842	0.028	6.098	1.744	1.134	0.031	0.001
Chromium	50.616	0.118	13.087	2.156	3.537	0.038	0.005
Copper	469.46	1.216	138.96	28.639	31.341	0.310	0.047
Iron	5,034.4	10.265	1,193.8	184.24	330.37	3.159	0.458
Lead	283.51	0.441	66.011	10.004	18.386	0.171	0.024
Magnesium	516.34	83.770	1,006.6	349.87	130.25	4.720	0.279
Mercury	0.032	<0.001	0.077	0.022	0.014	<0.001	<0.001
Nickel	5.312	0.021	3.040	0.720	0.669	0.013	0.001
Silver	2.534	0.135	21.091	6.163	3.831	0.108	0.005
Sodium	179.87	855.23	679.86	365.93	96.640	12.825	0.498
Zinc	104.75	2.386	196.48	73.491	12.340	0.228	0.039

^a NA = not applicable. It was assumed that nonbreeding red-spotted newts obtained their daily water requirements directly from other sources (e.g., dermal uptake of ground moisture)

^b "-" denotes that the contaminant was not detected in media contributing to this exposure pathway. This value was assumed to be zero for the contaminant uptake modeling.

^c Combined ADD from incidental ingestion of soil and direct dermal absorption of contaminants from soil.

TABLE 5.53 Estimated Concentrations of Contaminants (mg/kg) in Terrestrial Vegetation and Amphibians at the South Beach Trench Area

Contaminant	Vegetation	Leopard Frog	Red-Spotted Newt (breeding)
Aluminum	1.74	1.75	1.75
Cadmium	1.82	- ^a	-
Copper	3.36	-	-
Iron	42.31	129.00	129.00
Lead	1.88	-	-
Magnesium	160.15	103.00	103.00
Nickel	0.68	-	-
Silver	-	0.60	0.60
Zinc	42	17.49	17.49

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value was assumed to be zero for the contaminant uptake modeling.

TABLE 5.54 Estimated Applied Daily Doses (mg/kg-d) of Contaminants for Receptors at the South Beach Trench Area

Contaminant	Organism						
	Red-Spotted Newt (nonbreeding)	Black Racer	American Robin	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
<i>ADD from Drinking Water</i>							
Aluminum	NA ^a	0.003	0.012	0.023	0.002	<0.001	<0.001
Cadmium	NA	- ^b	-	-	-	-	-
Copper	NA	-	-	-	-	-	-
Iron	NA	0.025	0.100	0.188	0.015	0.003	<0.001
Lead	NA	-	-	-	-	-	-
Magnesium	NA	0.040	0.160	0.301	0.024	0.004	<0.001
Nickel	NA	-	-	-	-	-	-
Silver	NA	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Zinc	NA	0.001	0.006	0.011	0.001	<0.001	<0.001
<i>ADD from Incidental Soil Ingestion</i>							
Aluminum	2,560.0 ^c	0.725	326.37	86.960	28.659	0.265	0.028
Cadmium	0.874 ^c	<0.001	0.111	0.030	0.010	<0.001	<0.001
Copper	6.857 ^c	0.002	0.874	0.233	0.077	0.001	<0.001
Iron	2,802.4 ^c	0.793	357.27	95.195	31.373	0.290	0.031
Lead	7.339 ^c	0.002	0.936	0.249	0.082	0.001	<0.001
Magnesium	326.40 ^c	0.092	41.162	11.087	3.654	0.034	0.004
Nickel	2.991 ^c	0.001	0.381	0.102	0.033	<0.001	<0.001
Silver	-	-	-	-	-	-	-
Zinc	27.820 ^c	0.008	3.547	0.945	0.311	0.003	<0.001

TABLE 5.54 (Cont.)

Contaminant	Organism						
	Red-Spotted Newt (nonbreeding)	Black Racer	American Robin	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
<i>ADD from Food Ingestion</i>							
Aluminum	0.019	0.114	1.469	0.783	0.082	0.002	0.006
Cadmium	0.020	0.003	1.533	0.817	0.085	0.002	<0.001
Copper	0.036	0.006	2.841	1.514	0.158	0.005	<0.001
Iron	0.458	0.357	35.727	19.039	1.992	0.058	0.009
Lead	0.020	0.004	1.591	0.848	0.089	0.003	<0.001
Magnesium	1.734	0.433	135.24	72.068	7.540	0.219	0.009
Nickel	0.007	0.001	0.572	0.305	0.032	0.001	<0.00
Zinc	0.455	0.008	35.467	18.900	1.977	0.058	0.002
<i>Total ADD</i>							
Aluminum	2,560.0	0.842	327.85	87.766	28.743	0.267	0.034
Cadmium	0.894	0.004	1.644	0.846	0.095	0.003	<0.001
Copper	6.893	0.008	3.715	1.747	0.235	0.005	<0.001
Iron	2,802.9	1.176	393.10	114.42	33.380	0.350	0.039
Lead	7.359	0.006	2.526	1.097	0.171	0.003	<0.001
Magnesium	328.31	0.566	177.01	83.456	11.218	0.257	0.012
Nickel	2.999	0.002	0.953	0.406	0.065	0.001	<0.001
Silver	-	0.001	<0.001	0.001	<0.001	<0.001	<0.001
Zinc	28.275	0.109	39.019	19.856	2.290	0.061	0.002

See next page for footnotes.

Footnotes for Table 5.54

- ^a NA = not applicable. It was assumed that nonbreeding red-spotted newts obtained their daily water requirements directly from other sources (e.g., dermal uptake of ground moisture)
- ^b “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value was assumed to be zero for the contaminant uptake modeling.
- ^c Combined ADD from incidental ingestion of soil and direct dermal absorption of contaminants from soil.

TABLE 5.55 Estimated Concentrations of Contaminants (mg/kg) in Terrestrial Vegetation and Amphibians at the Robins Point Demolition Ground Area

Contaminant	Grasses	Red-Spotted Newts (Breeding)
2,4-Dinitrotoluene	0.771	- ^a
Aluminum	1.531	330.30
Antimony	0.010	-
Cadmium	-	0.908
Chromium	0.093	0.393
Copper	1.729	3.755
Iron	55.507	19,100
Lead	2.095	17.100
Magnesium	115.63	6,100.0
Manganese	3.450	184.10
Mercury	0.040	2.991
Nickel	0.435	7.320
RDX	-	0.004
Silver	15.450	0.250
Sodium	2.230	84,400
Zinc	32.760	132.70

^a “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value was assumed to be zero for the contaminant uptake modeling.

TABLE 5.56 Estimated Applied Daily Doses (mg/kg-d) of Contaminants for Receptors at the Robins Point Demolition Ground Area

Contaminant	Organism								
	Red-Spotted Newt (nonbreeding)	Black Racer	American Robin	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
<i>ADD from Drinking Water</i>									
2,4-Dinitrotoluene	NA ^a	- ^b	-	-	-	-	-	-	-
Aluminum	NA	0.460	1.833	0.010	0.001	4.424	0.271	0.046	0.001
Antimony	NA	-	-	-	-	-	-	-	-
Cadmium	NA	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Chromium	NA	0.001	0.002	<0.001	<0.001	0.006	<0.001	<0.001	<0.001
Copper	NA	0.001	0.005	<0.001	<0.001	0.011	0.001	<0.001	<0.001
Iron	NA	2.897	11.554	0.060	0.005	27.886	1.706	0.289	0.008
Lead	NA	0.003	0.014	0.001	<0.001	0.033	0.002	<0.001	<0.001
Magnesium	NA	1.850	7.380	0.038	0.003	17.812	1.090	0.185	0.005
Manganese	NA	0.080	0.318	0.002	<0.001	0.768	0.047	0.008	<0.001
Mercury	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	NA	0.001	0.004	<0.001	<0.001	0.011	0.001	<0.001	<0.001
RDX	NA	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Silver	NA	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Sodium	NA	12.801	51.057	0.266	0.024	123.22	7.540	1.276	0.036
Zinc	NA	0.009	0.035	<0.001	<0.001	0.085	0.005	0.001	<0.001
<i>ADD from Incidental Soil Ingestion</i>									
2,4-Dinitrotoluene	0.302 ^c	<0.001	0.030	NA	NA	0.01	0.003	<0.001	<0.001
Aluminum	2,254.056 ^c	0.496	223.50	NA	NA	76.567	19.626	0.181	0.019
Antimony	0.237 ^c	<0.001	0.023	NA	NA	0.008	0.002	<0.001	<0.001

TABLE 5.56 (Cont.)

Contaminant	Organism								
	Red-Spotted Newt (nonbreeding)	Black Racer	American Robin	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
Cadmium	-	-	-	NA	NA	-	-	-	-
Chromium	3.279 ^c	0.001	0.325	NA	NA	0.111	0.029	<0.001	<0.001
Copper	3.542 ^c	0.001	0.349	NA	NA	0.120	0.031	<0.001	<0.001
Iron	3,677.2 ^c	0.809	364.56	NA	NA	124.89	32.013	0.296	0.031
Lead	8.184 ^c	0.002	0.809	NA	NA	0.277	0.071	<0.001	<0.001
Magnesium	236.93 ^c	0.052	23.369	NA	NA	8.005	2.052	0.019	0.002
Manganese	30.507 ^c	0.007	3.021	NA	NA	1.035	0.265	0.008	<0.001
Mercury	0.029 ^c	<0.001	0.003	NA	NA	0.001	<0.001	<0.001	<0.001
Nickel	1.925 ^c	<0.001	0.190	NA	NA	0.065	0.017	<0.001	<0.001
RDX	-	-	-	-	-	-	-	-	-
Silver	2.896 ^c	0.001	0.271	NA	NA	0.093	0.024	<0.001	<0.001
Sodium	11.841 ^c	0.003	1.172	NA	NA	0.401	0.103	0.001	<0.001
Zinc	22.054 ^c	0.005	2.152	NA	NA	0.737	0.189	0.002	<0.001
<i>ADD from Food Ingestion</i>									
2,4-Dinitrotoluene	0.008	0.001	0.506	<0.001	<0.001	0.347	0.028	0.001	<0.001
Aluminum	0.017	0.405	1.006	0.050	0.003	0.689	0.056	0.002	0.004
Antimony	<0.001	<0.001	0.006	<0.001	<0.001	0.004	<0.001	<0.001	<0.001
Cadmium	-	0.001	-	<0.001	<0.001	-	-	-	<0.001
Chromium	0.001	0.004	0.061	0.001	<0.001	0.042	0.003	<0.001	<0.001
Copper	0.019	0.006	1.136	0.001	<0.001	0.778	0.063	0.002	<0.001
Iron	0.601	18.794	36.456	0.121	0.007	24.978	2.033	0.059	0.009
Lead	0.023	0.020	1.376	0.001	<0.001	0.943	0.077	0.002	<0.001

TABLE 5.56 (Cont.)

Contaminant	Organism								
	Red-Spotted Newt (nonbreeding)	Black Racer	American Robin	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
Magnesium	1.252	6.118	75.948	0.078	0.003	52.036	4.234	0.123	0.005
Manganese	0.037	0.186	2.266	0.003	<0.001	1.553	0.126	0.004	<0.001
Mercury	<0.001	0.003	0.026	<0.001	<0.001	0.018	0.001	<0.001	<0.001
Nickel	0.005	0.008	0.286	<0.001	<0.001	0.196	0.016	<0.001	<0.001
RDX	-	<0.001	-	<0.001	<0.001	-	-	-	<0.001
Silver	0.167	0.022	10.147	0.009	<0.001	6.953	0.566	0.016	0.001
Sodium	0.024	82.171	1.465	0.052	0.005	1.004	0.082	0.002	0.004
Zinc	0.355	0.176	21.516	0.019	0.001	14.742	1.200	0.035	0.001
<i>Total ADD</i>									
2,4-Dinitrotoluene	0.310	0.001	0.536	<0.001	0.028	0.357	0.031	0.001	<0.001
Aluminum	2,254.1	1.361	226.34	0.060	0.004	81.680	19.953	0.229	0.024
Antimony	0.237	<0.001	0.030	<0.001	<0.001	0.012	0.002	<0.001	<0.001
Cadmium	-	0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
Chromium	3.279	0.005	0.061	0.001	<0.001	0.159	0.032	<0.001	<0.001
Copper	3.542	0.008	1.136	0.001	<0.001	0.909	0.095	0.002	<0.001
Iron	3,677.2	22.501	36.456	0.181	0.012	177.75	35.752	0.644	0.048
Lead	8.184	0.025	1.376	0.001	<0.001	1.253	0.150	0.003	<0.001
Magnesium	236.93	8.020	75.948	0.117	0.077	77.853	7.376	0.327	0.013
Manganese	30.507	0.272	2.266	0.005	<0.001	3.355	0.439	0.014	0.001
Mercury	0.029	0.003	0.026	<0.001	<0.001	0.019	0.002	<0.001	<0.001
Nickel	1.925	0.009	0.286	<0.001	<0.001	0.272	0.033	0.001	<0.001
RDX	-	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001

TABLE 5.56 (Cont.)

Contaminant	Organism								
	Red-Spotted Newt (nonbreeding)	Black Racer	American Robin	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
Silver	2.896	0.023	10.418	0.009	<0.001	7.045	0.590	0.017	0.001
Sodium	11.841	94.974	53.693	0.319	0.029	124.63	7.725	1.280	0.040
Zinc	22.054	0.190	23.703	0.019	0.001	15.564	1.394	0.038	0.001

^a NA = not applicable. It was assumed that nonbreeding red-spotted newts obtained their daily water requirements directly from other sources (e.g., dermal uptake of ground moisture). The American kestrel and red-tailed hawk were considered to have no incidental ingestion of soil.

^b “-” denotes that the contaminant was not detected in media contributing to this exposure pathway. This value was assumed to be zero for the contaminant uptake modeling.

^c Combined ADD from incidental ingestion of soil and direct dermal absorption of contaminants from soil.

**TABLE 5.57 Estimated Concentrations
(mg/kg) of Contaminants in Terrestrial
Grasses at the Prototype Building Area**

Contaminant	Estimated Tissue Concentration
Acetone	0.089
Aluminum	3.312
Antimony	0.019
Benzo(k)fluoranthene	0.001
Cadmium	1.925
Copper	9.737
Cyanide	35.100
Endrin aldehyde	<0.001
Iron	62.000
Lead	4.066
Magnesium	138.76
Manganese	13.176
Mercury	0.049
Nickel	0.864
Sodium	4.225
Zinc	76.000

TABLE 5.58 Estimated Applied Daily Doses (mg/kg-d) of Contaminants for Receptors at the Prototype Building Area

Contaminant	Organism								
	Black Racer	American Robin	Tree Swallow	American Kestrel	Red-Tailed Hawk	White-Footed Mouse	Eastern Cottontail	White-Tailed Deer	Red Fox
<i>ADD from Drinking Water^a</i>									
Acetone	^b	-	-	-	-	-	-	-	-
Aluminum	0.173	0.232	0.045	0.005	<0.001	0.242	0.153	0.026	0.001
Antimony	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-
Cyanide	-	-	-	-	-	-	-	-	-
Endrin aldehyde	-	-	-	-	-	-	-	-	-
Iron	0.313	0.421	0.081	0.010	0.001	0.439	0.277	0.047	0.001
Lead	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium	15.600	21.00	4.050	0.486	0.044	21.900	13.784	2.333	0.066
Manganese	0.020	0.026	0.005	0.001	<0.001	0.028	0.017	0.003	<0.001
Mercury	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-
Sodium	118.56	159.6	30.780	3.697	0.336	166.44	104.760	17.733	0.499
Zinc	0.003	0.004	0.001	<0.001	<0.001	0.004	0.003	<0.001	<0.001
<i>ADD from Incidental Soil Ingestion</i>									
Acetone	<0.001	<0.001	NA ^c	NA	NA	<0.001	<0.001	<0.001	<0.001
Aluminum	7.360	1,118.7	NA	NA	NA	165.60	138.61	4.032	0.425
Antimony	0.001	0.106	NA	NA	NA	0.016	0.013	<0.001	<0.001
Benzo(k)fluoranthene	<0.001	0.013	NA	NA	NA	0.002	0.002	<0.001	<0.001

TABLE 5.58 (Cont.)

Contaminant	Organism								
	Black Racer	American Robin	Tree Swallow	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
Cadmium	0.001	0.213	NA	NA	NA	0.032	0.026	0.001	<0.001
Copper	0.030	4.554	NA	NA	NA	0.674	0.564	0.016	0.002
Cyanide	0.001	0.158	NA	NA	NA	0.023	0.020	0.001	<0.001
Endrin aldehyde	<0.001	<0.001	NA	NA	NA	<0.001	<0.001	<0.001	<0.001
Iron	6.200	942.40	NA	NA	NA	139.50	116.76	3.396	0.358
Lead	0.024	3.636	NA	NA	NA	0.538	0.450	0.013	0.001
Magnesium	0.427	64.895	NA	NA	NA	9.606	8.040	0.234	0.025
Manganese	0.176	26.691	NA	NA	NA	3.951	3.307	0.096	0.010
Mercury	<0.001	0.008	NA	NA	NA	0.001	0.001	<0.001	<0.001
Nickel	0.006	0.876	NA	NA	NA	0.130	0.108	0.003	<0.001
Sodium	0.034	5.138	NA	NA	NA	0.761	0.637	0.019	0.002
Zinc	0.076	11.552	NA	NA	NA	1.710	1.431	0.042	0.004
<i>ADD from Food Ingestion</i>									
Acetone	0.001	0.135	0.009	0.001	0.004	0.040	0.033	0.001	<0.001
Aluminum	1.138	5.034	0.343	1.437	0.082	1.490	1.247	0.036	0.088
Antimony	<0.001	0.029	0.002	<0.001	<0.001	0.009	0.007	<0.001	<0.001
Benzo(k)fluoranthene	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	0.019	2.926	0.200	0.013	<0.001	0.866	0.725	0.021	0.175
Copper	0.329	31.498	3.857	0.184	0.005	11.549	3.667	0.107	0.012
Cyanide	0.339	53.352	3.639	0.235	0.008	15.795	13.220	0.385	0.015
Endrin aldehyde	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.037

TABLE 5.58 (Cont.)

Contaminant	Organism								
	Black Racer	American Robin	Tree Swallow	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
Iron	1.613	100.08	7.424	1.648	0.083	30.406	23.352	0.679	0.101
Lead	0.010	3.785	0.013	0.016	0.001	0.801	1.532	0.045	0.021
Magnesium	8.043	680.43	94.459	4.283	0.121	264.00	52.262	1.520	0.175
Manganese	0.141	19.064	1.203	0.116	0.005	5.517	4.960	0.144	0.007
Mercury	<0.001	0.075	0.005	0.001	<0.001	0.022	0.019	0.001	<0.001
Nickel	0.009	1.313	0.090	0.007	<0.001	0.389	0.325	0.009	0.028
Sodium	7.601	472.62	79.942	3.983	0.152	202.03	1.591	0.046	0.161
Zinc	1.687	183.62	19.493	0.983	0.029	63.432	28.625	0.833	0.047
<i>Total ADD</i>									
Acetone	0.001	0.135	0.009	0.001	<0.001	0.040	0.033	0.001	<0.001
Aluminum	8.670	1,124.0	0.388	1.442	0.083	167.33	140.01	4.094	0.513
Antimony	0.001	0.136	0.002	0.001	<0.004	0.024	0.020	0.001	<0.001
Benzo(k)fluoranthene	<0.001	0.014	<0.001	<0.001	<0.001	0.002	0.002	<0.001	<0.001
Cadmium	0.020	3.139	0.200	0.013	<0.001	0.898	0.751	0.022	0.176
Copper	0.359	36.052	3.857	0.184	0.005	12.224	4.232	0.123	0.013
Cyanide	0.340	53.510	3.639	0.235	0.008	15.818	13.240	0.385	0.015
Endrin aldehyde	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.037
Iron	8.126	1,042.9	7.505	1.658	0.084	170.35	140.39	4.122	0.460
Lead	0.034	7.421	0.013	0.016	0.001	1.340	1.983	0.058	0.022

TABLE 5.58 (Cont.)

Contaminant	Organism								
	Black Racer	American Robin	Tree Swallow	American Kestrel	Red- Tailed Hawk	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
Magnesium	24.069	766.33	98.509	4.769	0.165	295.50	74.086	4.087	0.265
Manganese	0.336	45.782	1.208	0.116	0.005	9.495	8.285	0.243	0.018
Mercury	0.001	0.083	0.005	<0.001	<0.001	0.023	0.020	0.001	<0.001
Nickel	0.015	2.189	0.090	0.007	<0.001	0.518	0.434	0.013	0.029
Sodium	126.19	637.36	110.72	7.680	0.488	369.23	106.99	17.798	0.662
Zinc	1.766	195.17	19.494	0.983	0.029	65.146	30.059	0.875	0.052

^a ADDs from drinking water were modeled by using exposure point concentrations derived from analyses of surface water from nearshore locations.

^b “-” denotes that the contaminant was not detected in media that contribute to this exposure pathway. This value was considered to be zero for contaminant uptake modeling.

^c NA = not applicable. The tree swallow, American kestrel, and red-tailed hawk were considered to have no incidental ingestion of soil.

TABLE 5.59 Estimated Sitewide Applied Daily Doses (mg/kg-d) of Contaminants for the Tree Swallow

Contaminant	TBP ADD	WPP ADD	PB ADD	RPDG ADD	Sitewide ADD
1,1 Oxathiane	<0.01	- ^a	-	-	<0.01
1,1,2,2-Tetrachloroethane	0.09	-	-	-	0.09
1,1-Dichloroethene	<0.01	-	-	-	<0.01
1,4-Dichlorobenzene	0	-	-	-	<0.01
1,4-Dithiane	<0.01	-	-	-	<0.01
1,4-Oxathiane	<0.01	-	-	-	<0.01
2,4,6-Trichloroaniline	0.33	-	-	-	0.33
2,4-Dinitrotoluene	0	-	-	0.01	0.01
2-Butanone	<0.01	-	-	-	<0.01
2-Methylnaphthalene	<0.01	-	-	-	<0.01
2-Methylphenol	0.04	-	-	-	0.04
4-Methylphenol	0.04	-	-	-	0.04
Acetone	0.01	<0.01	0.01	-	0.02
Aluminum	0.37	1.48	0.39	0.09	2.33
Antimony	0.23	0.01	<0.01	<0.01	0.24
Aroclor 1248	<0.01	-	-	-	<0.01
Arsenic	0.02	0.02	<0.01	<0.01	0.05
Barium	0.04	6.41	0.59	0.06	7.10
Benzo(a)anthracene	-	<0.01	-	-	<0.01
Benzo(a)pyrene	-	<0.01	-	-	<0.01
Benzo(b)fluoranthene	<0.01	<0.01	-	-	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	-	<0.01
bis(2-Ethylhexyl)phthalate	-	<0.01	-	-	<0.01
Cadmium	0.19	0.33	0.20	<0.01	0.73
Carbon disulfide	<0.01	-	-	-	<0.01
Chloroethane	<0.01	-	-	-	<0.01
Chloroform	<0.01	-	-	-	<0.01
Chromium	0.11	0.06	0.01	<0.01	0.19
Chrysene	-	<0.01	-	-	<0.01
Cobalt	0.04	0.02	0.01	<0.01	0.07
Copper	1.86	1.97	3.86	0.02	7.70
Cyanide	68.59	-	3.64	-	72.23

TABLE 5.59 (Cont.)

Contaminant	TBP ADD	WPP ADD	PB ADD	RPDG ADD	Sitewide ADD
Diethyl phthalate	0.03	-	-	-	0.03
DIMP	<0.01	-	-	-	<0.01
Dithiane	<0.01	-	-	-	<0.01
Endrin aldehyde	-	-	<0.01	-	<0.01
Fluoranthene	<0.01	<0.01	-	-	<0.01
Fluorene	<0.01	-	-	-	<0.01
Hexachlorobenzene	<0.01	-	-	-	<0.01
Hexachloroethane	<0.01	-	-	-	<0.01
Indeno(1,2,3-cd)pyrene	-	<0.01	-	-	<0.01
Iron	8.14	35.09	7.51	1.06	51.79
Lead	0.44	3.53	0.01	0.02	4.00
Magnesium	49.51	77.76	98.51	1.49	227.26
Manganese	2.03	2.06	1.21	0.05	5.35
Mercury	<0.01	0.01	0.01	<0.01	0.02
N-Nitrosodiphenylamine	0.01	-	-	-	<0.01
Nickel	0.22	0.23	0.09	<0.01	0.54
Nitroglycerin	0.57	-	-	-	0.57
Phenol	0.07	-	-	-	0.07
Pyrene	<0.01	<0.01	-	-	<0.01
RDX	-	-	-	<0.01	<0.01
Selenium	0.39	0.34	0.01	-	0.74
Silver	2.66	0.30	-	0.16	3.11
Sodium	171.45	72.25	110.72	2.24	356.66
Tetrachloroethene	0.01	-	-	-	0.01
Thallium	0.20	-	-	-	0.20
Trichloroethene	0.09	-	-	-	0.09
Vinyl chloride	<0.01	-	-	-	<0.01
Zinc	10.29	52.86	19.49	0.33	82.98

^a - = not detected for the indicated AOC.

TABLE 5.60 Estimated Sitewide Applied Daily Doses (mg/kg-d) of Contaminants for the American Kestrel

Contaminant	TBP ADD	WPP ADD	PB ADD	RPDG ADD	Sitewide ADD
1,1 Oxathiane	<0.01	- ^a	-	-	<0.01
1,1,2,2-Tetrachloroethane	0.01	-	-	-	0.01
1,1-Dichloroethene	<0.01	-	-	-	<0.01
1,4-Dichlorobenzene	0	-	-	-	<0.01
1,4-Dithiane	<0.01	-	-	-	<0.01
1,4-Oxathiane	<0.01	-	-	-	<0.01
2,4,6-Trichloroaniline	0.02	-	-	-	0.02
2,4-Dinitrotoluene	0	-	-	<0.01	<0.01
2-Butanone	<0.01	-	-	-	<0.01
2-Methylnaphthalene	<0.01	-	-	-	<0.01
2-Methylphenol	<0.01	-	-	-	<0.01
4-Methylphenol	<0.01	-	-	-	<0.01
Acetone	<0.01	<0.01	<0.01	-	<0.01
Aluminum	0.85	4.75	1.44	0.06	7.10
Antimony	0.03	<0.01	<0.01	<0.01	0.03
Aroclor 1248	<0.01	-	-	-	<0.01
Arsenic	0.05	<0.01	<0.01	<0.01	0.06
Barium	0.07	0.46	0.06	<0.01	0.59
Benzo(a)anthracene	-	<0.01	-	-	<0.01
Benzo(a)pyrene	-	<0.01	-	-	<0.01
Benzo(b)fluoranthene	<0.01	<0.01	-	-	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	-	<0.01
bis(2-Ethylhexyl)phthalate	-	<0.01	-	-	<0.01
Cadmium	0.02	0.02	0.01	<0.01	0.06
Carbon disulfide	<0.01	-	-	-	<0.01
Chloroethane	<0.01	-	-	-	<0.01
Chloroform	<0.01	-	-	-	<0.01
Chromium	0.03	0.01	<0.01	<0.01	0.05
Chrysene	-	<0.01	-	-	<0.01
Cobalt	0.01	<0.01	<0.01	<0.01	0.01
Copper	0.82	0.14	0.18	<0.01	1.15
Cyanide	4.40	-	0.24	-	4.64
Diethyl phthalate	<0.01	-	-	-	<0.01

TABLE 5.60 (Cont.)

Contaminant	TBP ADD	WPP ADD	PB ADD	RPDG ADD	Sitewide ADD
DIMP	<0.01	-	-	-	<0.01
Dithiane	<0.01	-	-	-	<0.01
Endrin aldehyde	-	-	<0.01	-	<0.01
Fluoranthene	<0.01	<0.01	-	-	<0.01
Fluorene	<0.01	-	-	-	<0.01
Hexachlorobenzene	<0.01	-	-	-	<0.01
Hexachloroethane	<0.01	-	-	-	<0.01
Indeno(1,2,3-cd)pyrene	-	<0.01	-	-	<0.01
Iron	6.67	9.49	1.66	0.18	18.00
Lead	7.91	0.28	0.02	<0.01	8.20
Magnesium	2.87	6.23	4.77	0.12	13.99
Manganese	0.13	0.20	0.12	<0.01	0.44
Mercury	<0.01	<0.01	<0.01	<0.01	<0.01
N-Nitrosodiphenylamine	<0.01	-	-	-	<0.01
Nickel	0.02	0.02	0.01	<0.01	0.04
Nitroglycerin	0.04	-	-	-	0.04
Phenol	<0.01	-	-	-	<0.01
Pyrene	<0.01	<0.01	-	-	<0.01
RDX	-	-	-	<0.01	<0.01
Selenium	0.03	0.02	<0.01	-	0.05
Silver	0.17	0.02	-	0.01	0.20
Tetrachloroethene	<0.01	-	-	-	<0.01
Thallium	0.01	-	-	-	0.01
Trichloroethene	0.01	-	-	-	0.01
Vinyl chloride	<0.01	-	-	-	<0.01
Zinc	8.61	3.58	0.98	0.02	13.20

^a - = not detected for the indicated AOC.

TABLE 5.61 Estimated Sitewide Applied Daily Doses (mg/kg-d) of Contaminants for the Red-Tailed Hawk

Contaminant	TBP ADD	WPP ADD	PB ADD	RPDG ADD	Sitewide ADD
1,1 Oxathiane	<0.01	- ^a	-	-	<0.01
1,1,2,2-Tetrachloroethane	0.02	-	-	-	0.02
1,1-Dichloroethene	<0.01	-	-	-	<0.01
1,4-Dichlorobenzene	0	-	-	-	<0.01
1,4-Dithiane	<0.01	-	-	-	<0.01
1,4-Oxathiane	<0.01	-	-	-	<0.01
2,4,6-Trichloroaniline	<0.01	-	-	-	<0.01
2,4-Dinitrotoluene	0	-	-	<0.01	<0.01
2-Butanone	<0.01	-	-	-	<0.01
2-Methylnaphthalene	<0.01	-	-	-	<0.01
2-Methylphenol	<0.01	-	-	-	<0.01
4-Methylphenol	<0.01	-	-	-	<0.01
Acetone	<0.01	<0.01	<0.01	-	<0.01
Aluminum	0.05	0.31	0.08	<0.01	0.45
Antimony	<0.01	<0.01	<0.01	<0.01	<0.01
Aroclor 1248	<0.01	-	-	-	<0.01
Arsenic	<0.01	0.01	<0.01	<0.01	<0.01
Barium	<0.01	0.02	<0.01	<0.01	0.02
Benzo(a)anthracene	-	<0.01	-	-	<0.01
Benzo(a)pyrene	-	<0.01	-	-	<0.01
Benzo(b)fluoranthene	<0.01	<0.01	<0.01	-	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	-	-	<0.01
bis(2-Ethylhexyl)phthalate	-	<0.01	-	-	<0.01
Cadmium	<0.01	<0.01	0.04	<0.01	0.04
Carbon disulfide	<0.01	-	-	-	<0.01
Chloroethane	<0.01	-	-	-	<0.01
Chloroform	<0.01	-	-	-	<0.01
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	-	<0.01	-	-	<0.01
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	0.04	0.01	0.01	<0.01	0.05
Cyanide	0.14	-	0.01	-	0.14
Diethyl phthalate	<0.01	-	-	-	<0.01
DIMP	<0.01	-	-	-	<0.01
Dithiane	<0.01	-	-	-	<0.01

TABLE 5.61 (Cont.)

Contaminant	TBP ADD	WPP ADD	PB ADD	RPDG ADD	Sitewide ADD
Endrin aldehyde	-	-	<0.01	-	<0.01
Fluoranthene	<0.01	<0.01	-	-	<0.01
Fluorene	<0.01	-	-	-	<0.01
Hexachlorobenzene	<0.01	-	-	-	<0.01
Hexachloroethane	<0.01	-	-	-	<0.01
Indeno(1,2,3-cd)pyrene	-	<0.01	-	-	<0.01
Iron	0.36	0.56	0.08	0.01	1.02
Lead	0.19	0.01	<0.01	<0.01	0.20
Magnesium	0.11	0.29	0.17	0.01	0.57
Manganese	<0.01	0.01	<0.01	<0.01	0.02
Mercury	<0.01	<0.01	<0.01	<0.01	0.01
N-Nitrosodiphenylamine	<0.01	-	-	-	<0.01
Nickel	<0.01	<0.01	<0.01	<0.01	<0.01
Nitroglycerin	<0.01	-	-	-	<0.01
Phenol	<0.01	-	-	-	<0.01
Pyrene	<0.01	<0.01	-	-	<0.01
RDX	-	-	-	<0.01	<0.01
Selenium	<0.01	<0.01	<0.01	-	0.50
Silver	0.01	<0.01	-	<0.01	0.01
Tetrachloroethene	<0.01	-	-	-	<0.01
Thallium	<0.01	-	-	-	<0.01
Trichloroethene	<0.01	-	-	-	<0.01
Vinyl chloride	<0.01	-	-	-	<0.01
Zinc	0.36	0.12	0.03	<0.01	0.51

^a - = not detected for the indicated AOC.

TABLE 5.62 Estimated Sitewide Applied Daily Doses (mg/kg-d) of Contaminants for the White-Tailed Deer

Contaminant	TBP ADD	WPP ADD	RCP ADD	PB ADD	RPDG ADD	RPTS ADD	SBT ADD	SBDG ADD	Sitewide ADD
1,1 Oxathiane	<0.01	- ^a	-	-	-	-	-	-	<0.01
1,1,2,2-Tetrachloroethane	0.01	-	-	-	-	-	-	-	0.01
1,1-Dichloroethene	<0.01	-	-	-	-	-	-	-	<0.01
1,4-Dichlorobenzene	0	-	-	-	-	-	-	-	<0.01
1,4-Dithiane	<0.01	-	-	-	-	-	-	-	<0.01
1,4-Oxathiane	<0.01	-	-	-	-	-	-	-	<0.01
2,4,6-Trichloroaniline	0.04	-	-	-	-	-	-	-	0.04
2,4-Dinitrotoluene	0	-	-	-	<0.01	-	-	-	<0.01
2-Butanone	<0.01	-	-	-	-	-	-	-	<0.01
2-Methylnaphthalene	<0.01	-	-	-	-	-	-	-	<0.01
2-Methylphenol	<0.01	-	-	-	-	-	-	-	<0.01
4-Methylphenol	<0.01	-	-	-	-	-	-	-	<0.01
Acetone	<0.01	<0.01	<0.01	<0.01	-	<0.01	-	-	<0.01
Aluminum	2.07	11.97	4.20	4.09	0.23	4.40	0.27	<0.01	27.23
Antimony	0.07	<0.01	<0.01	<0.01	<0.01	-	-	-	0.07
Aroclor 1248	<0.01	-	-	-	-	-	-	-	<0.01
Arsenic	0.19	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	0.21
Barium	0.25	0.77	0.06	0.15	0.01	0.28	0.01	<0.01	1.53
Benzo(a)anthracene	-	<0.01	-	-	-	-	-	-	<0.01
Benzo(a)pyrene	-	<0.01	-	-	-	-	-	-	<0.01
Benzo(b)fluoranthene	<0.01	<0.01	-	<0.01	-	<0.01	-	-	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	-	-	-	-	-	-	<0.01
bis(2-Ethylhexyl)phthalate	-	<0.01	-	-	-	<0.01	-	-	<0.01
Cadmium	0.09	0.04	0.03	0.02	<0.01	0.01	<0.01	-	0.20
Carbon disulfide	<0.01	-	-	-	-	-	-	-	<0.01
Chloroethane	<0.01	-	-	-	-	-	-	-	<0.01

TABLE 5.62 (Cont.)

Contaminant	TBP ADD	WPP ADD	RCP ADD	PB ADD	RPDG ADD	RPTS ADD	SBT ADD	SBDG ADD	Sitewide ADD
Chloroform	<0.01	-	-	-	-	-	-	-	<0.01
Chromium	0.11	0.02	0.04	0.01	<0.01	0.01	<0.01	-	0.19
Chrysene	-	<0.01	-	-	-	-	-	-	<0.01
Cobalt	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	0.01
Copper	2.90	0.24	0.31	0.12	<0.01	0.09	0.01	-	3.67
Cyanide	7.26	-	-	0.39	-	-	-	-	7.64
Diethyl phthalate	<0.01	-	-	-	-	-	-	-	<0.01
DIMP	<0.01	-	-	-	-	-	-	-	<0.01
Dithiane	<0.01	-	-	-	-	-	-	-	<0.01
Endrin aldehyde	-	-	-	<0.01	-	-	-	-	<0.01
Fluoranthene	<0.01	<0.01	-	-	-	-	-	-	<0.01
Fluorene	<0.01	-	-	-	-	-	-	-	<0.01
Hexachlorobenzene	<0.01	-	-	-	-	-	-	-	<0.01
Hexachloroethane	<0.01	-	-	-	-	-	-	-	<0.01
Indeno(1,2,3-cd)pyrene	-	<0.01	-	-	-	-	-	-	<0.01
Iron	16.81	22.15	3.16	4.12	0.64	8.15	0.35	0.02	55.41
Lead	37.09	0.49	0.17	0.06	<0.01	0.18	<0.01	<0.01	37.98
Magnesium	2.96	12.96	4.72	4.09	0.33	4.77	0.26	0.02	30.09
Manganese	0.15	0.38	0.60	0.24	0.01	0.14	<0.01	0.01	1.52
Mercury	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	0.01
N-Nitrosodiphenylamine	<0.01	-	-	-	-	-	-	-	<0.01
Nickel	0.03	0.03	0.01	0.01	<0.01	0.01	<0.01	-	0.10
Nitroglycerin	0.06	-	-	-	-	-	-	-	0.06
Phenol	0.01	-	-	-	-	-	-	-	0.01
Pyrene	<0.01	<0.01	-	-	-	-	-	-	<0.01
RDX	-	-	-	-	<0.01	-	-	-	<0.01

TABLE 5.62 (Cont.)

Contaminant	TBP ADD	WPP ADD	RCP ADD	PB ADD	RPDG ADD	RPTS ADD	SBT ADD	SBDG ADD	Sitewide ADD
Selenium	0.04	0.04	0.01	0.01	-	0.01	-	-	0.11
Silver	0.28	0.03	0.11	-	0.02	-	<0.01	-	0.44
Tetrachloroethene	<0.01	-	-	-	-	-	-	-	<0.01
Thallium	0.02	-	-	-	-	-	-	-	0.02
Trichloroethene	0.01	-	-	-	-	-	-	-	0.01
Vinyl chloride	<0.01	-	-	-	-	-	-	-	<0.01
Zinc	33.45	5.88	0.23	0.87	0.04	2.16	0.06	<0.01	42.69

^a - = not detected for the indicated AOC.

TABLE 5.63 Estimated Sitewide Applied Daily Doses (mg/kg-d) of Contaminants for the Red Fox

Contaminant	TBP ADD	WPP ADD	RCP ADD	PB ADD	RPDG ADD	RPTS ADD	SBT ADD	SBDG ADD	Sitewide ADD
1,1 Oxathiane	<0.01	- ^a	-	-	-	-	-	-	<0.01
1,1,2,2-Tetrachloroethane	<0.01	-	-	-	-	-	-	-	<0.01
1,1-Dichloroethene	<0.01	-	-	-	-	-	-	-	<0.01
1,4-Dichlorobenzene	0	-	-	-	-	-	-	-	<0.01
1,4-Dithiane	<0.01	-	-	-	-	-	-	-	<0.01
1,4-Oxathiane	<0.01	-	-	-	-	-	-	-	<0.01
2,4,6-Trichloroaniline	<0.01	-	-	-	-	-	-	-	<0.01
2,4-Dinitrotoluene	0	-	-	-	<0.01	-	-	-	<0.01
2-Butanone	<0.01	-	-	-	-	-	-	-	<0.01
2-Methylnaphthalene	<0.01	-	-	-	-	-	-	-	<0.01
2-Methylphenol	<0.01	-	-	-	-	-	-	-	<0.01
4-Methylphenol	<0.01	-	-	-	-	-	-	-	<0.01
Acetone	<0.01	<0.01	<0.01	<0.01	-	<0.01	-	-	<0.01
Aluminum	0.29	1.51	0.62	0.51	0.02	0.65	0.03	<0.01	3.64
Antimony	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	-	<0.01
Aroclor 1248	<0.01	-	-	-	-	-	-	-	<0.01
Arsenic	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	0.02
Barium	0.02	0.04	<0.01	0.01	<0.01	0.02	<0.01	<0.01	0.09
Benzo(a)anthracene	-	<0.01	-	-	-	-	-	-	<0.01
Benzo(a)pyrene	-	<0.01	-	-	-	-	-	-	<0.01
Benzo(b)fluoranthene	<0.01	<0.01	-	<0.01	-	<0.01	-	-	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	-	-	-	-	-	-	<0.01
bis(2-Ethylhexyl)phthalate	-	<0.01	-	-	-	<0.01	-	-	<0.01
Cadmium	<0.01	<0.01	<0.01	0.18	<0.01	<0.01	<0.01	-	0.18
Carbon disulfide	<0.01	-	-	-	-	-	-	-	<0.01
Chloroethane	<0.01	-	-	-	-	-	-	-	<0.01

TABLE 5.63 (Cont.)

Contaminant	TBP ADD	WPP ADD	RCP ADD	PB ADD	RPDG ADD	RPTS ADD	SBT ADD	SBDG ADD	Sitewide ADD
Chloroform	<0.01	-	-	-	-	-	-	-	<0.01
Chromium	0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	-	0.02
Chrysene	-	<0.01	-	-	-	-	-	-	<0.01
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	0.01
Copper	0.13	0.02	0.05	0.01	<0.01	0.01	<0.01	-	0.22
Cyanide	0.30	-	-	0.01	-	-	-	-	0.32
Diethyl phthalate	<0.01	-	-	-	-	-	-	-	<0.01
DIMP	<0.01	-	-	-	-	-	-	-	<0.01
Dithiane	<0.01	-	-	-	-	-	-	-	<0.01
Endrin aldehyde	-	-	-	0.04	-	-	-	-	0.04
Fluoranthene	<0.01	<0.01	-	-	-	-	-	-	<0.01
Fluorene	<0.01	-	-	-	-	-	-	-	<0.01
Hexachlorobenzene	<0.01	-	-	-	-	-	-	-	<0.01
Hexachloroethane	<0.01	-	-	-	-	-	-	-	<0.01
Indeno(1,2,3-cd)pyrene	-	<0.01	-	-	-	-	-	-	<0.01
Iron	2.06	2.44	0.46	0.46	0.05	1.06	0.04	<0.01	6.57
Lead	1.81	0.03	0.02	0.02	<0.01	0.01	<0.01	<0.01	1.90
Magnesium	0.22	0.57	0.28	0.27	0.01	0.24	0.01	<0.01	1.60
Manganese	0.01	0.06	0.03	0.02	<0.01	0.01	<0.01	<0.01	0.13
Mercury	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	<0.01
N-Nitrosodiphenylamine	<0.01	-	-	-	-	-	-	-	<0.01
Nickel	<0.01	0.02	<0.01	0.03	<0.01	<0.01	<0.01	-	0.05
Nitroglycerin	<0.01	-	-	-	-	-	-	-	<0.01
Phenol	<0.01	-	-	-	-	-	-	-	<0.01
Pyrene	<0.01	<0.01	-	-	-	-	-	-	<0.01
RDX	-	-	-	-	<0.01	-	-	-	<0.01

TABLE 5.63 (Cont.)

Contaminant	TBP ADD	WPP ADD	RCP ADD	PB ADD	RPDG ADD	RPTS ADD	SBT ADD	SBDG ADD	Sitewide ADD
Selenium	<0.01	<0.01	<0.01	0.03	-	<0.01	-	-	0.03
Silver	0.01	<0.01	<0.01	-	<0.01	-	<0.01	-	0.02
Tetrachloroethene	<0.01	-	-	-	-	-	-	-	<0.01
Thallium	<0.01	-	-	-	-	-	-	-	<0.01
Trichloroethene	<0.01	-	-	-	-	-	-	-	<0.01
Vinyl chloride	<0.01	-	-	-	-	-	-	-	<0.01
Zinc	1.18	0.32	0.04	0.05	<0.01	0.11	<0.01	<0.01	1.71

^a - = not detected for the indicated AOC.

6 ECOLOGICAL EFFECTS ASSESSMENT

6.1 TOXIC BURNING PITS

The assessment of ecological effects at the TBP AOC included (1) evaluations of species abundance and community composition using quantitative and qualitative surveys of terrestrial vegetation and terrestrial and aquatic invertebrate and vertebrate biota; (2) quantitative evaluations of the physiological parameters of soil invertebrates, such as enzyme activity; (3) quantitative evaluations of biologically mediated nutrient-cycling processes, such as litter decomposition and nitrogen mineralization; and (4) toxicity evaluations of soils, sediments, and surface waters for a variety of invertebrates, vertebrates, and plants. Soil biota and processes are important components of terrestrial ecosystems, and soil processes, such as decomposition and nitrogen mineralization, are critical in the cycling of nutrients and thus in the primary productivity of terrestrial ecosystems. Evaluations of soil biota and biologically mediated soil processes were included in the effects assessment for the TBP AOC (and for other J-Field AOCs) because much of the contamination at these areas is associated with the soil. These evaluations were performed to complement standard evaluations of contaminated soils such as vegetation surveys and earthworm and lettuce seed toxicity tests. Sections 6.1.1 through 6.1.6 present the results of these assessments; details regarding the methods used in these assessments are presented in Appendix A.

6.1.1 Aquatic Habitats

Although no aquatic habitat exists within the TBP AOC proper, the TBP Pushout Area is surrounded by marsh habitat, and a pond is located within the marsh. On the basis of the topography of the TBP AOC, it is apparent that runoff from the Pushout Area drains into this marsh. Shallow groundwater from the TBP AOC may also enter surface water in the marsh and pond (Yuen et al. 1999).

6.1.1.1 Aquatic Invertebrates and Fish

6.1.1.1.1 Aquatic Invertebrates. Qualitative samples of aquatic invertebrates collected from marsh areas surrounding the TBP AOC (see Figure A.11 for sample locations) contained a variety of invertebrate biota, including oligochaetes, cladocerans (e.g., *Daphnia* spp.), copepods, amphipods (e.g., *Hyalella*), dipterans (e.g., Culicidae and Chironomidae), and coleopterans (e.g., Dytiscidae and Haliplidae).

Fifteen taxa of benthic invertebrates were identified in sediment collections from the pond in the marsh southeast of the TBP AOC (Table 6.1). Dominant taxa included roundworms (Nematoda), snails (Gastropoda), biting flies (Ceratopogonidae), and midges (Chironomidae). These taxa are commonly found in or on soft sediments like those present in the marsh pond. The mean densities of taxa collected from each station indicated that the richness, evenness, and diversity of the benthic community were greatest at station TPD-1-94 (Table 6.1). The lowest diversity and richness (five taxa) occurred at station SWQ-95, the sampling location nearest to the TBP AOC.

Artificial substrate samplers were placed in the pond for approximately 10 weeks to quantify the abundance of benthic invertebrates. Eight taxa were collected. The dominant taxa were midges and tubificid oligochaetes. These taxa were also observed in the samples of benthic invertebrates described earlier.

Because invertebrate species differ in their sensitivity to contaminants, the types of organisms present in the benthic samples were compared with information from tables giving the pollution tolerances of selected macroinvertebrates (EPA 1990b) to determine whether any of the species present could be used as indicators of habitat quality. Most species within the genera collected from the pond are considered facultative in their tolerance to organic wastes, and their presence does not indicate whether or not the pond is contaminated with organic compounds. Although the heavy-metal tolerance of most of the taxa collected is unknown, several species in the genus *Dicrotendipes* (order Diptera, family Chironomidae) are considered intolerant of heavy-metal contamination (EPA 1990b). However, the specimens of this genus collected from the pond and marsh were not identified to the species level, and it is unknown whether any metal-intolerant species were present.

6.1.1.1.2 Fish. The principal habitat for fish within the TBP AOC is the marsh and pond southeast of the Pushout Area. Two baited minnow traps placed in the pond on August 19, 1993, captured three blue-spotted sunfish (*Enneacanthus gloriosus*), one banded killifish (*Fundulus diaphanus*), and one spottail shiner (*Notropis hudsonius*).

Five baited minnow traps were placed in the pond on March 14 and 15, 1995, and retrieved the following day. Traps retrieved on March 15, 1995, contained 312 golden shiners (*Notemigonus crysoleucas*) and 11 blue-spotted sunfish; those retrieved on March 16, 1995, contained 637 golden shiners and 3 blue-spotted sunfish. Thus, a total of 949 golden shiners and 14 blue-spotted sunfish were collected over 10 trap nights (5 traps $\times$ 2 nights). The mean standard length of the golden shiners was 61.6 mm (range 45-79 mm), and mean mass was 3.9 g (range 1-8 g). The blue-spotted sunfish averaged 35.7 mm in standard length (range 22-79 mm), and mean mass was 1.6 g (range 1-6 g). These size ranges are within the ranges reported for both juvenile and adult blue-spotted sunfish (Jenkins and Burkhead 1994).

TABLE 6.1 Density (number/m²) and Diversity Indices for Benthic Invertebrates Collected from Three Sampling Stations in the Marsh Pond at J-Field

Taxon	Sample Location			
	SWQ-95	TPD-1-94	TPD-2-94	Overall
Phylum Nematoda	1591.0	21.5	21.5	544.7
Phylum Mollusca				
Class Gastropoda				
Family Physidae				
<i>Physella</i> sp.	0	64.5	107.5	57.3
Family Lymnaeidae	0	129.0	322.5	150.5
Unidentified Gastropoda	0	107.5	0	35.8
Phylum Annelida				
Class Oligochaeta				
Family Lumbriculidae	21.5	21.5	0	14.3
Family Tubificidae				
<i>Aulodrilus pigueti</i>	0	344.0	0	114.7
Unidentified Tubificidae	43.0	86.0	43.0	57.3
Family Naididae				
<i>Dero</i> sp.	0	129.0	0	43.0
Phylum Arthropoda				
Class Arachnida	0	0	21.5	7.2
Hydracarina				
Class Insecta				
Order Coleoptera				
Family Dytiscidae	0	21.5	43.0	21.5
Order Diptera				
Family Ceratopogonidae	107.5	0	494.5	200.7
Family Chironomidae				
<i>Chironomus</i> sp.	150.5	21.5	43.0	71.7
<i>Cricotopus</i> sp.	0	64.5	64.5	43.0
<i>Dicrotendipes</i> sp.	0	21.5	0	7.2
<i>Parachironomus</i> sp.	0	21.5	0	7.2
Number of taxa (<i>S</i>)	5	13	9	15
Total density (number/m ²)	1,913.5	1,053.5	1,161.0	1,376.0
Simpson's Diversity Index (<i>D</i>) ^a	1.426	6.109	3.636	4.852
Shannon's Diversity Index (<i>H</i>) ^b	0.651	2.136	1.614	2.022
Evenness Index (<i>J'</i>) ^c	0.404	0.833	0.735	0.747

See next page for footnotes.

TABLE 6.1 Footnotes

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- ^a Simpson (1949); $D = \frac{1}{\sum_{i=1}^S p_i^2}$, where p_i is the proportional abundance of the i th taxon in the sample and S is the total number of taxa in the sample.
- ^b Shannon and Weaver (1949); $H' = -\sum_{i=1}^S (p_i \ln p_i)$, where p_i is the proportional abundance of the i th taxon and S is the total number of taxa in the sample.
- ^c Pielou (1975); $J' = \frac{H'}{\ln(S)}$, where H' is Shannon's Diversity Index and S is the total number of taxa in the sample.

An electrofishing survey conducted in the pond on May 12, 1994, collected three adult blue-spotted sunfish ranging from 62 to 73 mm in total length. In addition, 132 larvae collected with a dip net during the electrofishing survey were identified as golden shiners; they ranged from 7 to 15 mm in length.

All of the fish collected appeared healthy, with no external lesions or abnormalities. These results seem to indicate that the pond is dominated by golden shiners and blue-spotted sunfish and that a reproducing population of golden shiners is present. These two species are common in vegetated and soft-bottomed pond habitats in the region (Rohde et al. 1994). The golden shiner is a common food for several predatory fishes (e.g., largemouth bass [*Micropterus salmoides*]) and birds (e.g., herons, egrets, and kingfishers) (Rohde et al. 1994). Although other fish taxa, such as catfish (family Ictaluridae) and largemouth bass, may also be present in the pond, none were observed while water, sediment, and benthic organisms were collected from the pond. Hook-and-line sampling targeting bass and catfish also failed to find any other fish taxa in the pond.

6.1.1.2 Aquatic Toxicity

Table 6.2 presents the results of toxicity testing of surface water, sediment, and groundwater from the TBP AOC; Figure 6.1 shows the sampling locations. No acute toxicity was evident in surface water from the pond or marsh.

Chronic toxicity of surface water to the green alga *Selenastrum* was observed at all TBP marsh locations. However, surface water from all J-Field locations, except TBP-B, elicited a statistically significant chronic response by this alga, even when no toxicity to other test organisms

TABLE 6.2 Results of Toxicity Testing with Sediment, Surface Water, and Groundwater Collected from the Toxic Burning Pits Area^{a,b}

Toxicity Test (medium, endpoint)	TBP Marsh				TBP Pond					Wells		
	SW-7	SW-10	SW-11	SW-12	TBP-A	TBP-B	SWQ-95	TPD-1	TPD-2	JF5-3	JF7-3	JF8-3
<i>Acute Tests</i>												
Microtox (water, inhibition)	-	-	-	-	-	-	-	-	-	-	-	-
Microtox (sediment, inhibition)	-	-	-	+	-	+	-	-	-	-	-	-
<i>Daphnia</i> (water, 48-hour survival)	-	-	-	-	-	-	-	-	-	+	-	+
<i>Hyalella</i> (sediment, 10-day survival)	-	-	-	+	-	-	-	-	-	-	-	-
<i>Hyalella</i> (sediment, 10-day growth)	-	-	* ^c	-	-	-	-	-	-	-	-	-
<i>Pimephales</i> (water, 48-hour survival)	-	-	-	-	-	-	-	-	-	-	-	+
<i>Rana</i> (water, 48-hour survival)	-	-	-	-	-	-	-	-	-	-	-	+
<i>Chronic Tests</i>												
<i>Lemna</i> (water, 96-hour production)	-	-	+	+	-	+	-	-	-	-	+	-
<i>Selenastrum</i> (water, 96-hour production)	+	+	+	+	+	-	+	+	+	+	+	+
<i>Ceriodaphnia</i> (water, 7-day survival)	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ceriodaphnia</i> (water, 7-day reproduction)	+	-	-	-	-	+	-	-	-	-	-	-
<i>Hyalella</i> (sediment, 28-day survival)	-	-	-	-	-	-	-	-	-	-	-	-
<i>Hyalella</i> (sediment, 28-day growth)	-	-	+	-	-	-	-	-	-	-	-	-
<i>Pimephales</i> (water, 7-day survival)	-	+	-	-	-	-	-	-	-	-	-	-
<i>Pimephales</i> (water, 7-day growth)	-	-	-	-	-	+	+	-	-	-	-	-

^a See Figure 6.1 for sample locations.

^b - = test results indicated media were not toxic compared with laboratory controls; + = test results indicated media were toxic compared with laboratory controls; blank cell indicates not tested.

^c * = statistical comparison of growth of *Hyalella* not determined because of differences in survival between sample and laboratory control.

FIGURE 6.1 Approximate Locations of Media Collection Sites at J-Field (MBP = Mustard Burning Pit)

was observed. *Selenastrum* is more sensitive to contaminants than other organisms commonly used in toxicity tests, including daphnids (*Daphnia*), fathead minnows (*Pimephales promelas*), and the bacterium used in the Microtox test (*Photobacterium phosphoreum*) (Toussaint et al. 1995). It is unclear whether the observed response of *Selenastrum* was due to contaminants in the tested media or some natural water-quality parameter of the water at the J-Field site.

Chronic toxicity of surface water to the floating vascular plant duckweed (*Lemna*) was detected at sites SW-11 (13% inhibition), SW-12 (15% inhibition), and TBP-B (12% inhibition).

Chronic toxicity to larval fish (*Pimephales*) was detected at site SW-10, with 60% survival of larval fish after 7 days in ambient surface water (no observable effect concentration = 25% of ambient water concentration), compared with 92% survival in laboratory controls. Significant differences in the growth rates of larval fish (compared with laboratory controls) were detected after 7 days in water from location TBP-B, although survival was not significantly affected.

Microtox screening of sediments from TBP locations detected significant inhibition (compared with controls) for sites SW-12 and TBP-B. Sediment from site SW-12 also significantly reduced survival of the amphipod *Hyaella azteca* after 10 days of exposure, but no significant reduction in survival or growth of *Hyaella* was detected during 28-days tests with sediment from this location. Metal concentrations in surface water from sites SW-10, SW-11, and SW-2 exceeded acute and chronic ambient water quality criteria for several metals (Yuen et al. 1999).

No acute toxicity was detected in surface water or sediment from the TBP pond. However, surface water from the pond reduced production of *Selenastrum* during 96-hour exposures (Table 6.2). (30, 35, and 41% inhibition compared with controls at sites SWQ-95, TPD-2, and TPD-1, respectively). Surface water from location SWQ-95 also reduced growth of *Pimephales* larvae after 7 days of exposure, although survival of *Pimephales* larvae was not significantly affected by surface water from pond locations SWQ-95 or TPD-1. No chronic effects to *Lemna* or the water flea *Ceriodaphnia* were detected after exposure to surface water from the pond.

Several results indicated that groundwater from the surficial aquifer in the TBP AOC was toxic (Table 6.2). Water from well JF8-3 contained high levels of TCLEA, 12DCE, TCLEE, TRCLE, and 112TCE (Yuen et al. 1999). Exposure to the water resulted in significantly reduced survival of *Daphnia*, *Pimephales*, and *Rana* during acute testing, and affected production of *Selenastrum* in chronic tests. Water from well JF5-3 significantly reduced the survival of *Daphnia*, although no significant effects on the survival of *Pimephales* or *Rana* were detected. *Selenastrum* production was significantly affected by water from well JF5-3 after 96 hours, although *Lemna* production was not affected. Water from well JF7-3 did not significantly affect survival of *Daphnia*, *Pimephales*, or *Rana* during acute testing but did significantly reduce production of *Lemna* and *Selenastrum* during 96-hour chronic tests. No chronic toxicity tests of water from these wells were conducted with *Ceriodaphnia* or *Pimephales*.

An additional aquatic toxicological investigation of the TBP AOC was initiated in the spring of 1997 by the University of Maryland (UM) to further define potential toxicity to the marsh ecosystem that may occur as a result of changes in the seasonal groundwater discharge to the marsh (Burton and Turley 1997). That investigation involved performing aqueous phase bioassays on surface water samples from marsh locations SW-10, SW-11, and SW-12 east of the Pushout Area and along the Pushout Area-marsh boundary, and on groundwater from well JF8-3. A sediment-phase bioassay was also conducted on a composite sediment sample collected from location SW-11. These are the sample locations at which previous toxicological studies conducted to support the J-Field ERA (see previous text, this section) identified surface water, groundwater, and/or sediment toxicity.

Results of the UM (Burton and Turley 1997) acute surface water toxicity tests were consistent with the results of the ERA toxicity evaluations. No acute toxicity to daphnids or frogs was evident from any of the surface water sites. Acute surface water toxicity was indicated at one site (SW-11) for *Pimephales* following 96 hours of exposure; the ERA toxicological study reported no acute toxicity to this receptor at any site following 48 hours of exposure. Among the chronic toxicity evaluations of surface water performed in the UM study (Burton and Turley 1997), all marsh samples exhibited chronic toxicity to the green alga *Selanastrum*, while toxicity to daphnids (following a seven-day exposure) was evident only at SW-11. In contrast to the results of the ERA toxicity evaluations, which reported chronic toxicity to *Pimephales* only for site SW-10, the UM study reported chronic toxicity to *Pimephales* at all three marsh sites. Neither study determined chronic toxicity of marsh surface water to frogs; the UM study did report embryo malformations in teratogenicity assays at all three marsh sites in 1997.

The UM study (Burton and Turley 1997) conducted a 28-day chronic exposure study using sediment from SW-11 and reported no sediment toxicity to the amphipod *Hyaella*. Acute toxicity evaluations conducted for the ERA of the sediment from SW-11 showed no toxicity to the amphipod, while a chronic 28-day evaluation found sediment from SW-11 to be toxic to the amphipod (reduction in growth). In the UM study, acute and chronic toxicity to all test organisms was evident for groundwater collected from well JF8-3, located upgradient from the Pushout Area-marsh boundary. These results are similar to those obtained during the ERA toxicity evaluations.

6.1.2 Soil Biota

6.1.2.1 Soil Macroinvertebrate Community

The total number of macroinvertebrates in the Pushout Area in late autumn (November) 1993 and spring (April-May) 1994 was significantly lower than the number in the local background site (Tables 6.3 and 6.4). This difference was due largely to the greater abundance of ants at the

TABLE 6.3 Abundance of Soil Macroinvertebrates in the Toxic Burning Pits Area, November 1993

Taxa	Mean Abundance (number/m ² ± 1 SE; <i>n</i> = 9)	
	Pushout Area (TBTF)	Local Background Site (TBTC)
Lumbricidae	- ^a	1.11 ± 1.11
Isopoda	1.11 ± 1.1	-
Aranea	-	87.78 ± 14.2
Diplura	-	2.22 ± 1.47
Diptera larvae	6.67 ± 2.4	4.44 ± 2.4
Gryllidae	-	1.11 ± 1.11
Formicidae	54.44 ± 52	970 ± 317.25
Lepidoptera larvae	3.33 ± 2.4	2.22 ± 1.5
Elateridae	3.33 ± 1.67	26.67 ± 5.5
Scarabaeidae	-	1.11 ± 1.11
Curculionidae	4.44 ± 4.4	-
Carabidae	3.33 ± 1.7	4.44 ± 1.8
Staphylinidae	-	6.67 ± 2.9
Other Coleoptera	-	14.4 ± 5.8
Other ^b	4.44 ± 3.4	2.22 ± 1.5
Total ^c	81.1 ± 51.7	1124.44 ± 325.5

^a - = not found.

^b Includes Hemiptera and insect pupae.

^c Total numbers are significantly different at *P* < 0.001. Statistical analyses (*t*-test) were performed for total numbers on ln-transformed data.

TABLE 6.4 Abundance of Soil Macroinvertebrates in the Toxic Burning Pits Area, April–May 1994

Taxa	Mean Abundance (number/m ² ± 1 SE; <i>n</i> = 30)	
	Pushout Area (TBTF)	Local Background Site (TBTC)
Lumbricidae	- ^a	9.31 ± 6.5
Aranea	13.97 ± 10.3	139.68 ± 26.8
Diplura	-	41.90 ± 15.2
Diptera larvae	121.06 ± 62.4	23.28 ± 11.8
Formicidae	1047.6 ± 374.1	3939 ± 1235
Lepidoptera larvae	9.31 ± 9.31	-
Elateridae	-	27.94 ± 12.3
Scarabaeidae	-	4.66 ± 4.66
Carabidae	27.94 ± 14.1	32.59 ± 12.9
Staphylinidae	18.62 ± 11.1	18.62 ± 8.8
Other Coleoptera	-	13.97 ± 7.8
Other ^b	9.31 ± 6.5	9.31 ± 6.5
Total ^c	1247.81 ± 424.5	4260.24 ± 1231.7

^a - = not found.

^b Includes Hemiptera and insect pupae.

^c Total numbers are significantly different at *P* < 0.001. Statistical analyses (*t*-test) were performed for total numbers on ln transformed data.

background site. In autumn 1994, the total abundance of macroinvertebrates did not differ significantly between the two sites, but it was significantly lower than that for the reference site at Gunpowder Falls State Park (see Figure A.10) (Table 6.5). The three most abundant groups of soil macroinvertebrates in these sites were ants, spiders, and beetles. In fall 1993 and spring 1994, the abundance of ants and spiders in the Pushout Area was much lower than that of the local background site. The abundance of several taxa of beetles, including Elateridae and Scarabaeidae, was also lower in the Pushout Area on these dates. The effects of soil conditions on the macroinvertebrate community were pronounced in October 1994. In undisturbed soils, commonly abundant taxa, such as Lumbricidae, Gastropoda, Isopoda, Lithobiomorpha, Geophilomorpha, Symphyla, Diplopoda, and Diplura, were negatively affected in both the Pushout Area and local background sites (Table 6.5).

TABLE 6.5 Abundance of Soil Macroinvertebrates in the Toxic Burning Pits Area and the Reference Site, October 1994

Taxa	Mean Abundance (number/m ² ± 1 SE; n = 30)		
	Pushout Area (TBTF)	Local Background Site (TBTC)	Reference Site (RSA)
Lumbricidae	9.31 ± 6.5	- ^a	349.20 ± 40
Gastropoda	-	-	13.97 ± 7.8
Isopoda	23.28 ± 15.1	-	102.4 ± 29.9
Lithobiomorpha	-	-	23.28 ± 9.7
Geophilomorpha	-	-	69.84 ± 20.9
Symphyla	-	18.62 ± 8.8	195.55 ± 45.7
Diplopoda	-	-	32.59 ± 17.3
Aranea	135.02 ± 36.4	167.62 ± 29.5	172.27 ± 34.6
Diplura	-	4.66 ± 4.7	1112.78 ± 211
Diptera larvae	18.62 ± 11.1	37.25 ± 13.3	55.87 ± 17.2
Formicidae	530.8 ± 282.1	572.69 ± 169.6	4.66 ± 4.7
Lepidoptera larvae	4.66 ± 4.7	4.66 ± 4.7	18.62 ± 11.1
Elateridae	4.66 ± 4.7	37.25 ± 13.3	-
Scarabaeidae	-	9.31 ± 6.5	-
Curculionidae	4.66 ± 4.7	13.97 ± 7.8	4.66 ± 4.7
Carabidae	65.18 ± 23.9	27.94 ± 10.4	130.37 ± 29.1
Staphylinidae	97.78 ± 43.5	65.18 ± 21.9	41.90 ± 17.9
Other Coleoptera	13.97 ± 7.8	23.28 ± 13.5	27.94 ± 14.1
Other ^b	13.97 ± 10.3	-	51.22 ± 17.1
Total ^c	921.89 ± 307.9	982.42 ± 194.16	2407.15 ± 270

^a - = not found.

^b Includes Hemiptera and insect pupae.

^c Total numbers are not significantly different between the Pushout Area and the local background site, but mean abundance in the TBP AOC sites is significantly ($P < 0.001$) lower than that in the reference site. Statistical analyses (ANOVA) were performed for total numbers on ln-transformed data.

Overall, the abundance of soil macroinvertebrates in the TBP AOC was lower than that in similar uncontaminated habitats.

6.1.2.2 Epigeic Invertebrates

The activity of epigeic invertebrates (epigeic refers to invertebrates occurring on or near the surface) was higher in the Pushout Area on all three sampling dates, although it was significantly higher only in fall 1993 (Table 6.6). The four most active groups of epigeic fauna were woodlice, spiders, ants, and beetles. Epigeic fauna do not have the same level of exposure to soil contaminants as do soil invertebrates and thus are probably less affected by soil contamination. Migration of animals from less polluted locations to the Pushout Area is also possible because the open spaces with less vegetation cover in the Pushout Area may be a favorable habitat for active foraging epigeic predators, such as spiders, tiger beetles, and ground beetles.

6.1.2.3 Soil Nematode Community

Nematodes were considered strong indicators of soil contamination in the TBP AOC. On all three sampling dates, the numbers of some nematode groups were significantly lower in the Pushout Area than in the local background site (Table 6.7). Where significant differences ($P \leq 0.05$) occurred, the mean nematode abundance was always lower at the Pushout Area of the AOC than at the background and/or reference sites. In spring, the total number of nematodes in the Pushout Area was 85% less than the number in the local background site, and measures for all trophic groups were significantly lower in the Pushout Area. Differences in the structure and abundance of the nematode community were not as pronounced in summer, but the fungivore and hatchling abundances were significantly lower in the Pushout Area than in the local background area. In autumn, the abundance of fungivorous, omnivorous, and hatchling nematodes was significantly lower in the Pushout Area than in the local background site or the reference site, although total nematode abundance did not differ significantly among sites.

6.1.2.4 Soil Microbial Biomass

Except for SIR, all measures of microbial biomass were significantly lower in the Pushout Area than for the local background and reference sites (Table 6.8). The FDA-active bacterial biomass levels in the Pushout Area and local background site were only 19% and 70%,

TABLE 6.6 Captures of Epigeic Fauna in the Toxic Burning Pits Area

Season	Mean Captures (number/trap/d, $n = 10$)			<i>P</i> -Value ^a
	Pushout Area (TBTF)	Local Background (TBTC)	Reference Site (RSA)	
Fall 1993	35.53	24.83	- ^b	<0.0001 ^c
Spring 1994	18.10	12.10	-	0.2738
Fall 1994	8.50	5.00	7.20	0.5497

^a Statistical analyses (*t*-test for fall 1993 and spring 1994; ANOVA for fall 1994) were performed on natural log-transformed data.

^b - = not evaluated.

^c Significantly different at $P \leq 0.05$.

respectively, of the biomass found at the reference site. Total fungal length and fungal biomass in the Pushout Area and local background site were approximately 85% and 50%, respectively, lower than those in the reference site. The ratios of FDA-active bacterial to FDA-active fungal biomass were greatest in the Pushout Area (4.6) and lowest in the local background site (0.8). These ratios are often used as indicators of soil condition (Ingham and Coleman 1984; Ingham and Horton 1987) because of the different environmental requirements of soil fungal and bacterial populations.

Good correspondence existed between some components of microbial biomass and enzyme activity and between microbial biomass and total heavy-metal concentration (Table 6.9). The Pearson correlation coefficient was highest between the heavy-metal concentration and the total fungal length, total fungal biomass, substrate-induced respiration (SIR), and activities of all enzymes (except alkaline phosphatase). FDA-active fungal length and biomass did not correlate significantly with any of the enzyme activities measured. A high degree of correlation existed between total metal concentration and FDA-active bacterial biomass, total (bacterial and fungal) FDA-active biomass, total fungal and FDA-active length, and SIR (Table 6.9). FDA-active fungi length showed the least correlation with total metal concentration of all the microbial biomass indicators measured.

No significant differences in microbial biomass nitrogen pool size were found between the Pushout Area and local background site on any sampling date (Table 6.10). Values at the Pushout Area were, however, lower than those at the local background site on all dates. Biomass nitrogen in the reference site was significantly higher than that in both TBP sites. Caution should be used in interpreting these data, however, because of methodological issues. Difficulties arose in determining

TABLE 6.7 Seasonal Changes in the Abundance and Trophic Structure of the Nematode Community in the Toxic Burning Pits Area^a

Season	Trophic Group	Number/g DW Soil			P-Value
		Pushout Area (TBTF)	Local Background Site (TBTC)	Reference Site (RSA)	
Spring (April 24, 1994) (<i>n</i> = 9)	Fungivore	0.29	5.3	- ^b	0.0001 ^c
	Bacterivore	1.82	6.42	-	0.0012 ^c
	Herbivore	0.10	2.49	-	0.0004 ^c
	Omnivore	0	0.21	-	0.0160 ^c
	Hatchling	0.05	0.78	-	0.0031 ^c
	Total	2.41	15.72	-	0.0001 ^c
Summer (June 16, 1994) (<i>n</i> = 10)	Fungivore	0.04	5.11	-	0.0001 ^c
	Bacterivore	12.98	12.99	-	0.3812
	Herbivore	2.08	3.34	-	0.0565
	Omnivore	0.04	0.21	-	0.2302
	Hatchling	0	1.59	-	0.0001 ^c
	Total	15.2	24.02	-	0.0567
Fall (October 20, 1994) (<i>n</i> = 10)	Fungivore	1.09 B ^d	3.43 A	6.54 A	0.0006 ^c
	Bacterivore	6.47	11.22	8.07	0.1224
	Herbivore	4.16	2.36	0.77	0.1337
	Omnivore	0	0.31 A	1.92 B	0.0001 ^c
	Hatchling	0.19 A	0.85 B	1.45 B	0.0047 ^c
	Total	12.06	18.6	19.59	0.0781

^a Nematode numbers are means and expressed as number per gram of dry-weight soil. Statistical analyses were performed on natural log-transformed data [$\ln(x + 1)$].

^b - = not evaluated.

^c Within each trophic group, values are significantly different ($P \leq 0.05$).

^d Within each trophic group, numbers with the same letter are not significantly different ($P > 0.05$).

TABLE 6.8 Microbial Biomass Parameters (mean $\pm$ SE) and Substrate-Induced Respiration (SIR) of Soils at the Toxic Burning Pits Area and the Reference Site

Microbial Parameter	Pushout Area (TBTF)	Local Background Site (TBTC)	Reference Site (RSA)	P-Value
FDA-active bacterial biomass (μg bacteria/g DW soil)	2.9 ^a (0.3) A ^b	10.9 (1.6) B	15.4 (3.1) B	0.0001
FDA-active fungal length (m hyphae/g DW soil)	0.33 (0.28) A	6.57 (2.01) B	4.70 (0.63) B	0.0003
FDA-active fungal biomass (μg bacteria/g DW soil)	0.6 (0.5) A	13.2 (4.0) B	9.1 (1.6) B	0.0005
Total fungal length (m hyphae/g DW soil)	27.0 (5.6) A	90.9 (15.0) B	175.5 (24.8) C	0.0001
Total fungal biomass (μg bacteria/g DW soil)	49.0 (10.2) A	182.9 (30.1) B	335.3 (61.3) B	0.0001
SIR (μg CO ₂ /g DW soil/min)	0.42 (0.05) A	0.60 (0.05) A	1.9 (0.10) B	0.0001
Ratio of FDA-active bacterial to fungal biomass	4.59	0.82	1.69	

^a Mean ($n = 5$) with standard error in parentheses.

^b Results of Fisher PLSD test; within each microbial category, sites with different letters are significantly different ($P \leq 0.05$).

TABLE 6.9 Pearson Correlation Coefficients for Various Measures of Microbial Biomass, Enzyme Activities, and Total Heavy Metal Concentrations

Enzyme	FDA-Active Bacteria	FDA-Active Fungal Length	Total FDA-Active Biomass	Total Fungal Length	SIR
Endocellulase	0.477	0.212	0.412	0.757 ^a	0.791 ^a
B-glucosidase	0.627 ^b	0.185	0.468	0.836 ^c	0.975 ^c
n-Acetylglucosaminidase	0.619 ^b	0.219	0.484	0.872 ^c	0.961 ^c
Acid phosphatase	0.687 ^b	0.222	0.525	0.835 ^c	0.982
Alkaline phosphatase	0.439	-0.071	0.192	0.554 ^d	0.780 ^a
Total phosphatase	0.674 ^b	0.191	0.497	0.821 ^a	0.982 ^b
Total metals (mmol)	-0.732 ^b	-0.636 ^b	-0.825 ^a	-0.760 ^a	-0.659 ^b

^a $P \leq 0.001$.^b $P \leq 0.01$.^c $P \leq 0.0001$.^d $P \leq 0.05$.

microbial biomass nitrogen with the fumigation-extraction method. Negative biomass nitrogen values were calculated, and digested blanks had high nitrate concentrations. The negative biomass values were a problem mainly with the Pushout Area soils that had the highest concentrations of soil contaminants. Soil samples collected in June 1994 were redigested and rerun, but the results were similar to those from previous runs.

6.1.3 Biologically Mediated Processes in Soil

6.1.3.1 Soil Enzyme Activity and Soil Respiration

The activity of carbon-, nitrogen-, and phosphorus-acquiring enzymes in the Pushout Area was significantly lower than that in the background and reference sites for most cases (Table 6.11 and Figure 6.2). Enzyme activity was expressed in grams per gram of DW soil and grams per gram of ash-free DW soil to adjust for differences in total soil activity due to the lower percentages of organic matter found in the heavy-metal-exposed sites. The β -glucosidase activity was greatly reduced in the heavy-metal-contaminated sites; activity in the Pushout Area was only 3.3% that of the reference site. The activity of other enzymes in the Pushout Area was also lower than that of the reference site: acid phosphatase activity was 7.8% of the levels measured in the reference site, n-acetylglucosaminidase 10.8%, endocellulase 18.9%, and alkaline phosphatase 91.6%.

TABLE 6.10 Seasonal Changes in Soil Microbial Biomass Nitrogen ($\mu\text{g N/g DW soil}$) in the Toxic Burning Pits Area^a

Date	Pushout Area (TBTF)	Local Background Site (TBTC)	Reference Site (RSA)	P-Value
October 13, 1993	7.34	10.50	- ^b	0.1182 NS ^c
April 25, 1994	2.69	6.04	-	0.4611 NS
June 16, 1994	3.13	4.12	-	0.7210 NS
October 20, 1994	11.07 A ^d	13.04 A	79.90 B	0.0001

^a Numbers are means ($n = 10$) and expressed as micrograms of nitrogen per gram of dry-weight soil.

^b - = not evaluated.

^c NS = no significant difference at $P \leq 0.05$. Statistical analyses (t -test) were performed on log-transformed data.

^d Numbers with the same letter are not significantly different at $P \leq 0.05$. Statistical analyses were performed on natural log-transformed data.

All soil enzyme activity correlated significantly and positively with calcium and percentage of organic matter. Except for alkaline phosphatase, enzyme activity correlated significantly and negatively, but nonlinearly, with pH and total heavy-metal concentration (Table 6.12). Enzyme activity approached zero at total heavy-metal concentrations of 9-12 mmol/kg DW soil (750-1,109 mg/kg) (Figure 6.3). However, alkaline phosphatase activity actually increased; at total heavy-metal concentrations of 30-48 mmol/kg DW soil (3,723 mg/kg), enzyme activity approached the levels measured for the reference site. The activity of the other four enzymes was low but detectable up to a total heavy-metal concentration of 48 mmol/kg.

Microbial activity in the soil of the TBP AOC was significantly lower than that in the reference site soil. The SIR rates in the Pushout Area and local background site were 22% and 32% of that of the reference site, respectively (Table 6.8). The cumulative CO_2 evolution during a 27-day incubation of soil in microcosms was lower in the Pushout Area than in the local background area (Figure 6.4).

These results indicate that the changes in soil conditions caused by disposal activities at the Pushout Area of the TBP AOC have had a large negative effect on soil microbes, soil respiration, and extracellular enzyme activity. Both fungal and bacterial biomass decreased by as much as an

TABLE 6.11 Activity of Carbon-, Nitrogen-, and Phosphorus-Acquiring Enzymes in Soils of Three Sites Containing Different Levels of Heavy Metals

Enzyme	Enzyme Activity ($\mu\text{mol/h/g}$) ^a			P-Value
	Pushout Area (TBTF)	Local Background Site (TBTC)	Reference Site (RSA)	
Endocellulase ^b				
g DW	9.2 (4.0) B ^c	16.30 (4.9) B	88.7 (16.9) A	0.0004
g AFDW	361.0 (121.0) B	769.0 (158.0) A,B	1,912.0 (384) A	0.006
β -glucosidase				
g DW	0.012 (0.010) C	0.089 (0.023) B	0.629 (0.032) A	0.0001
g AFDW	0.445 (0.282) C	4.191 (0.973) B	13.567 (0.931) A	0.0001
N-acetylglucosaminidase				
g DW	0.016 (0.004) C	0.065 (0.015) B	0.268 (0.020) A	0.0001
g AFDW	0.623 (0.094) C	3.044 (0.446) B	5.785 (0.507) A	0.0001
Acid phosphatase				
g DW	0.081 (0.041) C	0.402 (0.080) B	1.782 (0.069) A	0.0001
g AFDW	3.011 (1.142) C	19.098 (2.039) B	38.814 (3.565) A	0.0001
Alkaline phosphatase				
g DW	0.145 (0.048) B	0.118 (0.020) B	0.296 (0.029) A	0.04
g AFDW	5.901 (1.843) A	5.914 (0.817) A	6.439 (0.875) A	0.69
Total phosphatase				
g DW	0.227 (0.081) C	0.520 (0.094) B	2.078 (0.092) A	0.0001
g AFDW	8.913 (2.540) B	25.002 (2.376) A	45.253 (4.302) A	0.0001

^a Enzyme activity is expressed as micromoles substrate converted per hour per gram of dry-weight soil or per gram of ash-free dry-weight soil. Values are averages ($n = 5$) with standard errors in parentheses.

^b Enzyme activity is expressed in viscometric units.

^c Means in the same row with the same letter are not significantly different ($P \leq 0.05$; Fisher PLSD test).

order of magnitude, as did soil respiration and the activity of four out of five extracellular enzymes involved in the breakdown of organic carbon, nitrogen, and phosphorus.

6.1.3.2 Litter Decomposition and Nutrient Dynamics

The litter used for testing at the TBP AOC consisted of common reed (*Phragmites australis*) leaves that had initial carbon and nitrogen contents of 47.58% and 0.7267%, respectively. The carbon/nitrogen (C/N) ratio of the initial litter was 65.47. Although litter appeared to decompose faster at the Pushout Area than at the local background site, the percent carbon and

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FIGURE 6.2 Relative Soil Enzyme Activity in Sites with Varying Concentrations of Heavy Metals

TABLE 6.12 Pearson Correlation Coefficients between Enzyme Activities and Edaphic Factors

Enzyme	Organic Matter (%)	Calcium (mg/kg)	Total Heavy Metal (mmol/g DW)	pH
Endocellulase	0.885 (0.0001) ^a	0.641 (0.0002)	-0.566 (0.028)	-0.574 (0.01)
β-Glucosidase	0.954 (0.0001)	0.823 (0.01)	-0.673 (0.006)	-0.643 (0.025)
n-Acetylglucos-aminidase	0.932 (0.0001)	0.844 (0.0001)	-0.709 (0.003)	-0.678 (0.006)
Acid phosphatase	0.946 (0.0001)	0.817 (0.0002)	-0.712 (0.003)	-0.693 (0.004)
Alkaline phosphatase	0.713 (0.003)	0.665 (0.007)	-0.254 (0.361)	-0.331 (0.228)
Total phosphatase	0.941 (0.0001)	0.819 (0.0002)	-0.674 (0.006)	-0.666 (0.007)

^a *P*-values for each correlation are given in parentheses.

percent nitrogen remaining was significantly different only after 12 months (Table 6.13). Only 7% of the initial carbon remained in test litter at the Pushout Area after 20 months. The relative nitrogen concentration increased over time at both sites. Such an increase in relative nitrogen concentration during decomposition is often related to microbial incorporation of nutrients released as carbon is mineralized (Blair 1988). The percent nitrogen content of the litter was significantly higher at the Pushout Area for the 6-month and 20-month sampling intervals.

Change in the absolute amount of nitrogen (percent nitrogen remaining) during decomposition (net immobilization or mineralization) is a function of both mass loss and change in the relative nitrogen concentration in the residual litter. The nitrogen dynamics of decomposing litter showed contrasting patterns at the two sites. Net nitrogen mineralization from litter was significantly greater at the local background site than at the Pushout Area after 6 months. By 12 months, however, the litter at the local background site had begun to show net nitrogen immobilization, while the litter at the Pushout Area had net nitrogen mineralization ($P = 0.0005$). The more rapid decay and greater net nitrogen mineralization in litter at the Pushout Area may partly explain the lower carbon and nitrogen content of soil at this site, indicating longer term effects of contaminants on the dynamics of organic matter in the soil.

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FIGURE 6.3 Relationships between Relative Soil Enzyme Activities and Total Heavy-Metal Concentrations in Soil in the Toxic Burning Pits Area

FIGURE 6.4 Cumulative CO₂ Evolution (mean $\pm$ SE) in Microcosms with Soil from the Pushout Area (TBTF) and Local Background Site (TBTC) of the Toxic Burning Pits Area

By 20 months, there was a more than twofold difference in percent carbon remaining in the two sites, but this difference was not statistically significant ($P = 0.1050$). The litter at the local background site had 17% carbon remaining and showed further decomposition since the 12-month sample was taken. No further decay occurred at the Pushout Area between 12 and 20 months (the slight increase in percent carbon remaining at 20 months is likely due to variability among litterbags). Thus, decomposition at the Pushout Area was essentially complete by 12 months (6% carbon remaining is a very small amount).

When a negative exponential model is applied to the data, the following equations are generated:

$$\text{Local background site: } y = 4.399 - 0.0028x, r^2 = 0.92; \text{ and}$$

$$\text{Pushout Area: } y = 4.225 - 0.0046x, r^2 = 0.82.$$

TABLE 6.13 Changes in Carbon and Nitrogen Content in Decomposing Common Reed Litter in the Toxic Burning Pits Area^a

Parameter/Time	Pushout Area (TBTF)	Local Background Site (TBTC)	P-Value
<i>Percent carbon remaining</i>			
6 months	26.37	39.82	0.0660
12 months	6.18	25.22	0.0001
20 months	6.88	17.46	0.1050
<i>Percent nitrogen content^b</i>			
6 months	1.04	0.81	0.0343
12 months	1.60	1.29	0.0622
20 months	2.15	1.30	0.0001
<i>Percent nitrogen remaining^c</i>			
6 months	94.09	77.85	0.0789
12 months	73.01	108.84	0.0005
20 months	105.02	92.22	0.5128

^a Numbers are means ($n = 10$).

^b Change in the relative concentration of nitrogen in litter.

^c Change in the absolute concentration of nitrogen in litter.

These equations give decomposition constants (k) of -0.0028 and -0.0046 d^{-1} for the local background site and Pushout Area, respectively. These are reasonable decay rates for this type of litter material and confirm that decomposition occurs more rapidly at the polluted site. The high regression coefficients ($r^2 > 0.8$) for both sites indicate that the decomposition process is reasonably well represented by the negative exponential model.

The nitrogen content of the litter at the Pushout Area continued to be significantly higher than that at the local background site ($P = 0.0001$) (Table 6.13). The small amount of litter left at the Pushout Area continued to increase in nitrogen content throughout the 20-month period. However, the nitrogen content of the litter at the local background site did not change between 12 and 20 months. No significant difference in percent nitrogen between the two sites remained after 20 months. However, contrasting patterns of net nitrogen mineralization/immobilization were evident. At the local background site, litter showed net mineralization at 6 months, net immobilization at 12 months, and a tendency for net mineralization at 20 months. Several studies

reported a similar pattern (Berg and Staaf 1981; Blair and Crossley 1988). In contrast, at the Pushout Area, litter showed slight net mineralization at 6 months, greater nitrogen mineralization at 12 months, and net immobilization at 20 months. The measured differences in carbon and nitrogen dynamics in the litter at the two sites strongly suggest that soil contamination in the Pushout Area is altering nutrient cycling processes, possibly by suppressing soil biotic activity. Such suppression is also suggested by the results of the enzyme activity evaluations (Section 6.1.3.1).

6.1.3.3 Soil Nitrogen Dynamics

Soil carbon and nitrogen contents were higher at the local background site (0.7551% carbon, 0.0453% nitrogen, C/N = 16.67) than in the Pushout Area (0.7087% carbon, 0.0264% nitrogen, C/N = 26.8). Few significant differences ($P \leq 0.05$) in the availability of soil $\text{NH}_4\text{-N}$, $\text{NO}_3\text{-N}$, and total nitrogen were found between the Pushout Area and the local background site, although on three of four sampling dates, soil nitrogen concentrations were higher in the Pushout Area (Table 6.14). Also, no significant differences were found in the net soil nitrogen mineralization rates between the two sites (Table 6.15), and the rates were generally low. A slight net immobilization of nitrogen was detected in fall 1993 at both TBP sites. In fall 1994, the net nitrogen mineralization rates in both sites were approximately 20 times lower than that at the reference site.

6.1.4 Soil Toxicity

6.1.4.1 Earthworm Toxicity

6.1.4.1.1 Earthworm Screening Test. Table 6.16 presents the results of the earthworm screening test. The results indicated both lethal and sublethal effects in soil from the Southern Main Pit (JHDP in Figure A.12 in Appendix A). The surviving earthworms were found clinging to the sides of the beakers above the soil; they survived the 14-day study by not penetrating the test soil. The test results also indicated both lethal (reduced survival) and sublethal effects (reduced growth) on earthworms from the JBPC-P104 soil sample. The earthworm survival rate (ESR) was 93–100% for all other soil samples.

TABLE 6.14 Seasonal Changes in Soil Extractable Nitrogen ($\mu\text{g N/g DW soil}$) in the Toxic Burning Pits Area^a

Date/Parameter	Pushout Area (TBTF)	Local Background Site (TBTC)	Reference Site (RSA)	P-Value ^b
October 13, 1993				
NH ₄ -N	5.44	4.88	- ^c	0.8195
NO ₃ -N	2.39	1.30	-	0.1849
Total nitrogen	7.83	6.17	-	0.5899
April 25, 1994				
NH ₄ -N	1.61	0.57	-	0.2259
NO ₃ -N	0.10	0.22	-	0.1069
Total nitrogen	1.71	0.79	-	0.3672
June 16, 1994				
NH ₄ -N	1.34	0.88	-	0.1234
NO ₃ -N	0.40	0.15	-	0.2793
Total nitrogen	1.73	1.03	-	0.0948
October 20, 1994				
NH ₄ -N	0.26 B ^d	0.58 A	3.08 C	0.0052
NO ₃ -N	1.17	0.94	1.11	0.5834
Total nitrogen	1.43 B	1.52 B,C	4.19 C	0.0172

^a Numbers are means ($n = 10$) and expressed as micrograms of nitrogen per gram of dry-weight soil.

^b Statistical analyses (t -test for October 1993, April 1994, and June 1994 data; ANOVA for October 1994 data) were performed on log-transformed data.

^c - = not evaluated.

^d For each parameter, numbers with different letters are significantly different ($P \leq 0.05$).

TABLE 6.15 Seasonal Changes in Net Nitrogen Mineralization Rate ($\mu\text{g N/g DW soil/day}$) in Soils of the Toxic Burning Pits Area^a

Date	Pushout Area (TBTF)	Local Background Site (TBTC)	Reference Site (RSA)	P-Value ^b
Oct. 13–Nov. 11, 1993	-0.049	-0.064	- ^c	0.8503
April 25–June 2, 1994	0.099	0.098	-	0.9580
June 12–July 14, 1994	0.059	0.029	-	0.3053
Oct. 20–Nov. 17, 1994	0.030 B ^d	0.026 B	0.427 C	0.0018

^a Numbers are means ($n = 10$) and expressed as micrograms of nitrogen per gram of dry-weight soil per day.

^b Statistical analyses (t -test for October 1993, April 1994, and June 1994 data; ANOVA for October 1994 data) were performed on untransformed data.

^c - = not evaluated.

^d For each parameter, numbers with different letters are significantly different at $P = 0.05$.

6.1.4.1.2 Earthworm Definitive Test. An earthworm definitive test was conducted on soil from the Southern Main Pit (JHDP) because this soil produced lethal and sublethal effects in both the seed emergence (see Section 6.1.4.2) and earthworm screening tests. The test soil was mixed with an appropriate amount of reference (Winters Run) soil (WR) to produce concentrations of 100, 75, 50, 25 and 0% (by weight) of JHDP sample soil. Table 6.17 presents the results of this study. Both lethal and sublethal effects were produced at the 100% JHDP soil level. Overall, these effects diminished as the amount of JHDP soil decreased. The general effect was weight loss by the earthworms in mixtures with >25% test soil.

An analysis of covariance (ANCOVA) was used to statistically evaluate the differences between initial and final weights for the definitive earthworm test, using the initial weight for each sample as a covariate in the analysis. Thus, the analysis evaluated the differences in the final weights among treatments while accounting for differences in the initial weights of the replicates within each treatment (SAS 1985). There was a highly significant difference ($P < 0.001$) in the change in mass of earthworms among treatments. The 0% (control soil WR-) and the 25% JHDP soil mixtures were significantly different from all other treatment levels (50%, 75%, and 100% JHDP soil), and the results supported a conclusion that the treatment effect increased with increasing concentrations of the JHDP soil (Table 6.18). All earthworms that survived the 100% JHDP soil treatment were found at the tops of the test containers, apparently avoiding burrowing in the soil.

TABLE 6.16 Earthworm Toxicity Screening of Soils from the Toxic Burning Pits and Adjacent Areas

Sample Location	Replicate	ESR (%)	Initial Weight Mean ^a (g/worm)	Final Weight Mean ^a (g/worm)	Difference (g)
WR+ ^b		0			
	A		0.39	None ^c	NA ^d
	B		0.42	None	NA
	C		0.42	None	NA
WR- ^e		100			
	A		0.44	0.45	+0.01
	B		0.50	0.59	+0.09
	C		0.43	0.44	+0.01
JBPM-B		93			
	A		0.38	0.25	-0.13
	B		0.43	0.38	-0.05
	C		0.60	0.41	-0.19
JHDP		40			
	A		0.41	None	NA
	B		0.35	0.27	-0.08
	C		0.47	0.26	-0.21
JBPP-C		100			
	A		0.45	0.47	+0.02
	B		0.30	0.30	0.00
	C		0.39	0.38	-0.01
JBPM-A		100			
	A		0.41	0.40	-0.01
	B		0.35	0.29	-0.06
	C		0.34	0.35	+0.01
JBPP-A		100			
	A		0.50	0.37	-0.13
	B		0.48	0.44	-0.04
	C		0.49	0.30	-0.19

TABLE 6.16 (Cont.)

Sample Location	Replicate	ESR (%)	Initial Weight Mean ^a (g/worm)	Final Weight Mean ^a (g/worm)	Difference (g)
JBP2-C		100			
	A		0.35	0.31	-0.04
	B		0.39	0.30	-0.09
	C		0.42	0.33	-0.09
JBP1-C		100			
	A		0.46	0.40	-0.06
	B		0.53	0.42	-0.11
	C		0.54	0.42	-0.12
JBPP-B		93			
	A		0.66	0.49	-0.17
	B		0.47	0.42	-0.05
	C		0.48	0.41	-0.07
JBPG-F		100			
	A		0.39	0.43	+0.04
	B		0.45	0.50	+0.05
	C		0.57	0.60	+0.03
JBPC-P104		80			
	A		0.51	0.34	-0.17
	B		0.45	0.35	-0.10
	C		0.33	0.22	-0.11

^a $n = 5$.^b Positive control (Winters Run soil with added spike of 50 g paranitrophenol/g soil).^c "None" indicates that no living worms were found at the end of incubation.^d NA = not applicable; weights were not taken for dead, decomposing worms.^e Negative control (Winters Run soil with no added spike).

TABLE 6.17 Definitive Earthworm Toxicity Test of JHDP Soil

Sample Location	Replicate	ESR (%)	Initial Weight Mean ^a (g/worm)	Final Weight Mean ^a (g/worm)	Difference (g)
WR+ ^b		0			
	A		0.39	None ^c	NA ^d
	B		0.42	None	NA
	C		0.42	None	NA
WR- ^e		100			
	A		0.44	0.45	+0.01
	B		0.5	0.59	+0.09
	C		0.43	0.44	+0.01
JHDP (100%)		47			
	A		0.40	0.24	-0.16
	B		0.58	0.43	-0.15
	C		0.61	0.35	-0.26
JHDP (75%)		93			
	A		0.39	0.31	-0.08
	B		0.37	0.27	-0.10
	C		0.39	0.34	-0.05
JHDP (50%)		100			
	A		0.34	0.30	-0.04
	B		0.43	0.34	-0.09
	C		0.43	0.37	-0.06
JHDP (25%)		100			
	A		0.42	0.45	-0.02
	B		0.55	0.57	+0.03
	C		0.5	0.52	+0.02

^a $n = 5$.^b Positive control (Winters Run soil with added spike of 50 g paranitrophenol/g soil).^c "None" indicates that no living worms were found at the end of incubation.^d NA = not applicable; weights were not taken for dead, decomposing worms.^e Negative control (Winters Run soil with no added spike).

TABLE 6.18 Comparison of Treatment Results for Definitive Toxicity Testing with JHDP Soil^a

Treatment	Initial Mean Weight (g/worm)	Final Mean Weight (g/worm)	Mean Change in Weight (g/worm)	Statistical Comparison of Mean Final Weight ^b
0% JHDP Soil (WR- ^c)	0.46	0.49	+0.04	A
25% JHDP Soil	0.49	0.51	+0.02	A
50% JHDP Soil	0.40	0.34	-0.06	B
75% JHDP Soil	0.38	0.31	-0.08	B, C
100% JHDP Soil	0.53	0.34	-0.19	C

^a There was a significant difference among treatments ($F=16.10$, $P<0.001$) adjusted for differences in initial mean weights ($F=21.04$, $P<0.01$) using ANCOVA (SAS 1985). Values are rounded to two significant figures.

^b Treatments with different letters were significantly different ($P<0.05$) in a least square means comparison test (SAS 1985).

^c Control soil from Winter's Run, which was also used to dilute JHDP soil in other treatments.

6.1.4.2 Phytotoxicity Test

Indices of toxicity examined included the seed emergence rate (SER), average plant height, and average dry weight for each soil sample tested. Table 6.19 presents the results of the soil phytotoxicity screening with lettuce seeds. Figure A.12 in Appendix A shows the locations of sampling points in the TBP AOC. Soil samples from the Southern Main Pit (JHDP) had a SER of 0%. The SERs for soils from the Pushout Area (OT-29 and OT-30) were 0–2.5%. Soil collected near the VX pit (JBPM-B) had a SER of 100%, but none of the seedlings survived to day 14. Soils from other areas of the TBP AOC (JBPP-B, CLP-8, CLP-9, OT-11, OT-32, SGTBP-11, and TBSPBOR-2) had SERs of 75%. Soils with SERs of <75% were considered toxic. JBPG-F soil yielded a 10% SER; only two seedlings survived to day 14. JBPC-P104 soil produced a 30% SER; five seedlings survived to day 14. The remaining samples had SERs of 75–100%.

6.1.5 Terrestrial Vegetation Surveys

Terrestrial vegetation near the TBP AOC consists primarily of old-field communities dominated by grasses such as broomsedge (*Andropogon virginicus*), which are mowed annually. This old-field area is bordered on the south by a narrow band of upland forest next to a wetland area (see Appendix C for a discussion of wetlands). On the north and east, old-field is bordered by wetland. Other areas in the AOC that were disturbed by disposal activities contain several

TABLE 6.19 Phytotoxicity Screening of Soils from the Toxic Burning Pits Area

Sample Site	SER (%)	Mean Plant Height (mm)	Mean Dry Weight (mg)
<i>Winters Run Control Study^a</i>			
JBPM-B	100	0	0
JHDP	0	0	0
JBPP-C	75	10.8	6.49
JBPM-A	75	8.9	5.31
JBPP-A	75	8.8	5.12
JBP2-C	100	8.5	7.1
JBP1-C	100	7.2	4.57
JBPP-B	60	10.9	3.25
JBPG-F	10	6.0	2.90
JBPC-P104	30	4.6	3.54
WR+ ^b	25	2	0.67
WR- ^c	65	8.1	6.14
<i>Standard Soil Control Study^d</i>			
Control ^e	91.1	NT ^f	NT
CLP-4	78.3 ^g	NT	NT
CLP-5	75 ^g	NT	NT
CLP-8	56.7 ^g	NT	NT
CLP-9	36.7 ^g	NT	NT
OT-3	86.7	NT	NT
OT-4	83.3	NT	NT
OT-8	78.3	NT	NT
OT-11	74.2 ^g	NT	NT
OT-16	77.5 ^g	NT	NT
OT-17	78.3 ^g	NT	NT
OT-29	2.5 ^g	NT	NT
OT-30	0 ^g	NT	NT
OT-32	18.3 ^g	NT	NT
SGTBP-11	65.8 ^g	NT	NT
TBNPBOR-1	83.3	NT	NT
TBSPBOR-1	86.7	NT	NT
TBSPBOR-2	34.2 ^g	NT	NT

See next page for footnotes.

TABLE 6.19 Footnotes

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- ^a Toxicity study by Phillips and Checkai (1995).
 - ^b Positive control (Winters Run soil with an added spike of 1,000 µg copper/g soil).
 - ^c Negative control (Winters Run soil with no added spike).
 - ^d Toxicity study by ESI (1995).
 - ^e Control = standard soil consisting of 10% screened sphagnum mass, 20% kaolinite clay, and 70% fine clean silica sand (by weight). The pH of the soil was within the range of 5.0 to 9.0.
 - ^f NT = not tested.
 - ^g SER was significantly lower than in standard control soil (Tukey method, $P \leq 0.05$).

graminoids, including *Agrostis perennans*, *Arthraxon hispidus*, *Aristida oligantha*, and *Phragmites australis* (Dunn and Stull 1995).

Terrestrial vegetation was sampled in July and November 1993, November 1994, and September 1995. Data were collected from six grids (ranging in size from 25 to 400 m²; four in grassy communities and two in the forested area) and several scattered plots from which soil characterization data were also collected (Figure A.2 in Appendix A). Data collected included percent cover, density, and aboveground biomass. Table D.1 in Appendix D presents biomass and percent cover data collected in 1993 from grids in the AOC; Table D.2 presents biomass data collected in 1994 from grids TBTC and TBTF; and Table D.3 presents biomass data collected in 1995 at various locations in the AOC, along with soil concentrations of heavy metals and macronutrients.

Vegetation and biomass in the TBP AOC vary by season and year. Grids TBTC and TBTF show the greatest contrast. Grid TBTC is located slightly upgradient from the pits and away from the Pushout Area and is thus expected to be less influenced by past activities in the AOC. In 1993, broomsedge dominated grid TBTC (Table D.4), whereas in 1994 the grid was dominated by both *Aristida oligantha* and broomsedge (Table D.5). In both years, grid TBTF was dominated by common reed, although the grid was largely bare soil (62%). Despite these temporal fluctuations, grid TBTC consistently supported a higher species diversity (Table 6.20) and a greater total biomass (Figure 6.5). The combination of species composition and vegetation indices suggests that site factors are responsible for clear and consistent vegetation differences. Such site factors may include natural differences in soils (chemistry, texture, moisture, etc.) and water table depth. Levels of contaminants and physical disturbance in the grids may also differ. Results from studies of soil biota and biologically mediated soil processes suggest considerable differences in soil ecology that correlate strongly with levels of contaminants such as heavy metals. Thus, it is likely that differing levels of soil contaminants are, in part, responsible for differences in the vegetation community.

TABLE 6.20 Vegetation Indices for the Local Background (TBTC) and Pushout Area (TBTF) Grids at the Toxic Burning Pits Area: November 1993 and 1994

Index	TBTC ^a		TBTF ^b	
	1993	1994	1993	1994
Number of species	10	19	2	9
Bare ground (%)	19	11	82	62
Diversity Index (H) ^c	1.01	- ^d	0.68	- ^d

^a Control grid.

^b Contaminated grid.

^c H = Shannon-Weiner diversity index.

^d - = not measured.

The reference site for comparison with the old-field data collection plots at J-Field was located at Gunpowder Falls State Park. This reference site is similar to J-Field in soils and mowing regime. Ten plots were sampled for aboveground vegetation biomass in November 1994. Table D.6 lists the species composition and biomass for each plot at the reference site. Total biomass ranged from 57 to almost 97 g/0.1 m², and the number of species (species richness) ranged from 4 to 9 per plot (Table 6.21). The Shannon-Weiner diversity index was calculated for terrestrial vegetation at each plot. This index incorporates species richness and species evenness. Diversity ranged from 0.74 to 1.66 and averaged 1.30 for the 10 plots (Table 6.21). Table D.7 summarizes biomass and species composition for the overall reference site.

Species diversity of the TBP grids, on the basis of 1993 data, was compared with that of the reference site. The diversity of grids TBTB, TBTC, and TBTD was not significantly different (at $P < 0.05$) from that of the reference site. However, the diversity of grid TBTF was significantly lower than that of the reference site; it ranged from 0 to 0.81 and averaged 0.081. Of the 10 plots sampled in grid TBTF, 9 had a diversity index of 0 (only one species present).

The biomass of the TBP grids and scattered plots, on the basis of 1994 and 1995 data, was correlated with heavy metals and macronutrients in the soil. The soil concentrations of total metals were 5.86-10.98 mmol/kg in grid TBTC, 28.03-242.60 mmol/kg in grid TBTF, and 2.78-495.98 mmol/kg in the scattered plots. For the TBTC and TBTF grids, the correlation was very low (-0.11 and -0.024, respectively) between metals and biomass. The negative correlation, though small, illustrates the relationship shown graphically in Figure 6.5. Although biomass varied

FIGURE 6.5 Relationships between Biomass and Heavy-Metal Concentrations in Soil at the Toxic Burning Pits Area

TABLE 6.21 Biomass, Species Richness, and Diversity at the Reference Site Plots

Plot	Biomass (g/0.1 m ²)	Number of Species	Diversity (H) ^a
1	74.96	4	0.74
4	57.29	5	0.92
6	64.90	5	1.22
10	96.80	5	1.29
3	63.04	7	1.36
5	73.66	6	1.36
9	61.58	5	1.43
7	79.85	6	1.43
8	80.09	5	1.56
2	85.50	9	1.66
Average		5.7	1.30

^a H = Shannon-Weiner diversity index.

considerably for plots with low metal concentrations, high metal concentrations tended to be associated with low biomass. Plots with relatively low biomass and low total metals tended to have relatively low levels of macronutrients. The correlation for the scattered plots was somewhat stronger (-0.4013) and negative. Soil concentrations of heavy metals in the reference site were quite low, ranging from 1.52 to 2.07 and averaging 1.75 mmol/kg. Again, the correlation between metal concentrations and biomass was very low (0.0525) but positive.

The biomass and total metal concentrations of the TBP AOC grids and scattered plots were compared with those of the reference site. A *t*-test showed the biomass at grid TBTC to be significantly lower than that at the reference site, and the total metal concentration was significantly higher. A *t*-test between grid TBTF and the reference site showed similar results. However, a test for data distribution normality showed that the data for TBTF were not normally distributed. A Mann-Whitney test showed that the biomass of grid TBTF was significantly lower than that at the reference site, and the total metal concentration was significantly higher ($P < 0.05$) at grid TBTF. The biomass and total metals data for the scattered sites were not normally distributed. A Mann-Whitney test was performed to compare the biomass and heavy-metal concentrations of the scattered plots with those of the reference site. The biomass of the scattered plots was significantly lower than that of the reference site. In addition, soil concentrations of heavy metals at the scattered plots were significantly higher than those of the reference site. These results show that soil contamination at the

TBP AOC may be at least partially responsible for adverse effects on the terrestrial vegetation community, in the form of reduced species diversity (in localized areas) and biomass production.

6.1.6 Vertebrate Surveys

6.1.6.1 Amphibians

No quantitative surveys of amphibians were performed at the TBP AOC. However, qualitative observations were made during other ERA activities. The southern leopard frog (*Rana utricularia*) and the pickerel frog (*Rana palustris*) were commonly observed in the marsh surrounding the TBP AOC. In addition, American toads (*Bufo americanus*) and Fowler's toads (*Bufo woodhousei fowleri*) were sometimes seen in upland areas.

6.1.6.2 Birds

Qualitative auditory and visual surveys of birds conducted in all seasons at the TBP AOC (Johnson 1995) detected 113 species. Table 6.22 lists the bird species that would be expected to occur in the J-Field area and indicates which ones were observed or heard in the TBP AOC surveys. Common bird species observed or heard during the surveys included mourning doves, American robins, white-throated sparrows, and song sparrows. Ospreys frequently fly over the TBP AOC and perch on telephone poles along Rickett's Point Road at the western edge of the TBP AOC. Two nest boxes were placed in the TBP AOC and monitored for nesting activity by Johnson (1995). A pair of eastern bluebirds nested in one nest box, and nine bluebirds were fledged (Johnson 1995). No birds occupied the other nest box.

6.1.6.3 Mammals

Table 6.23 lists small mammals collected during recent areawide surveys at APG (Whaley 1995). Most of these species are also expected to be found within the TBP AOC. Although the TBP AOC was not directly surveyed for small mammals, traps were placed in the AOC to collect small mammals for analyzing contaminant residuals. The white-footed mouse and meadow vole were most frequently collected. The short-tailed shrew was occasionally captured in pitfall traps used for estimating the abundance of terrestrial invertebrates. Red fox (*Vulpes fulva*) and feral house cats (*Felis catus*) were observed near the TBP AOC and probably enter the site regularly. Bats (Chiroptera) were observed flying over the TBP AOC. Other mammals likely to be found the TBP AOC include opossum (*Didelphis marsupialis*), raccoon (*Procyon lotor*), and striped skunk (*Mephitis mephitis*).

TABLE 6.22 Bird Species Observed (Seen or Heard) at J-Field

Species	Chronology ^a
Common loon (<i>Gavia immer</i>)	W, M
Horned grebe (<i>Podiceps auritus</i>)	W, M
Double-crested cormorant (<i>Phalacrocorax auritus</i>)	A
Great blue heron (<i>Ardea herodias</i>)	A
Black swan (<i>Cygnus atratus</i>)	E
Tundra swan (<i>Cygnus columbianus</i>)	W, M
Mute swan (<i>Cygnus olor</i>)	A
Wood duck (<i>Aix sponsa</i>)	M, B
Green-winged teal (<i>Anas crecca</i>)	W, M
American black duck (<i>Anas rubripes</i>)	A
Mallard (<i>Anas platyrhynchos</i>)	A
Canvasback (<i>Aythya valisineria</i>)	W, M
Redhead (<i>Aythya americana</i>)	W, M
Lesser scaup (<i>Aythya affinis</i>)	W, M
Oldsquaw (<i>Clangula hyemalis</i>)	W
Surf scoter (<i>Melanitta perspicillata</i>)	W
Common goldeneye (<i>Bucephala clangula</i>)	W, M
Bufflehead (<i>Bucephala albeola</i>)	W, M
Common merganser (<i>Mergus merganser</i>)	W, M
Red-breasted merganser (<i>Mergus serrator</i>)	W, M
Black vulture (<i>Coragyps atratus</i>)	A
Turkey vulture (<i>Cathartes aura</i>)	A
Osprey (<i>Pandion haliaetus</i>)	M, B
Bald eagle (<i>Haliaeetus leucocephalus</i>)	M, A
Northern harrier (<i>Circus cyaneus</i>)	W
Red-shouldered hawk (<i>Buteo lineatus</i>)	A
Red-tailed hawk (<i>Buteo jamaicensis</i>)	A
Northern bobwhite (<i>Colinus virginianus</i>)	A
Semipalmated plover (<i>Charadrius demipalmatus</i>)	M
Greater yellowlegs (<i>Tringa melanoleuca</i>)	W
Solitary sandpiper (<i>Tringa solitaria</i>)	M
Spotted sandpiper (<i>Actitis macularia</i>)	M, B
Pectoral sandpiper (<i>Calidris melanotos</i>)	M
American woodcock (<i>Scolopax minor</i>)	A
Laughing gull (<i>Larus atricilla</i>)	M, B ^d
Ring-billed gull (<i>Larus delawarensis</i>)	W, M
Herring gull (<i>Larus argentatus</i>)	A
Great black-backed gull (<i>Larus marinus</i>)	W
Forster's tern (<i>Sterna forsteri</i>)	M, B ^d

TABLE 6.22 (Cont.)

Species	Chronology ^a
Least tern (<i>Sterna antillarum</i>)	M, B
Mourning dove (<i>Zenaida macroura</i>)	A
Yellow-billed cuckoo (<i>Coccyzus americanus</i>)	M, B
Great horned owl (<i>Bubo virginianus</i>)	A
Barred owl (<i>Strix varia</i>)	A
Ruby-throated hummingbird (<i>Archilochus colubris</i>)	M, B
Red-bellied woodpecker (<i>Melanerpes carolinus</i>)	A ^b
Downy woodpecker (<i>Picoides pubescens</i>)	A
Hairy woodpecker (<i>Picoides villosus</i>)	A ^b
Northern flicker (<i>Colaptes auratus</i>)	A
Pileated woodpecker (<i>Dryocopus pileatus</i>)	A
Olive-sided flycatcher (<i>Contopus borealis</i>)	M
Eastern wood-pewee (<i>Contopus virens</i>)	M, B
Acadian flycatcher (<i>Empidonax virescens</i>)	M, B ^b
Eastern kingbird (<i>Tyrannus tyrannus</i>)	M, B
Tree swallow (<i>Tachycineta bicolor</i>)	M, B ^b
Barn swallow (<i>Hirundo rustica</i>)	M, B
Blue jay (<i>Cyanocitta cristata</i>)	A ^b
American crow (<i>Corvus brachyrhynchos</i>)	A
Fish crow (<i>Corvus ossifragus</i>)	A
Carolina chickadee (<i>Parus carolinensis</i>)	A ^b
Tufted titmouse (<i>Parus carolinensis</i>)	A ^b
Carolina wren (<i>Thryothorus ludovicianus</i>)	A ^b
House wren (<i>Troglodytes aedon</i>)	M, B
Blue-gray gnatcatcher (<i>Poliophtila caerulea</i>)	M, B
Eastern bluebird (<i>Sialia sialis</i>)	A ^b
Veery (<i>Catharus fuscescens</i>)	M, B ^b
Gray-cheeked thrush (<i>Catharus minimus</i>)	M ^b
Swainson's thrush (<i>Catharus ustulatus</i>)	M ^b
Hermit thrush (<i>Catharus guttatus</i>)	W ^b
Wood thrush (<i>Hylocichla mustelina</i>)	M, B ^b
American robin (<i>Turdus migratorius</i>)	A
Gray catbird (<i>Dumetella carolinensis</i>)	M, B ^b
White-eyed vireo (<i>Vireo griseus</i>)	M, B ^b
Yellow-throated vireo (<i>Vireo flavifrons</i>)	M, B
Red-eyed vireo (<i>Vireo olivaceus</i>)	M, B ^b
Northern parula (<i>Parula americana</i>)	M, B
Yellow warbler (<i>Dendroica petechia</i>)	M, B

TABLE 6.22 (Cont.)

Species	Chronology ^a
Chestnut-sided warbler (<i>Dendroica pensylvanica</i>)	M
Magnolia warbler (<i>Dendroica magnolia</i>)	M ^b
Black-throated blue warbler (<i>Dendroica caerulescens</i>)	M ^b
Yellow-rumped warbler (<i>Dendroica coronata</i>)	W ^b
Black-throated green warbler (<i>Dendroica virens</i>)	M
Blackburnian warbler (<i>Dendroica fusca</i>)	M
Prairie warbler (<i>Dendroica discolor</i>)	M, B
Palm warbler (<i>Dendroica palmarum</i>)	M
Blackpoll warbler (<i>Dendroica striata</i>)	M
Cerulean warbler (<i>Dendroica cerulea</i>)	M, B
Black-and-white warbler (<i>Mniotilta varia</i>)	M, B
American redstart (<i>Setophaga ruticilla</i>)	M, B
Ovenbird (<i>Seiurus aurocapillus</i>)	M, B ^b
Northern waterthrush (<i>Seiurus noveboracensis</i>)	M ^b
Common yellowthroat (<i>Geothlypis trichas</i>)	M, B
Scarlet tanager (<i>Piranga olivacea</i>)	M, B
Northern cardinal (<i>Cardinalis cardinalis</i>)	A ^b
Rose-breasted grosbeak (<i>Pheucticus ludovicianus</i>)	M
Blue grosbeak (<i>Guiraca caerulea</i>)	M, B
Indigo bunting (<i>Passerina cyanea</i>)	M, B ^b
Rufous-sided towhee (<i>Pipilo erythrophthalmus</i>)	A ^b
Chipping sparrow (<i>Spizella passerina</i>)	M, B
Song sparrow (<i>Melospiza melodia</i>)	A
White-throated sparrow (<i>Zonotrichia albicollis</i>)	W, M ^b
Dark-eyed junco (<i>Junco hyemalis</i>)	W
Red-winged blackbird (<i>Agelaius phoeniceus</i>)	A
Eastern meadowlark (<i>Sturnella magna</i>)	A
Common grackle (<i>Quiscalus quiscula</i>)	A ^b
Brown-headed cowbird (<i>Molothrus ater</i>)	A
Orchard oriole (<i>Icterus spurius</i>)	M, B
Northern oriole (<i>Icterus galbula</i>)	M, B
House finch (<i>Carpodacus mexicanus</i>)	A
Common redpoll (<i>Carduelis flammea</i>)	W
American goldfinch (<i>Carduelis tristis</i>)	A

^a W = Winter; M = migrant; B = breeding; E = escapee, probable escaped species.

^b Banded on the site.

Source: Johnson (1995).

TABLE 6.23 Small Mammals Collected during Land Condition Trend Analysis^a

Common Name	Scientific Name
Short-tailed shrew	<i>Blarina brevicauda</i>
Southern flying squirrel	<i>Glaucomys volans</i>
Marsh rice rat	<i>Oryzomys palustris</i>
White-footed mouse	<i>Peromyscus leucopus</i>
Meadow vole	<i>Microtus pennsylvanicus</i>
Pine vole	<i>Microtus pinetorum</i>
House mouse	<i>Mus musculus</i>
Meadow-jumping vole	<i>Zapus hudsonius</i>

^a Surveys were conducted September 13–November 1, 1994, and September 6–November 2, 1995. Animals were collected in Sherman live traps baited with rolled oats. These sitewide surveys excluded wetlands with standing water.

Source: Whaley (1996).

6.1.7 Summary

The assessment of ecological effects at the TBP AOC included the following:

- Evaluations of species abundance and community composition using quantitative and qualitative surveys of wetland and upland vegetation and terrestrial and aquatic invertebrate and vertebrate biota;
- Quantitative evaluations of physiological parameters of soil invertebrates, such as enzyme activity and respiration rates;
- Quantitative evaluations of processes mediated by soil invertebrates, such as litter decomposition and nitrogen mineralization; and
- Toxicity tests of site soils, sediments, and surface waters on a variety of invertebrates, vertebrates, and plants.

Surveys of the aquatic invertebrate community at the TBP AOC marsh and pond showed a diverse community representing a wide variety of taxa. Except in the site nearest the Pushout Area,

the benthic fauna in the pond and marsh represented communities expected to occur in such habitats. Several genera were collected from taxonomic groups that include species intolerant of poor water quality. The fish community was dominated by two species, one of which was present in very large numbers. No fish collected exhibited any external evidence (lesions, ulcers, fin rot, exophthalmus) of contaminant effects or other environmental stressors.

The vertebrate surveys showed a very diverse bird community inhabiting or using the site; more than 100 species were identified. No individuals exhibited any obvious external abnormalities. One of two nest boxes placed at the site was used by eastern bluebirds, and eight young birds were fledged from the nest. Four amphibian species were positively identified, and four native mammal species (white-footed mouse, meadow vole, short-tailed shrew, and red fox) were collected or observed. None of the specimens exhibited any external abnormalities (lesions or tumors).

The survey results showed reduced invertebrate abundance in the disturbed soils of the AOC. Total macroinvertebrate numbers, bacterial and fungal biomass, and nematode numbers, particularly at the Pushout Area, were significantly lower than those measured at on-site and off-site reference areas. The trophic structure of the nematode community at the Pushout Area was also different from that observed at the reference area.

The activity of several bacterial and fungal nutrient-acquiring enzymes in the Pushout Area was significantly lower than that at the reference site. Enzyme activity was significantly and negatively correlated with the total metal content of the soil. Substrate-induced respiration and soil nitrogen dynamics were also lower in the Pushout Area than in the reference location.

Toxicity testing of aquatic media showed no acute toxicity (following 48 hours of exposure) of surface water from the pond or marsh, but chronic toxicity was indicated for surface water collected from the marsh immediately next to the Pushout Area. This toxicity was manifested as growth reduction in the green alga *Selenastrum*, growth inhibition of the floating vascular plant *Lemna*, and reduced survival and growth in larval fish. Chronic toxicity to the green alga was detected for surface water at several locations from the ponds, and to daphnids at a single location from the Pushout Area-marsh boundary. Toxicity testing of sediments indicated bacterial (Microtox) inhibition, and some tests showed an increase in mortality of the amphipod *Hyalella*. The sediments exhibiting toxic effects were all collected from along the boundary between the Pushout Area and the marsh. No toxicity was detected in sediments collected from the pond. Testing of groundwater from the surficial aquifer at the TBP AOC showed both acute and chronic toxicity to a variety of test organisms, including zooplankton, vascular plants, amphibians, and larval fish.

Soils from the AOC had lethal and sublethal effects on earthworms and vegetation. Soils from the Southern Main Pit and the Pushout Area resulted in nearly 100% mortality in earthworms; significant weight loss in worms was detected in soil mixtures containing more than 25% of site soil. Toxicity testing evaluating seedling emergence, growth, and survival in lettuce showed $SER \leq 2.5\%$

for soils from the Pushout Area and Southern Main Pit and SER < 75% from other areas of the AOC. A SER of 100% was measured for soil from the VX pit, but none of the seedlings survived during the 14-day exposure.

6.2 WHITE PHOSPHORUS BURNING PITS

Initially, several investigations were planned for the WPP AOC (Hlohowskyj et al. 1995), including multiseasonal studies to evaluate soil invertebrate communities and soil processes (e.g., litter decomposition rates, nitrogen mineralization). However, these investigations were terminated shortly after initiation because of continued open detonation operations at the WPP AOC. As a result, some of the results of the effects assessment at the WPP AOC are based on data collected over a limited time period.

The assessment of ecological effects at the WPP AOC included (1) evaluations of species abundance and community composition using quantitative and qualitative surveys of terrestrial invertebrate and vertebrate biota and wetland and upland vegetation; (2) quantitative evaluations of soil microbial respiration rates and biologically mediated nutrient cycling processes, such as litter decomposition and nitrogen mineralization; and (3) toxicity tests of site soils, sediments, and surface waters on a variety of invertebrates, vertebrates, and plants. The results of these assessments are presented in Sections 6.2.1 through 6.2.6, and details regarding the assessment methods are presented in Appendix A.

6.2.1 Aquatic Habitats

The principal aquatic habitat in the WPP AOC is a small permanent pond north of the Northern Main Pit and in the Northwestern Suspect Burning Area (Figure A.4 in Appendix A). The pond receives runoff from the pit via a narrow ditch. The pond is approximately 50 ft long, 25 ft wide, and 1.5 ft deep. It contains substantial amounts of emergent vegetation, predominantly common reed (*Phragmites*), and duckweed (*Lemna*). A marsh consisting predominantly of stands of *Phragmites* is located in the Northwestern and Southwestern Suspect Burning Areas. Because this marsh contains standing water only during wet times of the year and dries out completely during the summer and early fall, aquatic communities are limited.

6.2.1.1 Aquatic Invertebrates and Fish

Qualitative samples of invertebrates were collected from the pond and marsh areas surrounding the WPP AOC. Cladocerans, copepods, midge and mosquito larvae, amphipods, and water mites were present in these samples and were also observed during other sampling activities.

No fish were collected in minnow traps placed overnight in the pond, and no fish were observed in the pond near the active portion of the WPP AOC.

6.2.1.2 Aquatic Toxicity

Table 6.24 presents the results of toxicity testing of surface water and sediments from the pond in the WPP AOC (locations WPP-A, WPP-B, and WPP-C in Figure A.4 in Appendix A). No significant inhibition from surface water or sediments from these locations was detected in Microtox tests. No acute toxicity to surface water from these locations was detected for *Daphnia*, *Pimephales* larvae, or *Rana* larvae. Survival and growth of *Hyalella* were not affected by sediments after 10 days of exposure. *Lemna* production was not affected after a 96-hour chronic exposure to surface water, although production of *Selenastrum* was significantly lower in a chronic test than that in laboratory controls. No chronic testing of media from the WPP AOC was conducted with *Ceriodaphnia*, *Hyalella*, or *Pimephales* because operations at the site limited access before all toxicity testing could be completed.

6.2.2 Soil Biota

6.2.2.1 Soil Macroinvertebrate Community

The soil invertebrate community was surveyed in the WPP AOC in the spring of 1994. Figure A.4 in Appendix A shows the sampling locations. The total number of animals was significantly higher ($P \leq 0.001$) in the pit area (WPS) than in the local background site (WPE) (Table 6.25). This greater abundance was due primarily to a large number of ants (Order Formicidae) collected at the pit area (9,596 in the pit area compared with 107 at the background site). Excluding ants, invertebrate numbers were similar between the pit and the local background site (682 and 601, respectively). No strong indications of adverse effects on the soil invertebrate community were found in this area. No adverse effects on the activity of epigeic fauna were seen in the WPP AOC, and activity was actually significantly higher ($P = \leq 0.005$) in the pit area than in the local background site (Table 6.26).

6.2.2.2 Soil Nematode Community

No strong indications of negative effects on the nematode community were found in the WPP AOC (Table 6.27). The numbers of all trophic groups and the total numbers of nematodes in the pit area and the local background site were similar. The only significant difference ($P \leq 0.05$) between the sites was in the number of omnivorous nematodes, which was higher in the pit area.

TABLE 6.24 Results of Toxicity Testing with Media Collected from the RCP, SBT, RPDG, WPP, and SBDG Areas^a

	RCP	SBT	RPDG		WPP			SBDG
Toxicity Test (medium, endpoint)	RCP-1	SBT-1	DGD-1	DGD-2	WPP-A	WPP-B	WPP-C	SBDG-SW-1
<i>Acute Tests</i>								
Microtox, water (inhibition)	-	-	-	-	-	-	-	
Microtox, sediment (inhibition)	-	-	+	+	-	-	-	
<i>Daphnia</i> (48-hour survival)	-	-	+	-	-	-	-	
<i>Ceriodaphnia</i> (48-hour survival)								-
<i>Hyalella</i> , sediment (10-day survival)		-			-	-	-	
<i>Hyalella</i> , sediment (10-day growth)		-			-	-	-	
<i>Pimephales</i> , water (48-hour survival)		-			-	-	-	
<i>Rana</i> , water (48-hour survival)					-		-	
<i>Rana</i> , water (96-hour survival)	-	-		-				-
<i>Chronic Tests</i>								
<i>Lemna</i> , water (96-hour production)	-	-	-	-	-	-	-	-
<i>Selenastrum</i> , water (96-hour production)	+	+	+	+	+	+	+	
<i>Ceriodaphnia</i> , water (7-day survival)	-	-		-				
<i>Ceriodaphnia</i> , water (7-day reproduction)	-	-		-				
<i>Hyalella</i> , sediment (28-day survival)	-	-						+
<i>Hyalella</i> , sediment (28-day growth)	-	-						+
<i>Pimephales</i> , water (7-day survival)								

^a - = test results indicated media were not toxic compared with laboratory controls; + = test results indicated media were toxic compared with laboratory controls; blank cell indicates not tested.

TABLE 6.25 Abundance of Soil Macroinvertebrates in the White Phosphorus Burning Pits Area, October 1994

Taxa	Mean Abundance (number/m ² ± SE; n = 30)	
	Pit Area (WPS)	Local Background Site (WPE)
Lumbricidae	409.73 ± 82.3	265.39 ± 36.9
Isopoda	32.59 ± 16	13.97 ± 13.97
Geophilomorpha	9.31 ± 6.5	23.28 ± 9.7
Symphyla	46.56 ± 37.5	- ^a
Diplopoda	27.94 ± 12.3	51.22 ± 23.7
Aranea	55.87 ± 18.5	69.84 ± 20.9
Diplura	18.62 ± 11.1	32.59 ± 11
Diptera larva	4.66 ± 4.66	4.66 ± 4.66
Formicidae	9,596 ± 3,384	107.09 ± 58.6
Lepidoptera larva	4.66 ± 4.66	4.66 ± 4.66
Elateridae	4.66 ± 4.66	13.97 ± 7.8
Scarabaeidae	9.31 ± 6.5	18.62 ± 11.1
Curculionidae	9.31 ± 9.3	13.97 ± 7.8
Carabidae	18.62 ± 11.1	23.28 ± 11.8
Staphylinidae	9.31 ± 6.5	32.59 ± 11
Other Coleoptera	18.62 ± 11.1	32.59 ± 11
Other ^b	4.66 ± 4.66	-
Total ^c	10,280 ± 3,381	707.71 ± 86.5

^a - = not collected.

^b Includes Hemiptera and insect pupae.

^c Total numbers are significantly different at $P < 0.001$. Statistical analyses (*t*-test) were performed for total numbers on log-transformed data.

TABLE 6.26 Captures of Epigeic Fauna in the White Phosphorus Burning Pits Area

Date	Mean Captures (number/trap/d, $n = 10$)		<i>P</i> -Value ^a
	Pit Area (WPS)	Local Background Site (WPE)	
Fall 1993	45.30	16.04	0.0001
Spring 1994	27.40	16.90	0.0047

^a Statistical analyses (*t*-test) were performed on natural log-transformed data.

TABLE 6.27 Abundance and Trophic Structure of the Nematode Community in the White Phosphorus Burning Pits Area,^a April 1994

Trophic Group	Number/g soil		<i>P</i> -Value
	Pit Area (WPS)	Local Background Site (WPE)	
Fungivore	7.32	8.14	0.2499
Bacterivore	10.33	8.89	0.2582
Herbivore	1.31	0.50	0.1170
Omnivore	0.80	0.24	0.0308
Hatchling ^b	1.16	1.82	0.4634
Total	21.27	19.78	0.7955

^a Nematode numbers are means ($n = 10$) and expressed as number per gram soil dry mass. Statistical analyses (*t*-test) were performed on natural log-transformed data [$\ln(x+1)$].

^b The "Hatchling" category represents nematodes that could not be classified to another group because of immature condition.

6.2.2.3 Soil Microbial Biomass

There were no statistically significant differences in microbial biomass nitrogen pools between the pit area and the local background site (Table 6.28).

6.2.3 Soil Processes

6.2.3.1 Soil Respiration

No evidence was found of suppressed microbial activity measured as CO₂ evolution in incubated soils. The cumulative soil respiration was higher in the pit area than in the local background site (Figure 6.6), indicating increased microbial activity in the pit area.

6.2.3.2 Litter Decomposition and Nutrient Dynamics

The test litter used at the WPP AOC was composed of common reed and had the same initial carbon and nitrogen content as that used in the TBP AOC (Section 6.1.3.2). Measured loss of carbon was similar at the two sites in the WPP AOC after 6 and 12 months (Table 6.29). However, by the end of the first year, the nitrogen content of litter at the pit area was significantly greater than that at the local background site. The absence of change in percent nitrogen remaining in the litter at the pit area between 6 and 12 months, provides evidence of disturbed soil function (the percent nitrogen remaining did not change and little nitrogen was mineralized). In contrast, net mineralization of nitrogen continued at the local background site.

TABLE 6.28 Seasonal Changes in Soil Microbial Biomass Nitrogen ($\mu\text{g N/g DW soil}$) in the White Phosphorus Burning Pits Area^a

Date	Pit Area (WPS)	Local Background Site (WPE)	P-Value ^b
October 13, 1993	33.87	24.18	0.1388
December 4, 1994	33.06	33.24	0.8139

^a Numbers are means ($n = 10$) and expressed as micrograms of nitrogen per grams of dry-weight soil.

^b Statistical analyses were performed on natural log-transformed data.

FIGURE 6.6 Cumulative CO₂ Evolution (mean $\pm$ SE) in Microcosms with Soil from the Pit Area (WPS) and the Local Background Site (WPE) in the White Phosphorus Burning Pits Area

6.2.3.3 Soil Nitrogen Mineralization

The soil carbon and nitrogen contents and C/N ratios of the two sites were different: 0.8966% carbon, 0.0835% nitrogen, and C/N = 10.74 at the local background site and 1.4356% carbon, 0.0561% nitrogen, and C/N = 25.6 at the pit area. The higher carbon content and lower nitrogen content at the pit area led to a higher soil C/N ratio than that of the local background site. No significant differences in soil nitrogen concentrations (Table 6.30) or net nitrogen mineralization rates (Table 6.31) were found between the pit area and the local background site.

6.2.4 Soil Toxicity

6.2.4.1 Earthworm Toxicity

Table 6.32 presents the results of the earthworm screening test for the WPP AOC. Figure A.4 in Appendix A shows the locations of the sampling points. The results indicated a possible sublethal effect in soil from location JWPP-A, in that the average earthworm weight loss

TABLE 6.29 Changes in Carbon and Nitrogen Content in Decomposing Common Reed Litter in the White Phosphorus Burning Pits Area^a

Parameter/Time	Pit Area (WPS)	Local Background Site (WPE)	P-Value
<i>Percent carbon remaining</i>			
6 months	44.75	43.84	0.8953
12 months	23.35	25.57	0.5983
<i>Percent nitrogen content^b</i>			
6 months	1.10	0.89	0.0397
12 months	1.54	1.21	0.0019
<i>Percent nitrogen remaining^c</i>			
6 months	95.24	84.45	0.2109
12 months	95.73	77.30	0.0368

^a Numbers are means ($n = 10$).

^b Change in the relative concentration of nitrogen in litter.

^c Change in the absolute concentration of nitrogen in litter.

TABLE 6.30 Seasonal Changes in Soil Extractable Nitrogen ($\mu\text{g N/g DW soil}$) in the White Phosphorus Burning Pits Area^a

Date/Parameter	Pit Area (WPS)	Local Background Site (WPE)	P-Value ^b
October 13, 1993			
NH ₄ -N	6.17	6.27	0.9470
NO ₃ -N	1.38	0.85	0.6827
Total nitrogen	7.55	7.12	0.7701
April 12, 1994			
NH ₄ -N	0.85	0.90	0.5954
NO ₃ -N	0.14	0.13	0.9032
Total nitrogen	0.99	1.03	0.6407

^a Numbers are means ($n = 10$) and expressed as micrograms of nitrogen per gram of dry-weight soil.

^b Statistical analyses were performed on natural log-transformed data.

TABLE 6.31 Seasonal Changes in Net Nitrogen Mineralization Rate ($\mu\text{g N/g DW soil/day}$) in Soils of the White Phosphorus Burning Pits Area^a

Date	Pit Area (WPS)	Local Background Site (WPE)	P-Value ^b
Oct. 13–Nov. 11, 1993	0.15	0.12	0.7763
April 12–May 11, 1994	0.01	-0.01	0.5661

^a Numbers are means ($n = 10$) and expressed as micrograms of nitrogen per gram of dry-weight soil per day.

^b Statistical analyses were performed on untransformed data.

was slightly higher than in samples from other areas. This location is immediately west of the main pits in the suspect pushout area.

6.2.4.2 Phytotoxicity Test

Table 6.33 shows the results of the soil phytotoxicity screening with lettuce seeds. Indices of toxicity included the SER, average plant height, and average dry weight for each soil sample tested. Soil toxicity was indicated by reduced seedling emergence in soils from two locations, the Northern Main Pit (JWPP-2C) and the suspected pushout area (JWPP-A). The SER was only 70% in soils from these two locations, whereas it ranged from 93% to 100% in soils from other sites (Table 6.33). Toxicity was further indicated for the suspect pushout area (JWPP-A) by the low final dry weight of seedlings, which was less than half that for the negative control plants (2.92 and 6.14 mg, respectively). The mean final weight of plants grown in soil from the suspect filled trench was less than half that of plants grown in soils from other sites, but it did not differ from the negative control weights. All soils had 10 seedlings that survived to day 14.

6.2.5 Terrestrial Vegetation Surveys

Terrestrial vegetation near the WPP AOC consists of old-field communities dominated by grasses such as gama grass (*Tripsacum dactyloides*), which are mowed annually. This old-field area is bordered on the south by upland forest and on the north by upland forest and forested wetland. Marshes of common reed line much of the Gunpowder River to the west of the AOC.

In 1993, three vegetation sampling grids, one 10- × 10-m grid and two 5- × 5-m grids, were established in old-field communities in the AOC. Data collected from the grids in July 1993 included

TABLE 6.32 Earthworm Toxicity Screening of Soils from the White Phosphorus Burning Pits Area

Sample Location	Replicate	ESR (%)	Initial Weight Mean ^a (g/worm)	Final Weight Mean ^a (g/worm)	Difference (g)
WR+ ^b		0			
	A		0.39	None ^c	NA ^d
	B		0.42	None	NA
	C		0.42	None	NA
WR- ^e		100			
	A		0.44	0.45	+0.01
	B		0.50	0.59	+0.09
	C		0.43	0.44	+0.01
JWPP-1E		100			
	A		0.43	0.42	-0.01
	B		0.43	0.42	-0.01
	C		0.40	0.37	-0.03
JWPP-2C		100			
	A		0.55	0.54	-0.01
	B		0.49	0.54	+0.05
	C		0.52	0.52	0.0
JWPP-A		93			
	A		0.41	0.40	-0.01
	B		0.50	0.43	-0.07
	C		0.47	0.39	-0.08
JWPP-B		100			
	A		0.42	0.45	-0.03
	B		0.55	0.57	-0.02
	C		0.50	0.52	+0.02

^a $n = 5$.^b Positive control (Winters Run soil with added spike of 50 g paranitrophenol/g soil).^c "None" indicates that no living worms were found at the end of incubation.^d NA = not applicable; weights were not taken for dead, decomposing worms.^e Negative control (Winters Run soil with no added spike).

Source: Phillips and Checkai (1995).

TABLE 6.33 Phytotoxicity Screening of Soils from the White Phosphorus Burning Pits Area

Sample Site	SER ^a (%)	Mean Plant Height (mm)	Mean Dry Weight (mg)
JWPP-1E	95	9.5	14.25
JWPP-2c	70	10.2	12.26
JWPP-A	70	11.6	2.92
JWPP-B	80	11.8	5.45
WR+ ^b	25	2.0	0.67
WR- ^c	65	8.1	6.14

^a SER = seedling emergence rate.

^b Positive control (Winters Run soil with added spike of 1,000 µg copper/g soil).

^c Negative control (Winters Run soil with no added spike).

Source: Phillips and Checkai (1995).

percent areal cover for each species in each grid. Relative cover, the proportion of each species to the total cover of all species in a sample, was calculated for each species in each grid. Shannon-Weiner diversity indices, which incorporate species richness and evenness, were calculated for each grid. Table D.8 lists species name, percent cover, relative cover, and diversity indices.

Average species diversity for the WPP AOC grids ranged from 0.91 to 2.53, which was not below the range of indices for the old-field reference site (0.74-1.7) (Table 6.21). Grid WPE, located upgradient of the pits and less likely to be affected by disposal activities, had a diversity index of 1.07, which was below the average for the reference site (a mean diversity of 1.30), and a species richness of 5, slightly below the mean species richness for the reference site (5.7). The index for grid WPS (0.91), located near the pushout area, was slightly above the minimum of the reference site indices (0.74). Species richness for this grid was also 5. Grid WPW was located next to a ditch that drains excess surface water from the pits into a small pond. The diversity index for this grid was 2.53, which is higher than the maximum reference site index of 1.66. Species richness for this grid was 7, which is above the mean reference site species richness but below the reference site maximum of 9. Although a statistical comparison can not be performed, these results indicate that the vegetation community of the WPP AOC, on the basis of species richness and species diversity, has not been greatly affected by soil contamination at this location.

6.2.6 Vertebrate Surveys

6.2.6.1 Amphibians and Reptiles

The pond in the WPP AOC contained *Rana* larvae and adults during spring and summer 1994 and 1995. Qualitative surveys of amphibians were conducted near the WPP AOC from March through June 1995 (Johnson 1995). Species observed included adult red-spotted newts (*Notophthalmus viridescens*), spring peepers (*Pseudacris crucifer*), bullfrogs (*Rana catesbiana*), southern leopard frogs (*Rana utricularia*), and green frogs (*Rana clamitans*). Amplexing pairs of spring peepers were observed during March 1995, and *Rana* and *Pseudacris* larvae (tadpoles) were observed in April (Johnson 1995). Eastern painted turtles (*Chrysemys picta*) and northern water snakes (*Natrix sipedon*) were also observed in the WPP pond on several occasions.

6.2.6.2 Birds

Suitable habitats for many of the species listed in Table 6.22 are found near the WPP AOC, including offshore areas, forested areas, wetlands, and open fields. Bald eagles and ospreys commonly roost in large trees near the WPP AOC, and a pair of adult bald eagles was observed there on March 27, 1995 (Johnson 1995). On this same date, more than 1,000 lesser scaup were observed offshore of the WPP AOC (Johnson 1995). Other notable bird species observed near or in the WPP AOC include bufflehead, solitary sandpiper, northern bobwhite, wood duck, and eastern bluebird (Johnson 1995). A pair of eastern bluebirds occupied a nest box placed in the WPP AOC; four bluebirds were subsequently fledged from this nest (Johnson 1995).

6.2.6.3 Small Mammals

No survey of small mammals was conducted at the WPP AOC. Mammal species likely to occur at the TBP AOC (Section 6.1.6.3) are also likely to be found in the WPP AOC because similar habitats are available within the WPP AOC. The red fox has been observed in the WPP AOC on several occasions.

6.2.7 Summary

The assessment of ecological effects at the WPP AOC included the following:

- Evaluations of species abundance and community composition using quantitative and qualitative surveys of terrestrial invertebrate and vertebrate biota and wetland and upland vegetation;

- Quantitative evaluations of soil microbial respiration rates and soil invertebrate-mediated processes, such as litter decomposition and nitrogen mineralization; and
- Toxicity tests of site soils, sediments, and surface waters on a variety of invertebrates, vertebrates, and plants.

Surveys of the aquatic invertebrate community at the pond at the Northwestern Suspect Burning Area found many aquatic invertebrate taxa, including zooplankton, amphipods, and aquatic insect larvae of several species. No fish were collected, but their absence is probably due to factors other than contamination. The pond is small and isolated, and it has no connections to the nearby bay or other surface water bodies with fish that could colonize the pond. The pond may also dry out in hot, dry summers.

Qualitative observations of birds at the WPP AOC indicated a variety of species in the immediate vicinity, including bald eagle, osprey, and waterfowl. Neither the bald eagle nor the osprey is expected to forage or nest at the site, but waterfowl may use the site occasionally. Eastern bluebirds used a nest box at the site, and four young birds were fledged from the nest. Five amphibian species and two reptile species were found at the AOC. Reproducing adults of one amphibian species and larvae of two other species were observed at the pond in the Northwestern Suspect Burning Area. These observations suggest that at least some species reproduce in the surface waters at the AOC.

The survey results showed little contaminant impact on the total abundance of invertebrates at the site. In fact, total abundance was greater near the Southern Main Pit than at the local background site. This difference was attributable to a much greater abundance of ants in the Southern Main Pit; excluding ants, total macroinvertebrate abundance was almost equal between the pit and local background sites. No adverse effects were seen on nematode abundance or community trophic structure, both of which were similar in the pit and local background sites. Similarly, no difference in microbial biomass nitrogen was detected between the sites.

There were differences in litter decomposition rates and SIR between the pit and local background sites. In addition, no net mineralization was measured at the pit, which suggests altered soil nitrogen dynamics.

Toxicity testing of aquatic media with bacteria (*Microtox*), *Daphnia*, *Lemna*, *Hyaella*, *Pimephales*, and *Rana* found no acute or chronic toxicity of surface water or sediment from the pond or marsh. The only toxic effect detected for surface water was a significant reduction in the growth of the green alga *Selenastrum*.

Soils from the WPP AOC were not toxic to earthworms or plants. Seed emergence rates (SERs) of 70% or greater were measured for soil samples from all locations. Seedling survival was 100% for all locations. Seedling growth, measured as dry weight at the end of the test period, was less than half that measured for the negative control sample at one location (Northern Main Pit), but was approximately the same or greater than in the negative control sample for all other locations. Earthworm survival was 93 to 100% for all WPP locations sampled, although a small decrease in growth was observed for samples from the Northern Main Pit (Phillips and Checkai 1995).

6.3 RIOT CONTROL PIT

The assessment of ecological effects at the RCP AOC included (1) quantitative evaluations of soil invertebrate abundance and community composition; (2) qualitative surveys of wetland and upland vegetation; (3) qualitative surveys of aquatic and terrestrial invertebrates and vertebrates; (4) quantitative evaluations of the physiological parameters of soil invertebrates, such as enzyme activity and respiration rates; (5) quantitative evaluations of biologically mediated nutrient cycling processes, such as litter decomposition and nitrogen mineralization; and (6) toxicity tests of site soils, sediments, and surface waters on a variety of invertebrates, vertebrates, and plants. The results of these effects assessments are presented in Sections 6.3.1 through 6.3.6, and details regarding the assessment methods are presented in Appendix A.

6.3.1 Aquatic Habitats

Aquatic habitats in the RCP AOC are limited to ephemeral pools that develop in the pit. These pools, which can be up to 8 in. deep, are present during spring and fall; pools also form for short periods after heavy rains in other seasons. The pools are in a forested area and relatively protected from direct sunlight. Consequently, these areas remain moist throughout the summer, although standing water is not always present.

6.3.1.1 Aquatic Invertebrates and Fish

Qualitative samples of aquatic invertebrates collected from ephemeral pools in the RCP AOC included a variety of taxa common in such habitats, including cladocerans, copepods, amphipods, and midge and mosquito larvae. Because of the ephemeral nature of the pools, no fish are present.

6.3.1.2 Aquatic Toxicity

Table 6.24 presents the results of toxicity testing of surface water and sediments of the RCP AOC, and Figure 6.1 shows the approximate locations of the sample sites. Microtox activity in water and sediments from this location was not significantly different from that in laboratory controls. Surface water from sample location RCP-1, near the head of the pit in the largest and most persistent of the ephemeral pools, was not acutely toxic to *Daphnia* after 48 hours or to *Rana* larvae after 96 hours of exposure. This water exhibited chronic toxicity to the green alga *Selenastrum*, but it had no significant chronic effects on the survival or juvenile production of *Ceriodaphnia* after 7 days or on growth of *Lemna* after 96 hours. In addition, sediment from RCP-1 had no significant chronic effects on the survival or growth of *Hyaella* after 28 days of exposure.

6.3.2 Soil Biota

6.3.2.1 Epigeic Invertebrates

No effects on the activity of epigeic fauna were observed in the RCP AOC. No significant differences in the number of individuals collected per trap per day between the pit area (RCP) and the local background site (RCB) were observed on either 1994 sampling date (Table 6.34).

6.3.2.2 Soil Nematode Community

Some negative effects on the nematode community were found in the RCP AOC. No significant differences between the pit area and the background site were observed in spring, but significant negative effects on several trophic groups and total numbers (summer only) of nematodes were observed in summer and fall (Table 6.35). Because of differences in soil profiles between the

TABLE 6.34 Captures of Epigeic Fauna in the Riot Control Pit Area^a

Date	Mean Captures (number/trap/d, $n = 10$)		P-Value
	Pit Area (RCP)	Local Background Site (RCB)	
Spring 1994	25.70	13.80	0.2614
Fall 1994	8.70	8.90	0.8667

^a Statistical analyses were performed on natural log-transformed data.

TABLE 6.35 Seasonal Changes in the Abundance and Trophic Structure of the Nematode Community in the Riot Control Pit Area^a

Season	Trophic Group	Number/g DW Soil		P-Value
		Pit Area (RCP)	Local Background Site (RCB)	
Spring (April 26, 1994)	Fungivore	1.53	1.63	0.8966
	Bacterivore	3.85	2.63	0.4739
	Herbivore	0.81	1.02	0.6037
	Omnivore	0.51	0.36	0.3412
	Hatchling ^b	0.51	0.91	0.1937
	Total	7.57	6.72	0.9931
Summer (June 16, 1994)	Fungivore	1.43	2.91	0.0949
	Bacterivore	6.86	12.77	0.0144
	Herbivore	0.75	4.11	0.0013
	Omnivore	0.23	0.58	0.1225
	Hatchling	0.38	1.97	0.0019
	Total	10.12	23.22	0.0004
Fall (October 20, 1994)	Fungivore	4.41	2.85	0.8600
	Bacterivore	6.46	12.64	0.0350
	Herbivore	0.75	5.01	0.0180
	Omnivore	0.14	0.54	0.0339
	Hatchling	0.80	0.81	0.9392
	Total	13.40	22.17	0.0808

^a Nematode numbers are mean ($n = 10$) and are expressed as number per gram of soil dry mass. Statistical analyses were performed on natural log-transformed data [$\ln(x + 1)$].

^b The "Hatchling" category represents nematodes too immature to be identified as belonging to a specific trophic group.

pit area and the background site, it is difficult to attribute negative effects to soil contamination (surface soil was apparently removed when the RCP was constructed). The pit area contains largely B-horizon soil with low organic content, whereas the background site has a normal soil profile. Thus, lower numbers of nematodes would be expected in the pit regardless of the level of soil contamination.

6.3.2.3 Soil Microbial Biomass

Strong significant differences in soil microbial biomass were found between the pit area and the local background site. Microbial biomass nitrogen was nearly 50% lower in the pit area than at the local background site on all sampling dates in 1994 (Table 6.36). These differences should be interpreted cautiously because they may be a result of lower soil nutrient content in the pit (the A horizon is removed) and submergence of parts of the pit under water for several months, as well as soil contamination.

In spring of 1995, both average FDA-active bacterial biomass and total bacterial biomass at the RCP AOC were significantly higher than those at the reference site. Only total fungal biomass was significantly lower at the RCP AOC (Table 6.37). This result is important, however, because total fungal biomass accounted for most of the microbial biomass at these sites. Soil protozoa were not affected. The numbers of flagellates, amoebae, and ciliates at the RCP AOC were either higher than (but not statistically different) or similar to those at the reference site (Table 6.37).

6.3.3 Soil Processes

6.3.3.1 Enzyme Activity and Substrate-Induced Respiration

No significant difference was observed in the activity of dehydrogenase and N-acetylglucosaminidase in the RCP AOC compared with the reference site (Table 6.38). Activity of acid phosphatase was significantly higher in the RCP AOC. The SIR rate was not significantly different from the reference site.

6.3.3.2 Litter Decomposition and Nutrient Dynamics

The litter used for testing at this AOC was sweetgum leaves (*L. styraciflua*), a common species in the RCP AOC. The leaves had initial carbon and nitrogen contents of 48.56% and 1.1649%, respectively. Carbon disappeared more slowly in litter in the pit than at the local background site, although significantly so only after 1 year (Table 6.39). Nitrogen concentration increased more slowly in the pit, but the difference was significant only at 6 months. Both results

TABLE 6.36 Seasonal Changes in Mean Soil Microbial Biomass Nitrogen ($\mu\text{g N/g DW soil}$) in the Riot Control Pit Area^a

Date	Pit Area (RCP)	Local Background Site (RCB)	P-Value ^b
April 25, 1994	20.85	57.62	0.0013
June 16, 1994	32.66	70.02	0.0002
October 20, 1994	35.49	65.45	0.0011

^a Numbers are means ($n = 10$) and expressed as micrograms of nitrogen per gram of dry-weight soil.

^b Statistical analyses were performed on log-transformed data.

TABLE 6.37 Microbial Biomass Parameters (mean $\pm$ SE) of Soils at the Riot Control Pit Area and Reference Site, Spring 1995

Microbial Parameter	Riot Control Pit ^a	Reference Site (RSB) ^b	Significance
FDA-active fungal biomass ($\mu\text{g/g DW}$)	1.52 ± 0.27	0.58 ± 0.15^c	NS ^{d,e}
Total fungal biomass ($\mu\text{g/g DW}$)	215.39 ± 15.78	366.24 ± 51.64^c	$P = 0.0007^f$
FDA-active bacterial biomass ($\mu\text{g/g DW}$)	1.97 ± 0.12	1.07 ± 0.12^c	$P = 0.0001^f$
Total bacterial biomass ($\mu\text{g/g DW}$)	5.31 ± 0.58	2.69 ± 0.24^c	$P = 0.0025^e$
Flagellates (number/g DW)	1742.4 ± 726.0	563.79 ± 267.63^g	NS ^h
Amoebae (number/g DW)	149.75 ± 39.73	86.54 ± 21.20^g	NS
Ciliates (number/g DW)	7.62 ± 5.95	9.43 ± 3.84^g	NS

^a $n = 24$.

^b Reference site at Gunpowder Falls State Park.

^c $n = 9$.

^d NS = not significant ($P > 0.05$).

^e t -test on natural log-transformed data.

^f t -test on untransformed data.

^g $n = 7$.

^h Mann-Whitney test.

TABLE 6.38 Enzyme Activity and Substrate-Induced Respiration (SIR) (mean $\pm$ SE) in Soils at the Riot Control Pit Area and Reference Site, Spring 1995

Microbial Activity Parameter	Riot Control Pit ^a	Reference Site ^b (RSB)	Significance
Dehydrogenase ($\mu\text{mol/g/h}$)	0.019 $\pm$ 0.005	0.014 $\pm$ 0.011	NS ^c
Acid phosphatase ($\mu\text{mol/g/h}$)	1.772 $\pm$ 0.248	0.848 $\pm$ 0.151	$P = 0.0001^d$
N-acetylglucosaminidase ($\mu\text{mol/g/h}$)	0.225 $\pm$ 0.038	0.176 $\pm$ 0.049	NS
SIR ($\mu\text{g/g/min}$)	0.168 $\pm$ 0.020	0.143 $\pm$ 0.002	NS

^a $n = 24$.

^b Reference site at Gunpowder Falls State Park; $n = 9$, except SIR with $n = 5$.

^c NS = not significant ($P > 0.05$).

^d Mann-Whitney test; all others Student's t -test.

TABLE 6.39 Changes in Carbon and Nitrogen Content in Decomposing Sweetgum Litter in the Riot Control Pit Area

Parameter/Time	Pit Area (RCP) ^a	Local Background Site (RCB) ^a	P -Value
<i>Percent carbon remaining</i>			
6 months	64.38 A ^b	58.32 A	0.2808
12 months	38.08 B	29.07 A	0.0001
20 months	21.50 B	6.84 A	0.0100
<i>Percent nitrogen content^c</i>			
6 months	1.15 B	1.51 A	0.0448
12 months	1.77 A	1.91 A	0.3949
20 months	1.71 A	1.94 A	0.2067
<i>Percent nitrogen remaining^d</i>			
6 months	70.43 B	87.54 A	0.0434
12 months	81.17 A	69.18 A	0.3155
20 months	70.16 B	35.70 A	0.0082

^a $n = 10$.

^b Within each time period, values with different letters are significantly different ($P < 0.05$). Statistical analysis was student's t -test.

^c Change in the relative concentration of nitrogen in litter.

^d Change in the absolute concentration of nitrogen in litter.

suggest reduced biological activity in the pit. Whether this reduction is due to soil contamination or reduced soil carbon and nitrogen remains to be determined. At both sites, there was net mineralization of nitrogen after 6 months, but the percentage of nitrogen remaining was significantly lower at the pit. The pattern reversed, however, and by the end of the first year, the percentage of nitrogen remaining was somewhat lower at the local background site.

After 20 months, decomposition was significantly slower in the pit than in the local background site ($P = 0.01$). The decomposition constants were -0.0045 and $-0.0026/d$ for the local background site and pit area, respectively. The high regression coefficients for both sites (RCB: $r^2 = 0.97$; RCP: $r^2 = 0.99$) indicate that the decomposition process is reasonably well represented by the negative exponential model.

Although the percent nitrogen content of the litter was higher at the local background site after 20 months, there was no significant difference between the two sites. Between 12 and 20 months, the percent nitrogen content of the litter changed little at either site (Table 6.39). After 20 months, strong and significant ($P = 0.008$) differences in percent nitrogen remaining existed between the two sites. At the RCB site, there was continuous net mineralization of nitrogen in the litter throughout the study; by 20 months, only 36% of nitrogen remained in the litter. Although there was also net nitrogen mineralization at the pit area after 20 months, 70% of nitrogen remained in the litter.

6.3.3.3 Nitrogen Mineralization

Soil carbon and nitrogen contents were much higher at the local background site (3.72% carbon, 0.26% nitrogen, C/N = 14.6) compared with the pit area (1.43% carbon, 0.08% nitrogen, C/N = 18.1), although the C/N ratios were similar. The difference in soil carbon and nitrogen content is likely due to the different soil profiles at the pit and the local background site.

The local background site had higher available soil nitrogen concentrations than the pit area, except on the spring 1994 sampling date, when soil nitrogen concentrations at the two sites were similar (Table 6.40). Only the value for $\text{NO}_3\text{-N}$ during the fall of 1994 was significantly different from the local background site. Net nitrogen mineralization rates in soil were greater at the local background site on all three sampling dates, although significantly so only in the fall of 1994 (Table 6.41).

TABLE 6.40 Seasonal Changes in Soil Extractable Nitrogen ($\mu\text{g N/g DW soil}$) in the Riot Control Pit Area^a

Date/Parameter	Pit Area (RCP)	Local Background Site (RCB)	P-Value ^b
April 25, 1994			
NH ₄ -N	3.27	3.18	0.7878
NO ₃ -N	0.36	0.39	0.9771
Total nitrogen	3.63	3.57	0.7724
June 16, 1994			
NH ₄ -N	2.36	6.39	0.1451
NO ₃ -N	0.61	1.07	0.1423
Total nitrogen	2.97	7.46	0.0994
October 20, 1994			
NH ₄ -N	2.01	4.24	0.0987
NO ₃ -N	2.10	3.40	0.0146 ^c
Total nitrogen	4.11	7.64	0.0522

^a Numbers are means ($n = 10$) and expressed as micrograms of nitrogen per gram of dry-weight soil.

^b Statistical analyses (t -test) were performed on natural log-transformed data.

^c Significantly different at $P < 0.05$.

TABLE 6.41 Seasonal Changes in Net Nitrogen Mineralization Rate ($\mu\text{g N/g DW soil/day}$) in Soils in the Riot Control Pit Area^a

Date	Pit Area (RCP)	Local Background Site (RCB)	P-Value ^b
April 25–June 2, 1994	0.12	0.24	0.0685
June 16–July 14, 1994	0.30	0.56	0.2421
Oct. 20–Nov. 17, 1994	0.24	0.79	0.0063 ^c

^a Numbers are means ($n = 10$) and expressed as micrograms of nitrogen per gram of dry-weight soil per day.

^b Statistical analyses (t -test) were performed on untransformed data.

^c Significantly different at $P < 0.05$.

6.3.4 Soil Toxicity

6.3.4.1 Earthworm Toxicity

Indices of toxicity included earthworm survival and changes in body weight. Figure A.5 in Appendix A shows the locations of sampling points in the RCP AOC. Table 6.42 presents the results of the earthworm screening test. Earthworm survival was 100% in soils from the trench (JBT1-W) and a location north of the suspected previous trench (JBTM-A). The mean growth rates of earthworms maintained in soils from the RCP sample locations were not significantly different from those of earthworms in control (Winters Run) soils (t -test $P>0.10$).

TABLE 6.42 Earthworm Toxicity Screening of Soils from the Riot Control Pit Area

Sample Location	Replicate	ESR (%)	Initial Weight Mean (g/worm)	Final Weight Mean (g/worm)	Difference (g)
WR+ ^a		0			
	A		0.39	None ^b	NA ^c
	B		0.42	None	NA
WR- ^d	C	100	0.42	None	NA
	A		0.44	0.45	+0.01
	B		0.50	0.59	+0.09
JBTM-A	C	100	0.43	0.44	+0.01
	A		0.56	0.66	+0.10
	B		0.53	0.57	+0.04
JBT1-W (Main Pit)	C	100	0.59	0.58	-0.01
	A		0.53	0.53	0.00
	B		0.50	0.49	-0.01
	C		0.53	0.46	-0.07

^a Positive control (Winters Run soil with an added spike of 50 g paranitrophenol/g soil).

^b "None" indicates that no living worms were found at the end of incubation.

^c NA = not applicable; weights were not taken for dead, decomposing worms.

^d Negative control (Winters Run soil with no added spike).

Source: Phillips and Checkai (1995).

6.3.4.2 Phytotoxicity Test

Table 6.43 presents the results of the soil phytotoxicity screening using lettuce seeds. Two sets of studies, one using soil from an APG reference site (Phillips and Checkai 1995) and the other using a laboratory standard soil (ESI 1995), were conducted. The study using a standard soil control was initiated to test additional sample locations at the RCP AOC after the Winter's Run Control Study (Phillips and Checkai 1995) indicated low survival of lettuce seedlings for particular sample locations. Indices of toxicity on lettuce seeds included the SER for all samples and average plant height and average dry weight for soils from selected sites. Figure A.5 in Appendix A shows the locations of soil sampling points in the RCP AOC. No seedlings emerged in soil from the location north of the suspect previous trench (JBTM-A); trench soil (JBT1-W) had only a 40% SER; and soil from the center of the main trench (SGRCP-9) had a 69.2% SER. The remaining samples had SERs of 78–87%. The SER was 65% for the negative control and 91% for the standard control.

6.3.5 Terrestrial Vegetation Surveys

The terrestrial vegetation near the RCP AOC consists of an extensive community of mature upland forest extending from the marsh along the Gunpowder River and Chesapeake Bay to the marsh associated with the TBP AOC. The dominant tree species are sweetgum and red maple, and *Microstegium vimineum* (nepalgrass) dominates the herbaceous stratum. This area is relatively open with very little understory or shrub layer. Vegetation in and immediately next to the pit consists of herbaceous species such as common reed.

In June 1995, a transect was established in the forested area immediately south (and down gradient) of the lower end of the pit. A total of nine 0.5-m² plots were sampled at 3-m intervals along the 24-m transect. Data collected included species name, stratum, percent cover, and diameter (of woody stems only) for each species found in the plot. Species diversity was calculated for each plot by using the Shannon-Weiner diversity index, which incorporates species richness and evenness. Table D.9 presents the species, percent cover, and diversity of the plots. Table 6.44 presents a summary of species richness and diversity. Diversity indices ranged from 1.10 to 2.21 and averaged 1.82. When calculated over the entire transect, the diversity index is 2.60. Species richness for the transect totaled 19 species. Diversity indices were compared with a reference set of diversity indices for deciduous forest in other APG areas.

Species diversity and species richness were calculated for four 100-m transects from the Aberdeen Area of APG (Table 6.44). Data were collected from these transects in 1994 and 1995 as part of the Land Condition Trend Analysis Program (DeRoia 1995). The four transects were located in relatively undisturbed upland areas with a vegetation structure and community similar to that in the forested areas sampled at J-Field as part of the ERA. Species richness values for the four transects were 10, 12, 14, and 15, with a mean of 13 (Table 6.44). Shannon-Weiner species diversity indices for the transects were 1.74, 2.48, 2.93, and 3.46, with a mean diversity index of 2.65.

TABLE 6.43 Phytotoxicity Screening of Soils from the Riot Control Pit Area

Sample Site	SER (%)	Mean Plant Height (mm)	Mean Dry Weight (mg)
<i>Winters Run Control Study^a</i>			
WR+ ^b	25	2.0	0.67
WR- ^c	65	8.1	6.14
JBTM-A	0	NA ^d	NA
JBT1-W	40	11.25	6.14
<i>Standard Soil Control Study^e</i>			
Control ^f	91.1	NT ^g	NT
SGRCP-1	78.3	NT	NT
SGRCP-2	79.2	NT	NT
SGRCP-6	81.7	NT	NT
SGRCP-7	78.3	NT	NT
SGRCP-9	69.2 ^h	NT	NT
SGRCP-10	80.0	NT	NT
SGRCP-13	87.5	NT	NT
SGRCP-15	80.0	NT	NT
SGRCP-16	80.8	NT	NT
SGRCP-24	82.5	NT	NT

^a Toxicity study by Phillips and Checkai (1995).

^b Positive control (Winters Run soil with an added spike of 1,000 µg copper/g soil).

^c Negative control (Winters Run soil with no added spike).

^d NA = not applicable; no specimens available for measurement because SER was 0.

^e Toxicity study by ESI (1995).

^f Control = standard soil consisting of 10% screened sphagnum moss, 20% kaolinite clay, and 70% fine clean silica sand (by weight). The pH of the soil was within the range of 5.0 to 9.0.

^g NT = not tested.

^h SER was significantly lower than in standard soil (Student's *t*-test, $P < 0.05$).

The species richness of the RCP AOC transect was higher than the maximum species richness of the reference transects, and the species diversity was slightly below the mean diversity for the reference transects (yet higher than that in half the transects). These results indicate that on the basis of species richness and species diversity, the vegetation community within the forested portion of the RCP AOC does not show evidence of negative effects from soil contamination.

In September 1995, aboveground biomass of herbaceous vegetation collected from ten 0.25-m² plots in and around the pit was oven-dried at 70°C for 72 hours and weighed to the nearest 0.01 g (Table 6.45). (Figure A.5 in Appendix A). Biomass ranged from 0.0 to 27.71 g/0.1 m² and averaged 9.27 g/0.1 m². Table 6.45 lists the biomass values for each plot. Biomass was significantly lower in plots SGRCP-6, -7, and -9 than in the rest of the AOC. Several factors may be responsible for this

TABLE 6.44 Species Richness and Diversity Indices for RCP B6 and Reference Transects

Transect	Species Richness ^a	Diversity (H) ^b
<i>RCP Transect B6</i>		
Individual Plots		
Mean	8	1.82
Maximum	11	2.21
Minimum	4	1.10
Transect	19	2.60
<i>Reference Transects</i>		
A	10	1.74
B	12	2.93
C	14	3.46
D	15	2.48
Mean	13	2.65

^a Richness = number of species.

^b H = Shannon-Weiner diversity index.

TABLE 6.45 Biomass and Soil Chemistry for Sampling Points in the Riot Control Pit Area

Sampling Point ^a	Biomass (g/0.1 m ²)	Total Metals (mmol/kg)	Phosphorus (mg/kg)	Potassium (mg/kg)	Calcium (mg/kg)	Magnesium (mg/kg)
SGRCP-1	17.52	- ^b	-	-	-	-
SGRCP-2	9.02	-	-	-	-	-
SGRCP-6	0.0	2.7826	15	86	1,150	99.5
SGRCP-7	0.0	-	-	-	-	-
SGRCP-9	0.56	5.3466	7	44.5	1,030	121.5
SGRCP-10	5.80	-	-	-	-	-
SGRCP-13	27.71	-	-	-	-	-
SGRCP-15	9.46	-	-	-	-	-
SGRCP-16	5.08	-	-	-	-	-
SGRCP-24	17.55	-	-	-	-	-

^a See Figure A.5 for sample point locations.

^b - = no soil chemistry analyses were conducted.

condition, including soil contamination, soil disturbance, or reduced nutrient uptake. The total soil concentrations of heavy metals at two plots (SGRCP-6 and -9) with reduced biomass (Table 6.45), although higher than those at the reference site (1.5-2.1), were lower than those found at locations such as TBTC (5.9-11.0) or the scattered TBP plots (2.8-115.0) that supported much greater biomass but similar habitat. Thus, the total heavy-metal concentration alone does not explain the lower biomass production. Macronutrients at SGRCP-6 and -9 were similar to those at the reference site, except for elevated calcium levels.

6.3.6 Vertebrate Surveys

6.3.6.1 Amphibians

No specific surveys of amphibians were conducted at the RCP AOC because these areas contained standing water only for short periods of time. However, larvae of ambystomid salamanders and frogs were observed while sampling was being conducted for toxicology tests and analytical chemistry, indicating that the RCP AOC serves as reproductive habitat for amphibian species.

6.3.6.2 Birds

No bird surveys specific to the RCP AOC were conducted, although many of the species observed in other areas are likely to be found here because of the offshore, wooded, wetland, and old-field habitats nearby. Bird species noted during surveys at nearby Rickett's Point (Figure 6.1) included osprey, bald eagle, mourning dove, red-bellied woodpecker, downy woodpecker, olive-sided flycatcher, great-crested flycatcher, American robin, white-eyed vireo, song sparrow, and white-throated sparrow (Johnson 1995). A pair of tree swallows occupied a nest box placed within the RCP AOC and subsequently produced four fledglings (Johnson 1995).

6.3.6.3 Small Mammals

Mammal species likely to occur at the TBP AOC (Section 6.1.6.3) are also likely to be found in the RCP AOC because similar habitats are available nearby. Small mammals were trapped at the RCP AOC to obtain chemical analyses of tissues. Young, young adult, and adult white-footed mice were collected.

6.3.7 Summary

The assessment of ecological effects at the RCP AOC included the following:

- Quantitative evaluations of soil invertebrate abundance and community composition;
- Qualitative surveys of wetland (Appendix C) and upland vegetation;
- Qualitative surveys of aquatic and terrestrial invertebrates;
- Quantitative evaluations of the physiological parameters of soil invertebrates, such as enzyme activity and respiration rates, and soil invertebrate-mediated processes, such as litter decomposition and nitrogen mineralization; and
- Toxicity tests of site soils, sediments, and surface waters on a variety of invertebrates, vertebrates, and plants.

The RCP AOC contains only ephemeral surface waters, primarily ponded water in the trench. Qualitative surveys of these habitats revealed several zooplankton and diptera taxa and amphipods. Because the aquatic habitats are ephemeral, no extensive aquatic communities or fish were found.

No qualitative vertebrate surveys were conducted at the AOC. However, during surface water and sediment sampling for toxicity testing, ambystomid salamander and frog larvae were observed in the ephemeral surface water bodies. Local amphibian populations use these habitats for reproduction. Juvenile and adult white-footed mice were collected for tissue analysis; none of the specimens exhibited any external abnormalities (lesions or tumors). A pair of tree swallows used a nest box placed in the RCP AOC to fledge four young.

The soil invertebrate surveys showed no significant differences in the activity of epigeic invertebrates between the main trench and local background sites. However, significant differences in nematode abundance and trophic structure were observed. The soil microbial biomass nitrogen pool at the trench site was 50% lower than that measured at the local background site.

Evaluations of active and total fungal and bacterial biomass showed no reductions in active biomass at the RCP AOC compared with the off-site reference location, although total fungal biomass was lower at the RCP AOC than at the reference site. No significant differences were observed between the RCP AOC and the reference site in the activities of three different nutrient-acquiring enzymes or in SIR. Litter decomposition was significantly slower at the trench than at the local background site; nitrogen mineralization rates were also reduced in trench samples.

Toxicity testing of aquatic media found no acute or chronic toxicity of surface water or sediment to bacteria (Microtox), zooplankton, floating vascular plants, amphipods, or amphibian larvae. Surface water showed chronic toxicity to the green alga *Selenastrum*.

Earthworm survival was not affected by soils from the AOC, although earthworms tested with soil from the trench exhibited a 6% mean weight loss when the tests were completed. In contrast, earthworms tested in negative control soils and soils collected from north of the suspect previous trench exhibited a mean weight increase in excess of 6%. Soil toxicity testing to evaluate lettuce seed emergence, growth, and survival showed a 0% SER for soils from north of the suspect previous trench. Seed emergence rates for all other tested locations ranged from 78% to 87%; the SER was only 65% for the negative control sample and 91% for the standard control soil. Seedling height and weight were measured for plants grown in soil from north of the suspect previous pit, and no adverse effects were identified.

6.4 SOUTH BEACH TRENCH

The assessment of ecological effects at the SBT AOC was less intensive than for other AOCs because of its small size and limited wildlife habitat. The evaluations conducted included (1) quantitative surveys of soil-dwelling and epigeic invertebrates; (2) qualitative surveys of amphibians; (3) quantitative evaluations of the physiological parameters of soil invertebrates (enzyme activity and respiration rates); (4) toxicity tests of site soils, sediments, and surface waters on a variety of invertebrates, vertebrates, and plants; and (5) evaluation of the biomass of herbaceous vegetation. The results of these effects assessments are presented in Sections 6.4.1 through 6.4.6; details regarding the assessment methods are presented in Appendix A.

6.4.1 Aquatic Habitats

The main trench in the SBT AOC contains water only during wetter periods of the year. It typically is completely dry in late spring through fall except during short periods after major storms. Consequently, no aquatic organisms are present in this AOC during most of the year.

6.4.1.1 Aquatic Invertebrates and Fish

Although invertebrates were not targeted for collection in this location, a variety of taxa were observed during other sampling activities. These taxa were similar to those found at other ephemeral habitats at J-Field and included cladocerans, copepods, amphipods, and midge and mosquito larvae. Because of the ephemeral nature of the aquatic habitat in the SBT AOC, no fish are present.

6.4.1.2 Aquatic Toxicity

Table 6.24 presents the results of toxicity testing of surface water and sediments from the SBT AOC. Microtox screening of surface water and sediment from location SBT-1 (Figure 6.1) detected no significant inhibition compared with laboratory controls. Survival of *Daphnia* and *Pimephales* larvae was not significantly affected by acute (48-hour) exposure to water from location SBT-1, and survival of *Rana* larvae was not significantly affected during 96-hour exposures. No chronic effect of surface water from SBT-1 on *Lemna* production was observed, although a chronic effect was seen on *Selenastrum* (55% inhibition after 96 hours). No significant effect on *Ceriodaphnia* survival or reproduction was observed after 7 days of exposure. *Hyalella* experienced no significant mortality and no significant decrease in growth after 10- and 28-day exposures to sediments from this location.

6.4.2 Soil Biota

6.4.2.1 Soil Invertebrate Community

The soil invertebrate community in the SBT AOC was surveyed in the summer of 1994. Figure A.8 in Appendix A shows the locations of sampling points. No adverse effects on this community were observed. Total numbers of soil-dwelling macroinvertebrates from the trench area were not significantly different from those at the reference site (RSB) at Gunpowder Falls State Park (Table 6.46). The number of taxa of soil macroinvertebrates in the SBT AOC was almost twice that in the reference site. The total numbers of nematodes and surface-inhabiting invertebrates were not significantly different between the two sites.

6.4.2.2 Soil Microbial Biomass

The soil microbial community in the SBT AOC was surveyed in the spring of 1994. No adverse effects on the soil microbial community were observed. Average FDA-active fungal and bacterial biomass and total fungal and bacterial biomass at the SBT AOC were significantly higher than those at the reference site (RSB) at Gunpowder Falls State Park (Table 6.47). Soil protozoa were not affected at the SBT AOC. The number of amoebae was significantly higher than that at the reference site, but the numbers of flagellates and ciliates were not significantly different (Table 6.47).

TABLE 6.46 Total Abundance (mean $\pm$ SE) and Activity of Soil Invertebrates at the South Beach Trench Area and the Reference Site

Taxa	South Beach Trench ^a	Reference Site (RSB) ^b
Lumbricidae	292.1 $\pm$ 56.5	- ^c
Gastropoda	16.9 $\pm$ 8.1	-
Isopoda	114.3 $\pm$ 36.2	-
Lithobiomorpha	42.3 $\pm$ 14.2	-
Geophilomorpha	50.8 $\pm$ 14.7	93.1 $\pm$ 93.1
Symphyla	29.6 $\pm$ 13.3	-
Diplopoda	-	139.7 $\pm$ 139.7
Pseudoscorpionidae	4.2 $\pm$ 4.2	-
Aranea	33.9 $\pm$ 13.6	46.6 $\pm$ 46.6
Diplura	50.8 $\pm$ 18.1	-
Diptera larvae	38.1 $\pm$ 15.2	186.2 $\pm$ 46.6
Formicidae	313.2 $\pm$ 125.6	3538.6 $\pm$ 3538.6
Isoptera	72.0 $\pm$ 50.2	-
Hemiptera	8.5 $\pm$ 8.5	-
Psocoptera	4.2 $\pm$ 4.2	-
Lepidoptera larvae	4.2 $\pm$ 4.2	46.6 $\pm$ 46.6
Elateridae	16.9 $\pm$ 8.1	139.7 $\pm$ 80.4
Scarabaeidae	67.7 $\pm$ 29.9	139.7 $\pm$ 80.4
Curculionidae	12.7 $\pm$ 12.7	4.6 $\pm$ 4.6
Carabidae	29.6 $\pm$ 11.8	-
Staphylinidae	38.1 $\pm$ 15.2	93.1 $\pm$ 46.6
Other coleoptera	67.72 $\pm$ 16.2	93.1 $\pm$ 93.1
Other insects	-	46.6 $\pm$ 46.6
Total soil macroinvertebrates (number/m ²)	1347 $\pm$ 203	4658 $\pm$ 3182 ^d NS ^e
Total surface macroinvertebrates (number/trap/d)	24.97 $\pm$ 2.48	29.25 $\pm$ 1.44 ^f NS ^e
Total soil nematodes (number/g DW soil)	33.22 $\pm$ 5.71	55.98 $\pm$ 10.87 ^g NS ^e

^a $n = 11$.^b Reference site located at Gunpowder Falls State Park.^c - = not collected.^d $n = 3$.^e NS = no significant difference (t -test) at $P = 0.05$.^f $n = 4$.^g $n = 9$.

TABLE 6.47 Microbial Biomass Parameters (mean $\pm$ SE) of Soils at the South Beach Trench Area and the Reference Site, Spring 1995

Microbial Parameter	South Beach Trench ^a	Reference Site (RSB) ^b	Significance
FDA-active fungal biomass ($\mu\text{g/g DW}$)	6.53 $\pm$ 2.39	0.58 $\pm$ 0.15 ^c	$P = 0.0162^d$
Total fungal biomass ($\mu\text{g/g DW}$)	841.96 $\pm$ 191.86	366.24 $\pm$ 51.64 ^c	$P = 0.0052^d$
FDA-active bacterial biomass ($\mu\text{g/g DW}$)	2.42 $\pm$ 0.66	1.07 $\pm$ 0.12 ^c	NS ^{e,f}
Total bacterial biomass ($\mu\text{g/g DW}$)	11.08 $\pm$ 2.04	2.69 $\pm$ 0.24 ^c	$P = 0.0021^g$
Flagellates (number/g DW)	3236.96 $\pm$ 2331.12	563.79 $\pm$ 267.63 ^h	NS
Amoebae (number/g DW)	423.49 $\pm$ 162.89	86.54 $\pm$ 21.20 ^h	$P = 0.0350^d$
Ciliates (number/g DW)	12.16 $\pm$ 7.51	9.43 $\pm$ 3.84 ^h	NS

^a $n = 11$.

^b Reference site located at Gunpowder Falls State Park.

^c $n = 9$.

^d t -test on natural log-transformed data.

^e NS = not significant ($P > 0.05$).

^f Mann-Whitney test.

^g t -test on untransformed data.

^h $n = 7$.

6.4.3 Soil Processes

Biologically mediated soil processes in the SBT AOC were surveyed in the spring of 1994. Figure A.8 in Appendix A shows the locations of sampling points. No adverse effects on soil microbial activity were observed. The activity of dehydrogenase, acid phosphatase, and N-acetylglucosaminidase in the SBT AOC was not significantly different from that at the reference site (RSB) at Gunpowder Falls State Park (Table 6.48). The SIR rates were similar at both sites (Table 6.48).

6.4.4 Soil Toxicity

Seed emergence rate (SER) was used as the index of toxicity in the phytotoxicity test. Table 6.49 presents the results of the soil phytotoxicity screening with lettuce seeds. Figure A.8

TABLE 6.48 Enzyme Activity and Substrate-Induced Respiration (SIR) (mean $\pm$ SE) in Soils at the South Beach Trench Area and the Reference Site, Spring 1995

Microbial Activity Parameter	South Beach Trench ^a	Reference Site (RSB) ^b	Significance
Dehydrogenase ($\mu\text{mol/g/h}$)	0.014 $\pm$ 0.004	0.014 $\pm$ 0.011	NS ^c
Acid phosphatase ($\mu\text{mol/g/h}$)	0.739 $\pm$ 0.147	0.848 $\pm$ 0.151	NS
N-acetylglucosaminidase ($\mu\text{mol/g/h}$)	0.128 $\pm$ 0.027	0.176 $\pm$ 0.049	NS
SIR ($\mu\text{g/g/min}$)	0.140 $\pm$ 0.017	0.143 $\pm$ 0.002	NS

^a $n = 11$.

^b Reference site located at Gunpowder Falls State Park; $n = 9$, except SIR with $n = 5$.

^c NS = not significant $P > 0.05$ (Student's t -test).

shows the locations of sampling points in the SBT AOC. The SERs for soil from SGSBT-1 and SGSBT-2 located within the trench were 73.3% and 60.8%, respectively. The remaining samples had SERs greater than 75%. Although this may be indicative of greater soil contamination within the pit, other factors (e.g., soil structure) may also be the cause for lower SERs.

6.4.5 Terrestrial Vegetation Surveys

Terrestrial vegetation near the SBT AOC consists of an extensive mature upland forest extending from the marsh along the Gunpowder River and Chesapeake Bay to the marsh associated with the TBP AOC. The dominant tree species are sweetgum and red maple, and *Microstegium vimineum* dominates the herbaceous stratum. This area is relatively open with very little understory or shrub layer.

In September 1995, aboveground biomass (herbaceous vegetation only) was collected from five 0.25-m² plots in the AOC.

TABLE 6.49 Phytotoxicity Screening of Soils from the South Beach Trench Area

Sample Site	SER (%)
Control ^a	91.1
SGSBT-1	73.3
SGSBT-2	60.8 ^b
SGSBT-3	81.7
SGSBT-5	89.2
SGSBT-9	84.2
SGSBT-28	84.2

^a Control = standard soil consisting of 10% screened sphagnum moss, 20% kaolinite clay, and 70% fine clean silica sand (by weight). The pH of the soil was written the range of 5.0 to 9.0.

^b SER significantly different from control soil (Tukey method, $P < 0.05$).

Source: ESI (1995).

Figure A.8 in Appendix A shows the collection locations. Biomass ranged from 0.0 to 4.874 g/0.1 m² and averaged 1.887 g/0.1 m² (Table 6.50). Biomass was much lower in plots SGSBT-1 and -2 than in other plots at the AOC. The reduced biomass may have resulted from several factors, including soil contamination, soil disturbance, or reduced nutrient uptake.

6.4.6 Vertebrate Surveys

6.4.6.1 Amphibians

Frog species seen or heard during amphibian surveys included the southern leopard frog (Johnson 1995).

6.4.6.2 Birds

Birds did not use the nest box placed in the SBT AOC during the 1995 study period (Johnson 1995). No bird surveys were conducted at the SBT AOC.

6.4.6.3 Small Mammals

Mammal species likely to occur at the TBP AOC (Section 6.1.6.3) are also likely to be found in the SBT AOC because similar habitats are available nearby. No small mammals were trapped at the SBT AOC, although a single white-footed mouse was captured in a minnow trap placed in the SBT to capture frogs for analyzing chemical residues (Johnson 1995).

6.4.7 Summary

The assessment of ecological effects at the SBT AOC was less intensive than that for other AOCs, such as the TBP and RCP AOCs, because of the small size of this AOC and its limited wildlife habitat. The assessment included the following:

- Quantitative surveys of soil-dwelling and epigeic invertebrates;
- Qualitative surveys of amphibians;

TABLE 6.50 Biomass for Sampling Plots in the South Beach Trench Area

Plot	Biomass (g/0.1 m ²)
SGSBT-1	0.0
SGSBT-2	0.104
SGSBT-3	1.826
SGSBT-5	2.632
SGSBT-9	4.874
Mean	1.887
Minimum	0.0
Maximum	4.874

- Quantitative evaluations of the physiological parameters of soil invertebrates (enzyme activity and respiration rates);
- Toxicity tests of site soils, sediments, and surface waters on invertebrates, vertebrates, and plants; and
- Evaluation of herbaceous vegetation biomass.

Because the aquatic habitats at the site are ephemeral (primarily ponded water in the trench), no fish and only a limited aquatic invertebrate community are expected to be found at the SBT AOC. Thus, no surveys of fish or aquatic invertebrates were conducted. However, a variety of invertebrate taxa were observed at the site, including zooplankton, amphipods, and diptera larvae.

No significant differences in the abundance of soil-dwelling macroinvertebrates, epigeic macroinvertebrates, or soil nematodes were found between the AOC and the reference site. Active and total fungal and bacterial biomasses were higher at the AOC than at the reference site. The SBT AOC also had a greater abundance of soil protozoa than the reference site. No differences in the activity of nutrient-acquiring enzymes or soil respiration rates were detected between the AOC and the reference site.

Toxicity evaluations included acute and chronic tests on bacteria (Microtox), floating vascular plants, zooplankton, amphipods, fish, and amphibians. Except for the green alga *Selenastrum*, no toxicity to aquatic biota was indicated for surface water or sediment from the trench. Growth inhibition was indicated for *Selenastrum* following chronic exposure to surface water. Toxicity testing of soils evaluated seed emergence of lettuce; some toxicity was indicated for soils collected directly from the trench. The SERs for soils from these locations were 61% and 73%, whereas the SERs were greater than 80% at all other locations and 91% for control soils.

Surveys of amphibians identified only the southern leopard frog; few amphibians were expected because of the temporal nature of the aquatic habitats at this AOC. No birds used the nest placed at the site to evaluate nesting success. However, the lack of use was most likely due to factors other than contaminant effects.

6.5 SOUTH BEACH DEMOLITION GROUND

The SBDG AOC currently consists of a single large crater and a small fringe of shoreline habitat. Because of the small size of this AOC, the assessment of ecological effects at the SBDG AOC was limited to (1) qualitative surveys of fish and amphibians; and (2) toxicity tests of site sediments and surface waters on a variety of invertebrates, vertebrates, and plants. The results of

these assessments are presented in Sections 6.5.1 through 6.5.3, and details regarding the assessment methods are presented in Appendix A.

6.5.1 Aquatic Habitats

Although most of the SBDG AOC is now offshore of J-Field (and therefore outside the scope of this ERA) because of erosion, a single large crater remains near the shoreline that is probably related to past activities at this AOC. This crater now contains marsh vegetation and appears to contain water throughout the year.

6.5.1.1 Aquatic Invertebrates and Fish

Although no invertebrate surveys were conducted for the crater in the SBDG AOC, a variety of taxa (such as cladocerans, copepods, midge and mosquito larvae, amphipods, and water mites) were observed during other sampling activities. No fish were observed in the crater, and no fish were collected in baited minnow traps placed overnight in the crater.

6.5.1.2 Aquatic Toxicity

Table 6.24 presents the results of toxicity testing of surface water and sediments from the SBDG crater (location SBDGSW-1). Exposure to surface water from this location resulted in no significant reduction in survival of *Daphnia* after 48 hours or *Rana* larvae after 96 hours, or in *Lemna* production after 96 hours. However, *Hyalella* survival and growth was significantly lower than in controls after exposure to sediments for 28 days.

6.5.2 Terrestrial Vegetation Surveys

The terrestrial vegetation near the SBDG AOC includes the deciduous upland forest discussed in Section 6.4.5. The remainder of the AOC consists of unvegetated beach or subtidal areas. Because of the proximity of the SBT AOC to the SBDG AOC, the vegetation analysis in Section 6.4.5 also applies to the SBDG AOC.

6.5.3 Vertebrate Surveys

6.5.3.1 Amphibians and Reptiles

The crater in the SBDG AOC contained *Rana* larvae and adults (leopard frog and pickerel frog) during spring and summer 1995. Red-spotted newts and spotted salamanders (*Ambystoma maculatum*) were observed in the crater during amphibian surveys (Johnson 1995). In addition, turtles were observed at this location on several occasions.

6.5.3.2 Birds

No bird surveys were conducted at the SBDG AOC, although the similarity of nearby habitats to those at other AOCs where surveys were conducted suggests that similar bird species are likely to be found there.

6.5.3.3 Small Mammals

Mammal species likely to occur at the TBP AOC (Section 6.1.6.3) are also likely to be found near the SBDG AOC because similar habitats are available nearby. No small mammals were trapped near the SBDG AOC.

6.5.4 Summary

The assessment of ecological effects at the SBDG was limited because most of the site is now offshore in Chesapeake Bay. The assessment focused on the large detonation crater located onshore, north of the RPDG AOC. Activities included sampling for fish with traps, qualitative surveys of amphibians, and acute and chronic toxicity testing of surface water and sediment from the crater.

Although the ponded water in the crater appears permanent, no fish were collected in the traps. The absence of fish was not unexpected, given the small size and isolation (no immigration routes from fish source areas because of a lack of connection to the bay) of the pond. Although no aquatic invertebrate surveys were conducted, several taxa were observed, including zooplankton, amphipods, and diptera larvae.

Amphibian surveys found *Rana* larvae and adults inhabiting the pond, as well as adult red-spotted newts and spotted salamanders. The presence of both adult and larval *Rana* suggests that

this genus uses the pond for reproduction. Adult newts and salamanders typically dwell on forest floors and migrate to fishless ponds to reproduce. Their presence in the detonation crater indicates the use of this habitat for reproduction. Several turtles were also observed in the pond, but they were not identified to species.

No toxicity was indicated for surface water at the pond. Results did not differ from control results for acute (zooplankton and *Rana* larvae) and chronic (*Lemna*) surface water toxicity tests. In contrast, chronic sediment toxicity tests showed significantly lower survival and growth in the amphipod *Hyaella*.

6.6 ROBINS POINT DEMOLITION GROUND

The assessment of ecological effects at the RPDG AOC included (1) quantitative evaluations of soil invertebrate abundance and bacterial and fungal biomass; (2) qualitative surveys of wetland (Appendix C) and upland vegetation; (3) qualitative surveys of amphibians and birds; (4) quantitative evaluations of the physiological parameters of soil invertebrates (enzyme activity and respiration rates); and (5) toxicity tests of site soils, sediments, and surface waters on a variety of invertebrates, vertebrates, and plants. The results of these assessments are presented in Sections 6.6.1 through 6.6.6, and details regarding the assessment methods are presented in Appendix A.

6.6.1 Aquatic Habitats

The area to the east of the berm along the eastern edge of the RPDG received the most attention because the area west of the berm is still used for disposing of unexploded ordnance. Aquatic habitats at the RPDG AOC consist of pools that form to the west (the active side, location DGD-1 in Figure 6.1) and to the east (the inactive side, location DGD-2 in Figure 6.1) of the berm at the eastern edge of the RPDG. They consist of several craters in the cleared area on the eastern side of the berm. Although these areas remain moist most of the year, standing water is present only during wetter seasons. In addition, marsh wetlands are located between the cleared area to the east of the berm and the Bush River farther to the east.

6.6.1.1 Aquatic Invertebrates and Fish

Invertebrate surveys were not conducted in the pools that form at the RPDG AOC. However, several taxa (such as cladocerans, copepods, midge and mosquito larvae, and water mites) were observed during other sampling activities. The communities appeared similar to those found in other ephemeral aquatic habitats at J-Field. Because of the ephemeral nature of the aquatic habitat in the RPDG AOC, no fish were present.

6.6.1.2 Aquatic Toxicity

Table 6.24 presents the results of toxicity testing of surface water and sediments from the RPDG AOC; Figure 6.1 shows the sample locations. Microtox activity was not significantly inhibited by surface water from locations DGD-1 and DGD-2. However, Microtox activity was significantly inhibited in the elutriate from sediments collected from both locations. *Daphnia* survival was significantly reduced after exposure to surface water from location DGD-1 (active side of the berm) but was not affected after 48 hours of exposure to surface water collected from DGD-2 (inactive side of the berm). Survival of *Rana* larvae was not affected during acute 96-hour exposures to surface water from location DGD-2, and *Ceriodaphnia* showed no significant effect of surface water from DGD-2 during chronic exposures. The effect of surface water from DGD-1 on these species was not tested. Although *Lemna* production was not affected by exposure to surface water from locations DGD-1 and DGD-2, *Selenastrum* production was significantly lower than in laboratory controls after a 96-hour exposure to surface water from both locations. The effects of sediments from the RPDG AOC on *Hyalella* survival and reproduction were not evaluated.

6.6.2 Soil Biota

6.6.2.1 Soil Invertebrate Community

The soil invertebrate community in the RPDG AOC was surveyed in the summer of 1995. Figure A.6 in Appendix A shows the locations of sampling points in the RPDG AOC. No adverse effects on the soil invertebrate community were observed. The total numbers of soil macroinvertebrates were not significantly different from those at the reference site (RSA) at Gunpowder Falls State Park (Table 6.51). The number of soil macroinvertebrate taxa was higher in the RPDG AOC than in the reference site. Total abundance of nematodes was not significantly different between the two sites. The activity of surface-inhabiting arthropods was significantly higher ($P < 0.05$) at the RPDG AOC than at the reference site.

6.6.2.2 Soil Microbial Biomass

No adverse effects on the RPDG AOC soil microbial community were observed in the spring survey. Total fungal biomass was significantly higher ($P < 0.01$) at the RPDG AOC than at the reference site (Table 6.52). Total bacterial biomass was not significantly different between the two sites. In contrast, the FDA-active fungal and bacterial biomasses were significantly lower at the RPDG AOC (Table 6.52). However, the decrease in FDA-active biomass represents that portion of the total microbial biomass responding to current environmental conditions such as rainfall, whereas

TABLE 6.51 Total Abundance (mean $\pm$ SE) and Activity of Soil Invertebrates at the Robins Point Demolition Ground Area and the Reference Site

Taxa	Robins Point Demolition Ground ^a	Reference Site (RSA) ^b
Lumbricidae	17.5 $\pm$ 61.5	139.7 $\pm$ 139.7
Isopoda	- ^c	745.0 $\pm$ 610.6
Lithobiomorpha	5.8 $\pm$ 5.8	46.6 $\pm$ 46.6
Geophilomorpha	5.8 $\pm$ 5.8	-
Symphyla	40.7 $\pm$ 21.4	-
Diplopoda	-	46.6 $\pm$ 46.6
Aranea	-	273.8 $\pm$ 46.6
Diplura	17.5 $\pm$ 12.8	698.4 $\pm$ 241.9
Diptera larvae	46.6 $\pm$ 26.1	-
Formicidae	1804.2 $\pm$ 826.7	325.9 $\pm$ 259.2
Isoptera	163.0 $\pm$ 96.1	-
Hemiptera	-	46.6 $\pm$ 46.6
Scarabaeidae	5.8 $\pm$ 5.8	-
Curculionidae	5.8 $\pm$ 5.8	-
Carabidae	29.1 $\pm$ 23.8	-
Staphylinidae	5.8 $\pm$ 5.8	512.2 $\pm$ 512.2
Other coleoptera	29.1 $\pm$ 11.8	-
Other insects	11.6 $\pm$ 8.1	-
Total soil macroinvertebrates (number/m ²)	2,205 $\pm$ 850	2,964 $\pm$ 1,765 ^d NS ^e
Total surface macroinvertebrates (number/trap/d)	131.15 $\pm$ 30.47	24.0 $\pm$ 1.58 ^f S ^g
Total soil nematodes (number/g soil DW)	8.27 $\pm$ 1.83	7.34 $\pm$ 0.81 ^h NS ^e

^a $n = 8$.

^b Reference site located at Gunpowder Falls State Park.

^c - = not collected.

^d $n = 3$.

^e NS = not significant ($P > 0.05$).

^f $n = 4$.

^g S = significantly different at $P < 0.05$.

^h $n = 9$.

TABLE 6.52 Microbial Biomass Parameters (mean $\pm$ SE) of Soils at the Robins Point Demolition Ground Area and the Reference Site, Spring 1995

Microbial Parameter	Robins Point Demolition Ground ^a	Reference Site (RSA)	Significance
FDA-active fungal biomass ($\mu\text{g/g DW}$)	0.60 ± 0.38	5.03 ± 1.25^b	$P = 0.0021^c$
Total fungal biomass ($\mu\text{g/g DW}$)	709.28 ± 70.07	242.59 ± 31.31^b	$P = 0.0001^d$
FDA-active bacterial biomass ($\mu\text{g/g DW}$)	0.38 ± 0.07	3.83 ± 0.19^b	$P = 0.0001^d$
Total bacterial biomass ($\mu\text{g/g DW}$)	5.50 ± 0.53	6.02 ± 0.79^b	NS ^e
Flagellates (number/g DW)	2332.1 ± 1052.7	11169.7 ± 2421.8^f	$P = 0.0092$
Amoebae (number/g DW)	6488.3 ± 5921.0	837.43 ± 400.16^f	NS ^e
Ciliates (number/g DW)	10.01 ± 5.81	462.72 ± 386.04^f	$P = 0.0028$

^a $n = 8$.

^b $n = 9$.

^c Mann-Whitney test.

^d t -test on untransformed data.

^e NS = not significant ($P > 0.05$).

^f $n = 7$.

total biomass represents both living and dead microbial cells that accrue over a longer period and is a more representative indicator of the effects of long-term soil disturbance.

Soil protozoa were affected at the RPDG AOC. The numbers of flagellates and ciliates were significantly higher at the reference site (Table 6.52). Although amoebae were more abundant at the RPDG AOC than at the reference site, the difference was not statistically significant.

6.6.3 Soil Processes

Biologically mediated soil processes in the RPDG AOC were quantified in the spring of 1994. Figure A.6 in Appendix A shows the locations of sampling points in the RPDG AOC. There were indications that soil microbial activity was adversely affected in this area. Dehydrogenase activity and SIR rates in the RPDG AOC were significantly lower ($P < 0.001$) than those in the reference site (Table 6.53). There was no significant difference ($P > 0.05$) in the activity of acid phosphatase and N-acetyl-glucosaminidase between the RPDG AOC and the reference site.

TABLE 6.53 Enzyme Activity and Substrate-Induced Respiration (SIR) (mean $\pm$ SE) in Soils at the Robins Point Demolition Ground Area and the Reference Site, Spring 1995

Microbial Activity Parameter	Robins Point Demolition Ground ^a	Reference Site (RSA) ^b	Significance
Dehydrogenase ($\mu\text{mol/g/h}$)	0.0013 $\pm$ 0.0006	0.039 $\pm$ 0.013	$P = 0.0002^c$
Acid phosphatase ($\mu\text{mol/g/h}$)	0.914 $\pm$ 0.114	1.087 $\pm$ 0.075	NS ^d
N-acetylglucosaminidase ($\mu\text{mol/g/h}$)	0.154 $\pm$ 0.018	0.166 $\pm$ 0.021	NS
SIR ($\mu\text{g/g/min}$)	0.097 $\pm$ 0.006	0.363 $\pm$ 0.004	$P < 0.0001$

^a $n = 8$.

^b $n = 9$, except SIR with $n = 5$.

^c Analyses were performed on natural log-transformed data.

^d NS = not significant ($P > 0.05$).

6.6.4 Soil Toxicity

The SER was used as the index of toxicity in the phytotoxicity test. Table 6.54 presents the results of the soil phytotoxicity screening with lettuce seeds. Figure A.6 in Appendix A shows the locations of sampling points. Fifty percent of the samples from the RPDG AOCs showed toxic effects (SER less than 75%). The SERs for soils from locations RPDG-3 and RPDG-7 were 55.8% and 31.7%, respectively. The remaining samples had SERs of 80% or higher, and the SER for the control sample was 91%.

6.6.5 Terrestrial Vegetation Surveys

Terrestrial vegetation near the RPDG AOC includes extensive upland deciduous forest to the north and south of the demolition area. The dominant tree species include sweetgum, red maple, oak, and hickory. Much of the active

TABLE 6.54 Phytotoxicity Screening of Soils from Robins Point Demolition Ground

Sample Site	SER (%)
Control ^a	91.1
RPDG-3	55.8 ^b
RPDG-7	31.7 ^b
SGRPDG-1	83.3
SGRPDG-3	80.0

^a Control = standard soil consisting of 10% screened sphagnum moss, 20% kaolinite clay, and 70% fine clean silica sand (by weight). The pH of the soil was within the range of 5.0 to 9.0.

^b SER significantly different from control soil (Student's *t*-test, $P < 0.05$).

Source: ESI (1995).

portion of the AOC consists of scattered grasses and forbs that form an increasingly dense community toward the periphery of the AOC. An upland herbaceous community lies between the demolition ground berm and the large marsh along the Bush River.

In June 1995, two transects (B1 and B2) were established at the AOC (Figure A.1). The first transect (200 m long) was located in the deciduous forest north of the demolition area, near Area D, and consisted of 10 data plots. The second transect (300 m long) was in an old-field community and extended from the large marsh east of the AOC to the demolition ground berm. The second transect consisted of eight data plots. Data were collected from 0.5-m² plots at 2-m intervals and included species name, percent cover, and stratum. Relative cover was calculated for each species in each plot. Shannon-Weiner diversity indices, which incorporate species richness and evenness, were calculated for each plot. Table D.10 presents species name, stratum, percent cover, relative cover, and diversity indices for individual plots.

Species diversity calculated over the entire upland portion of the first transect was 2.93; the diversity of individual plots averaged 1.76 and ranged from 0.99 to 2.12. Twelve species were identified (Table 6.55). Diversity indices were compared with a reference set of diversity indices for deciduous forest in other areas of APG (see Section 6.3.5). Species diversity of the RPDG was higher than the mean species diversity of the reference transects (2.65), but below the maximum (3.46). Species richness for the RPDG was slightly below the mean species richness of the reference transects (13), but above the minimum (10). These results present no conclusive evidence of negative effects on species richness and diversity due to soil contamination in the vegetation community along transect B1, even though the area along the transect was covered by detonation craters from past activities.

Species diversity of individual plots along the upland portion of transect B2 averaged 2.33 and ranged from 1.58 to 3.16 (Table 6.56). A *t*-test compared the diversity of this transect with that of the old-field reference site

TABLE 6.55 Species Richness and Diversity Indices for RPDG B1 and Reference Transects

Transect	Species Richness ^a	Diversity (H) ^b
<i>RPDG Transect B1</i>		
Individual Plots:	NA ^c	
Mean		1.76
Maximum		2.12
Minimum		0.99
Transect	12	2.93
<i>Reference Transects</i>		
A	10	1.74
B	12	2.93
C	14	3.46
D	15	2.48
Mean	13	2.65

^a Richness = number of species.

^b H = Shannon-Weiner diversity index.

^c NA = not applicable.

TABLE 6.56 Species Richness and Diversity Indices at the RPDG Transect B2 Plots and the Reference Site Plots

B2 Plot	Reference Plot	Species Richness ^a		Diversity (H) ^b	
		B2	Reference	B2	Reference
D	1	5	4	1.58	0.74
C	4	9	5	1.86	0.92
E	6	8	5	2.04	1.22
A	10	9	5	2.33	1.29
G	3	11	7	2.40	1.36
F	5	12	6	2.51	1.36
H	9	9	5	2.74	1.43
B	7	1	6	3.16	1.43
	8	NA ^c	5	NA	1.56
	2	NA	9	NA	1.66
Mean		9.25	5.7	2.33	1.30

^a Richness = number of species.

^b H = Shannon-Weiner diversity index.

^c NA = not applicable.

(Section 6.1.5); the species diversity of transect B2 was significantly higher than that of the reference site (mean diversity of 1.30).

In September 1995, aboveground biomass was collected at scattered plots in the inactive portion of the AOC located between the berm and the marsh. Biomass was collected from four 0.25-m² plots, oven-dried at 70°C for 72 hours, and weighed to the nearest 0.01 g (Table D.11). A Mann-Whitney test found that the biomass of the RPDG plots did not differ significantly from that of the reference site. These analyses show that the species diversity and biomass production of the terrestrial vegetation community at this location have not been significantly affected by soil contamination.

6.6.6 Vertebrate Surveys

6.6.6.1 Amphibians and Reptiles

Within the RPDG AOC, amphibian species were frequently observed near craters and other depressions containing water. Frog species seen or heard during amphibian surveys at the RPDG AOC included southern leopard frogs, green frogs, and spring peepers (Johnson 1995). Other amphibians encountered included red-spotted newts and spotted salamanders (Johnson 1995). Egg masses of ambystomid salamanders were common in these areas during the spring, and hatching of some of these egg masses was documented (Johnson 1995).

Observations of reptiles within this AOC included a pair of mating black rat snakes, a red-sided garter snake, and a snapping turtle (Johnson 1995).

6.6.6.2 Birds

Many of the bird species listed in Table 6.22 are expected to be found near the RPDG AOC as well, because of the variety of habitats (wetlands, open ground, old field, and forests) available. At least 25 bird species were sighted or heard within or near the RPDG AOC, including bald eagle, osprey, American woodcock, yellow-billed cuckoo, great horned owl, eastern bluebird, scarlet tanager, blue grosbeak, indigo bunting, orchard oriole, and American goldfinch (Johnson 1995).

Four nest boxes were placed in the RPDG AOC, and pairs of eastern bluebirds initiated nesting activities in two of them. Although three eggs were produced in one box and four were produced in the other, no young were fledged. The cause of the failures is uncertain, but predation by ants in one nest box and burning of the tree supporting one of the nest boxes (although the nest box itself was relatively unscathed) in a fire of unknown origin may have contributed to the failures (Johnson 1995).

6.6.6.3 Small Mammals

Small mammal trapping for tissue analysis resulted in the capture of 11 adult white-footed mice. None of these individuals exhibited gross external or internal conditions indicative of adverse contaminant effects.

6.6.7 Summary

The assessment of ecological effects at the RPDG AOC included the following:

- Quantitative surveys of soil invertebrate abundance, bacterial and fungal biomass, and wetland (Appendix C) and terrestrial vegetation;
- Qualitative surveys of amphibians, reptiles, and birds;
- Quantitative evaluations of nutrient-acquiring enzyme activity and soil respiration rates;
- Evaluation of bird nesting success with nest boxes; and
- Soil, surface water, and sediment toxicity testing on a variety of plant, invertebrate, and animal species.

Because the surface water habitats are ephemeral, no surveys of fish or aquatic invertebrates were conducted in the clear area of the RPDG AOC. However, several aquatic invertebrate taxa were observed during other activities. The taxa inhabiting the temporary aquatic habitats at this AOC are probably similar to those inhabiting similar ephemeral habitats throughout J-Field.

No significant differences between the AOC and reference location were evident in the abundance of soil-dwelling macroinvertebrates and nematodes, whereas the activity of epigeic macroinvertebrates was greater at the AOC. Total fungal biomass was also greater at the AOC, but total bacterial biomass was similar between the two locations. In contrast, active bacterial and fungal biomass were much lower at the AOC. Active biomass reflects current conditions and probably reflects short-term responses to climate and season. In contrast, total biomass is a measure of long-term production and is probably a better indicator of contaminant effects.

Substrate-induced respiration rates and the activity of dehydrogenase enzyme at the RPDG AOC were significantly lower than those at the reference site. The activities of the other two enzymes measured at the site were similar to those at the reference site. Soil toxicity was evaluated by using the SER. Two locations in the clear area had SERs of 32% and 56%, suggesting soil toxicity; SERs at the other locations were $\geq 80\%$, and the control soil had an SER of 91%.

Qualitative surveys for amphibians found three frog species and two salamander species at the site. Ambystomid egg masses and hatching were also reported. Three reptile species were casually observed at the site. More than 25 bird species were seen or heard during qualitative bird surveys. Species observed included the bald eagle, osprey, eastern bluebird, and American goldfinch. Four nest boxes were established at the site, and eastern bluebirds used two for nesting. Although

eggs were found in both nest boxes, no successful fledging was documented. Nest failure at one nest box was attributed to a fire that swept the site, and ant predation was postulated as the cause of the other nest failure, although ants may have been consuming eggs that were not viable for other reasons.

Eleven white-footed mice were collected for tissue analyses. Necropsies detected no gross internal or external conditions indicative of adverse contaminant effects. Analysis of tissues for heavy metals, pesticides, and PCBs were below detection limits, except for lead (3.28 mg/kg detected in one mouse), DDE (0.005 to 0.010 mg/kg in three mice), and Aroclor 1260 (0.05 mg/kg in one mouse) (Whaley 1996).

6.7 ROBINS POINT TOWER SITE

The assessment of ecological effects at the RPTS AOC included (1) quantitative evaluations of soil invertebrate abundance and bacterial and fungal biomass; (2) quantitative surveys of wetland and upland vegetation; (3) qualitative surveys of amphibians and birds; (4) quantitative evaluations of microbial enzyme activity and soil respiration rates; and (5) toxicity tests of site soils. The results of these effects assessments are presented in Sections 6.7.1 through 6.7.6, and details regarding the assessment methods are presented in Appendix A.

6.7.1 Aquatic Habitats

No aquatic habitat is present within the RPTS AOC, although several small craters nearby contain water during the wetter times of the year. The aquatic communities were not evaluated, nor was toxicity testing conducted for these craters.

6.7.2 Soil Biota

6.7.2.1 Soil Invertebrate Community

The soil invertebrate community in the RPTS AOC was surveyed in the summer of 1995. Figure A.7 in Appendix A shows the locations of sampling points. No adverse effects on the activity of surface-inhabiting invertebrates were observed. The total number of soil nematodes in the RPTS AOC was significantly lower ($P < 0.01$) than that in the reference site (RSB) at Gunpowder Falls State Park (Table 6.57).

TABLE 6.57 Total Abundance and Activity (mean $\pm$ SE) of Soil Invertebrates at the Robins Point Tower Site and the Reference Site

Group	Robins Point Tower ^a	Reference Site (RSB)	Significance
Surface macroinvertebrates (number/ trap/d)	29.79 $\pm$ 2.51	29.25 $\pm$ 1.44 ^b	NS ^c
Soil nematodes (number/g DW)	29.87 $\pm$ 10.57	55.98 $\pm$ 10.87 ^d	$P = 0.0049^e$

^a $n = 24$.^b $n = 4$.^c NS = not significant ($P > 0.05$).^d $n = 9$.^e Analyses were performed on natural log-transformed data.

6.7.2.2 Soil Microbial Biomass

The soil microbial community in the RPTS AOC was surveyed in the spring of 1994. No adverse effects on the soil microbial community were observed. Most microbial parameters measured at the RPTS AOC, including total and FDA-active bacterial biomass and total fungal biomass were significantly higher ($P < 0.05$) than those at the reference site (Table 6.58). The numbers of soil protozoa were not significantly different between the two sites.

6.7.3 Soil Processes

Biologically mediated soil processes in the RPTS AOC were quantified in the spring of 1994. Figure A.7 in Appendix A shows the locations of sampling points. No adverse effects on soil microbial activity were observed. Dehydrogenase and N-acetylglucosaminidase activity did not differ significantly between the RPTS AOC and the reference site (Table 6.59). Activity of acid phosphatase was significantly higher ($P < 0.01$) at the RPTS AOC. The SIR rates were similar at both sites.

6.7.4 Soil Toxicity

The SER was used as the index of toxicity in the phytotoxicity test. Table 6.60 presents the results of the soil phytotoxicity screening with lettuce seeds. Figure A.7 in Appendix A shows the locations of sampling points in the RPTS AOC. The mean SER values for six sample locations

TABLE 6.58 Microbial Biomass Parameters (mean $\pm$ SE) of Soils at the Robins Point Tower Site and the Reference Site, Spring 1995

Microbial Parameter	Robins Point Tower ^a	Reference Site (RSB)	Significance
FDA-active fungal biomass ($\mu\text{g/g DW}$)	1.85 $\pm$ 0.49	0.58 $\pm$ 0.15 ^b	NS ^{c,d}
Total fungal biomass ($\mu\text{g/g DW}$)	611.51 $\pm$ 71.62	366.24 $\pm$ 51.64 ^b	$P = 0.0051^d$
FDA-active bacterial biomass ($\mu\text{g/g DW}$)	1.47 $\pm$ 0.11	1.07 $\pm$ 0.12 ^b	$P = 0.0290^d$
Total bacterial biomass ($\mu\text{g/g DW}$)	8.29 $\pm$ 1.07	2.69 $\pm$ 0.24 ^b	$P = 0.0001^e$
Flagellates (number/g DW)	2563.2 $\pm$ 1077.1	563.79 $\pm$ 267.63 ^f	NS ^d
Amoebae (number/g DW)	409.67 $\pm$ 191.02	86.54 $\pm$ 21.20 ^f	NS
Ciliates (number/g DW)	13.56 $\pm$ 11.02	9.43 $\pm$ 3.84 ^f	NS

^a $n = 24$.^b $n = 9$.^c NS = not significant ($P > 0.05$).^d t -test on natural log-transformed data.^e Mann-Whitney test.^f $n = 7$.**TABLE 6.59 Enzyme Activity and Substrate-Induced Respiration (SIR) (mean $\pm$ SE) in Soils at the Robins Point Tower Site and the Reference Site, Spring 1995**

Microbial Activity Parameter	Robins Point Tower ^a	Reference Site (RSB) ^b	Significance
Dehydrogenase ($\mu\text{mol/g/h}$)	0.015 $\pm$ 0.002	0.014 $\pm$ 0.011	NS ^c
Acid phosphatase ($\mu\text{mol/g/h}$)	1.119 $\pm$ 0.082	0.848 $\pm$ 0.151	$P = 0.0090^d$
N-acetylglucosaminidase ($\mu\text{mol/g/h}$)	0.215 $\pm$ 0.035	0.176 $\pm$ 0.049	NS
SIR ($\mu\text{g/g/min}$)	0.119 $\pm$ 0.011	0.143 $\pm$ 0.002	NS

^a $n = 24$.^b $n = 9$, except SIR with $n = 5$.^c NS = not significant ($P > 0.05$).^d Mann-Whitney test.

(B3NW, RPTS-6, SGRPT-10, SGRPT-14, SGRPT-23, and SGRPT-22) were significantly lower than the mean SER for standard soil. The remaining samples had SERs of >79% and were not significantly different from the control SER.

6.7.5 Terrestrial Vegetation Surveys

Terrestrial vegetation in the RPTS AOC consists primarily of forested areas dominated by mature sweetgum, red maple, and tulip tree. These areas have a very sparse understory and a herbaceous layer dominated by *Microstegium vimineum*. Small areas within the AOC are in early successional stages, dominated by dense sapling sweetgum or red maple, or in old-field community.

In June 1995, three transects (B3, B4, and B5) were established in the AOC. Transect B3 consisted of nine data plots in the deciduous forest to the north of the large marsh (southwest of the tower). Transect B4 consisted of four data plots in a forested area dominated by sweetgum saplings, southwest of the tower. Transect B5 consisted of five data plots in the deciduous forest in the northern portion of the AOC (northwest of the tower). Data were collected from 0.5-m² plots at 3-m intervals and included species name, percent cover, and stratum. Relative cover was calculated for each species in each plot. Shannon-Weiner diversity indices, which incorporate species richness and evenness, were calculated for each plot and for the overall upland portion of each transect. Table D.12 presents species name, stratum, percent cover, relative cover, and diversity indices. Table 6.61 presents a summary of diversity indices and species richness for each transect.

Along transect B3, species diversity was 2.15 overall and averaged 1.49 for individual plots (ranging from 0.78 to 1.94); species richness totaled 13 species. Along transect B4, species diversity was 2.58 overall and averaged 2.13 for individual plots (ranging from 1.78 to 2.54); species richness for the transect totaled 27 species. Along transect B5, species diversity was 1.78 overall and averaged 1.61 for the individual plots (ranging from 1.33 to 1.93); species richness for the transect totaled 11 species. Diversity indices were compared with a reference set of diversity indices for deciduous

TABLE 6.60 Phytotoxicity Screening of Soils from the Robins Point Tower Site

Sample Site	SER (%)
Control ^a	91.1
A3SE	83.3
B3NW	63.3 ^b
RPTS-6	53.3 ^b
SGRPT-2	94.2
SGRPT-4	88.3
SGRPT-10	65.0 ^b
SGRPT-14	76.7 ^b
SGRPT-18	79.2
SGRPT-22	65.0 ^b
SGRPT-23	75.8 ^b

^a Control = standard soil consisting of 10% screened sphagnum moss, 20% kaolinite clay, and 70% fine clean silica sand (by weight). The pH of the soil was within the range of 5.0 to 9.0.

^b SER significantly different from control soil (Student's *t*-test $P < 0.05$).

Source: ESI (1995).

forest in other areas of APG. Overall species diversity indices for the upland portion of each transect were below the mean species diversity of the reference transects (2.65). However, all were above the minimum reference diversity index (1.74). Species richness was higher than the minimum reference species richness (10) in each case; one transect was below the mean (13), one was equal to the mean, and one was well above the maximum reference species richness (15). These results did not provide conclusive evidence of negative effects due to soil contamination on the vegetation communities in this area.

In September 1995, aboveground biomass was collected at scattered plots throughout the AOC. Biomass was collected from ten 0.25-m² plots, oven-dried at 70°C for 72 hours, and weighed to the nearest 0.01 g. Table D.13 presents the biomass for each plot. A *t*-test compared the biomass of the three old-field plots (SGRPT-18, -22, and -23) with that of the reference site at Gunpowder Falls State Park. The biomass of the RPTS plots was significantly lower ($P < 0.05$) than that at the reference site. The reduced biomass could be a result of several factors, including soil contamination, soil disturbance, or reduced nutrient uptake. Biomass from one forested plot (RPTS-6) was much lower than that for the rest of the AOC. These analyses show that soil contamination may have adversely affected the biomass production of the terrestrial vegetation community at this location.

TABLE 6.61 Species Richness and Diversity Indices for RPTS Transects

Transect	Species Richness ^a	Diversity (H) ^b
<i>Transect B3</i>		
Individual Plots	NA ^c	
Mean		1.49
Maximum		1.94
Minimum		0.78
Transect	13	2.15
<i>Transect B4</i>		
Individual Plots	NA	
Mean		2.13
Maximum		2.54
Minimum		1.78
Transect	27	2.58
<i>Transect B5</i>		
Individual Plots	NA	
Mean		1.61
Maximum		1.93
Minimum		1.33
Transect	11	1.78

^a Richness = number of species.

^b H = Shannon-Weiner diversity index.

^c NA = not applicable.

6.7.6 Vertebrate Surveys

6.7.6.1 Amphibians

The only amphibian species identified during surveys at a crater near the RPTS AOC was the southern leopard frog, although calls of other, unidentified species were heard (Johnson 1995).

6.7.6.2 Birds

As at other sites at J-Field, any of the bird species listed in Table 6.22 may be found near the RPTS AOC because of the variety of habitats (open water offshore, shoreline, wetlands, open ground, old field, and forests) nearby. Nearly 30 bird species were sighted or heard within or near the RPTS AOC during surveys, including osprey (an active nest exists on the tower), red-tailed hawk, bufflehead, laughing gull, northern bobwhite, pileated woodpecker, fish crow, house wren, black-throated green warbler, black-and-white warbler, indigo bunting, orchard oriole, and American goldfinch (Johnson 1995).

Four nest boxes were placed in the RPTS AOC in 1995. One was occupied by an undetermined species (probably a wren), and another was occupied by a pair of southern flying squirrels. No activity was observed in the box with the bird nest, and it is believed that the nest was abandoned before eggs were laid (Johnson 1995).

6.7.6.3 Small Mammals

No small mammal trapping was conducted at the RPTS AOC.

6.7.7 Summary

Because the RPTS AOC contains no aquatic habitats, no surveys of aquatic biota or toxicity testing of surface water and sediment were done as part of the effects assessment for this AOC. The effects assessment did include the following:

- Quantitative surveys of soil invertebrates and bacterial and fungal biomass;
- Quantitative survey of wetland and upland vegetation;
- Quantitative evaluations of microbial enzyme activity and soil respiration rates;
- Qualitative surveys of amphibians and birds; and
- Soil toxicity testing to evaluate SERs.

No difference in the activity of epigeic macroinvertebrates was detected between the RPTS AOC and the reference site. The abundance of soil nematodes at the AOC was (nearly 50%) lower than that at the reference site. In contrast, total and active bacterial biomass and total fungal biomass

were greater at the AOC than at the reference site. No significant differences in soil protozoan abundance, microbial enzyme activity, or soil respiration rates were detected between the AOC and the reference site.

Tests showed soil toxicity for 4 of the 10 samples from locations at the RPTS AOC. Three samples came from the central portion of the AOC, and one came from the southwestern portion. The SERs for these locations ranged from 53% to 65%; the SERs for the other locations were 76% to 94%, and the SER for the control soil was about 91%.

Thirty bird species were observed or heard at the site, including osprey, bald eagle, red-tailed hawk, and American goldfinch. An active osprey nest sits atop the old tower structure. The four nest boxes placed at the AOC received only limited use. Although a nest was constructed in one of the nest boxes, it appeared to have been abandoned prior to production of eggs.

6.8 PROTOTYPE BUILDING

The assessment of ecological effects at the PB AOC included (1) quantitative evaluations of soil invertebrate abundance, (2) qualitative surveys of vegetation, (3) quantitative evaluations of fungal and bacterial biomass, (4) quantitative evaluations of the physiological parameters of soil invertebrates (enzyme activity and respiration rates), and (5) toxicity tests of site soils. The results of these effects assessments are presented in Sections 6.8.1 through 6.8.6, and details regarding the assessment methods are presented in Appendix A.

6.8.1 Aquatic Habitats

The PB AOC contains no aquatic habitat, although offshore habitats exist in the Gunpowder River to the west. Evaluation of offshore aquatic habitats was outside the scope of this ERA.

6.8.2 Soil Biota

6.8.2.1 Soil Invertebrate Community

The soil invertebrate community in the PB AOC was surveyed in the summer of 1995. Figure A.9 in Appendix A shows the locations of sampling points. No adverse effects on the soil invertebrate community were observed. The total abundance of soil macroinvertebrates in the AOC was not significantly different from that at the reference site (RSA) at Gunpowder Falls State Park

(Table 6.62). The number of taxa of soil macroinvertebrates in the PB AOC was almost twice that in the reference site ($P<0.05$). The activity of surface-inhabiting arthropods and total number of soil nematodes were significantly higher ($P<0.05$) at the PB AOC.

6.8.2.2 Soil Microbial Biomass

The soil microbial community in the PB AOC was surveyed in the spring of 1995. Total bacterial biomass was significantly higher ($P<0.01$) at the PB AOC than at the reference site (Table 6.63). The FDA-active fungal and bacterial biomass were significantly lower ($P<0.01$) at the PB AOC (Table 6.63). However, the decrease in FDA-active biomass represents the portion of the total microbial biomass that is responding to current environmental conditions, such as rainfall, whereas total biomass represents both living and dead microbial cells that accrue over a longer period and is a more representative indicator of the effects of long-term soil disturbance in the area.

Most soil protozoa were affected at the PB AOC. The abundance of flagellates and ciliates was significantly lower ($P<0.05$) than that at the reference site (Table 6.63). The abundance of amoebae was not significantly different from the reference site (Table 6.63).

6.8.3 Soil Processes

Biologically mediated soil processes in the PB AOC were quantified in the spring of 1995. Figure A.9 in Appendix A shows the locations of sampling points. There were some indications that soil microbial activity was adversely affected in this area. Dehydrogenase activity and SIR rates in the PB AOC were significantly lower ($P<0.05$) than those in the reference site (Table 6.64). There was no significant difference in the activity of acid phosphatase and N-acetylglucosaminidase between the PB AOC and the reference site.

6.8.4 Soil Toxicity

The SER was used as the index of toxicity in the phytotoxicity test. Table 6.65 shows the results of the soil phytotoxicity screening with lettuce seeds. The SERs for all PB AOC sample locations were significantly lower than for the standard soil control, which had a SER of 91% (Table 6.65).

TABLE 6.62 Total Abundance and Activity of Soil Invertebrates (mean $\pm$ SE) at the Prototype Building Area and the Reference Site

Taxa	Prototype Building ^a	Reference Site (RSA)
Lumbricidae	410.3 $\pm$ 61.5	139.7 $\pm$ 139.7
Isopoda	55.3 $\pm$ 25.1	745.0 $\pm$ 610.6
Lithobiomorpha	- ^b	46.6 $\pm$ 46.6
Geophilomorpha	26.2 $\pm$ 10.7	-
Symphyla	5.8 $\pm$ 5.8	-
Diplopoda	32.0 $\pm$ 13.9	46.6 $\pm$ 46.6
Aranea	148.4 $\pm$ 29.2	273.8 $\pm$ 46.6
Diplura	75.7 $\pm$ 42.0	698.4 $\pm$ 241.9
Diptera larvae	29.1 $\pm$ 16.1	-
Formicidae	6,265.2 $\pm$ 4,133.5	325.9 $\pm$ 259.2
Hemiptera	5.8 $\pm$ 4.1	46.6 $\pm$ 46.6
Elateridae	14.6 $\pm$ 7.5	-
Scarabaeidae	34.9 $\pm$ 13.5	-
Curculionidae	8.7 $\pm$ 4.9	-
Carabidae	37.8 $\pm$ 10.8	-
Staphylinidae	64.0 $\pm$ 14.4	512.2 $\pm$ 512.2
Other coleoptera	55.3 $\pm$ 14.2	-
Other insects	5.8 $\pm$ 5.8	-
Total soil macroinvertebrates (number/m ²)	7,454 $\pm$ 4,206	2,964 $\pm$ 1,765 ^c NS ^d
Total surface macroinvertebrates (number/trap/d)	39.93 $\pm$ 4.82	24.0 $\pm$ 1.58 ^e S ^f
Total soil nematodes (number/g DW)	28.66 $\pm$ 3.55	7.34 $\pm$ 0.81 ^g S ^f

^a $n = 16$.

^b - = not collected.

^c $n = 3$.

^d NS = not significant ($P > 0.05$).

^e $n = 4$.

^f S = mean numbers are significantly different ($P < 0.05$).

^g $n = 9$.

TABLE 6.63 Microbial Biomass Parameters (mean $\pm$ SE) of Soils at the Prototype Building Area and the Reference Site, Spring 1995

Microbial Parameter	Prototype Building ^a	Reference Site (RSA)	Significance
FDA-active fungal biomass ($\mu\text{g/g DW}$)	1.27 $\pm$ 0.39	5.03 $\pm$ 1.25 ^b	$P = 0.0028^c$
Total fungal biomass ($\mu\text{g/g DW}$)	306.55 $\pm$ 31.38	242.59 $\pm$ 31.31 ^b	NS ^{d,e}
FDA-active bacterial biomass ($\mu\text{g/g DW}$)	2.05 $\pm$ 0.17	3.83 $\pm$ 0.19 ^b	$P < 0.0001^e$
Total bacterial biomass ($\mu\text{g/g DW}$)	12.36 $\pm$ 1.76	6.02 $\pm$ 0.79 ^b	$P = 0.0044^f$
Flagellates (number/g DW)	5539.3 $\pm$ 2855.3	11169.7 $\pm$ 2421.8 ^g	$P = 0.0122$
Amoebae (number/g DW)	2168.69 $\pm$ 938.7	837.43 $\pm$ 400.16 ^g	NS
Ciliates (number/g DW)	22.77 $\pm$ 16.83	462.72 $\pm$ 386.04 ^g	$P = 0.0016$

^a $n = 16$.^b $n = 9$.^c Mann-Whitney test.^d NS = not significant ($P > 0.05$).^e t -test on untransformed data.^f t -test on naturally transformed data.^g $n = 7$.**TABLE 6.64 Enzyme Activity and Substrate-Induced Respiration (SIR) (mean $\pm$ SE) in Soils at the Prototype Building Area and the Reference Site, Spring 1995**

Microbial Activity Parameter	Prototype Building ^a	Reference Site (RSA) ^b	Significance
Dehydrogenase ($\mu\text{mol/g/h}$)	0.017 $\pm$ 0.003	0.039 $\pm$ 0.013	$P = 0.0005$
Acid phosphatase ($\mu\text{mol/g/h}$)	1.148 $\pm$ 0.053	1.087 $\pm$ 0.075	NS ^c
N-acetylglucosaminidase ($\mu\text{mol/g/h}$)	0.178 $\pm$ 0.008	0.166 $\pm$ 0.021	NS
SIR ($\mu\text{g/g/min}$)	0.233 $\pm$ 0.027	0.363 $\pm$ 0.004	$P = 0.0106^d$

^a $n = 16$.^b $n = 9$, except SIR with $n = 5$.^c NS = not significant ($P > 0.05$).^d Analyses were performed on natural log-transformed data.

6.8.5 Terrestrial Vegetation Surveys

Terrestrial vegetation near the PB AOC consists entirely of an old-field community surrounding the PB. This community has been managed under an infrequent mowing regime (at least annually) and is dominated by fescue and velvet grass. Immediately to the north of the AOC, open-canopied deciduous forest dominated by black locust lies next to forested wetland. Another area of deciduous forest is found southwest of the PB.

In September 1995, eight 0.25-m² plots were established for vegetation sampling in the AOC. Two plots were located on each side of the building within the old-field community. Aboveground biomass was collected from each plot, oven-dried at 70°C for 72 hours, and weighed to the nearest 0.01 g. Table D.14 shows the biomass for each plot. Biomass values (in g/0.1 m²) ranged from 26.00 to 59.79 and averaged 43.65. A *t*-test compared the biomass collected at the PB AOC plots with that at the reference site at Gunpowder Falls State Park. The aboveground biomass of the PB AOC plots was significantly lower ($P < 0.05$). The reduction in biomass may result from soil contamination, soil disturbance, reduced nutrient uptake, or mowing of the PB AOC. The biomass for the PB AOC plots was lower than the potential total biomass because the area had been mowed during the growing season.

6.8.6 Vertebrate Surveys

6.8.6.1 Amphibians

No amphibian surveys were conducted near the PB AOC because there were no appropriate aquatic habitats.

TABLE 6.65 Phytotoxicity Screening of Soils from the Prototype Building Area

Sample Site	SER (%)
Control ^a	91.1
SGPB-1	85.0 ^b
SGPB-2	85.0 ^b
SGPB-6	74.2 ^b
SGPB-7	55.0 ^b
SGPB-10	77.5 ^b
SGPB-11	64.2 ^b
SGPB-16	83.3 ^b
SGPB-17	73.3 ^b

^a Control = standard soil consisting of 10% screened sphagnum moss, 20% kaolinite clay, and 70% fine clean silica sand (by weight). The pH of the soil was within the range of 5.0 to 9.0.

^b SER significantly different from control soil (Student's *t*-test, $P < 0.05$).

Source: ESI (1995).

6.8.6.2 Birds

As in other sites at J-Field, many of the bird species listed in Table 6.22 could be found near the PB AOC because of the variety of habitats (open water offshore, shoreline, wetlands, open ground, old-field, and forests) nearby. At least 19 bird species were sighted or heard in or near the PB AOC during surveys. These species included osprey, red-tailed hawk, great blue heron, ruby-throated hummingbird, yellow warbler, northern cardinal, red-winged blackbird, eastern meadowlark, and orchard oriole (Johnson 1995). A pair of tree swallows occupied a nest box placed near the PB AOC and subsequently produced four fledglings (Johnson 1995).

6.8.6.3 Small Mammals

No small mammal trapping was conducted at the PB AOC.

6.8.7 Summary

The PB AOC contains no aquatic habitats; therefore, the effects assessments focused primarily on evaluations of soil biota and toxicity. Evaluations of the soil invertebrate community found greater macroinvertebrate activity, as well as greater soil nematode abundance, at the AOC than at the reference site. Total bacterial biomass was also greater at the AOC. In contrast, active fungal and bacterial biomass were lower at the AOC. Protozoan ciliates and flagellates were less abundant at the AOC, but the abundances of amoebae were similar. The activities of two microbial enzymes were also similar, but dehydrogenase activity and SIR rates were significantly lower at the AOC.

The SER was used as an indicator to evaluate soil toxicity. Soils from eight locations were tested, and SERs for all of these samples were significantly lower than for standard soil. The SERs at these locations ranged from 55% to 85%.

6.9 POTENTIAL AREAS OF CONCERN

The assessment of ecological effects at the PAOCs consisted of qualitative evaluations of amphibians and birds and toxicity tests of surface water and sediment. The results of these assessments are presented in Sections 6.9.1 and 6.9.2; details regarding the assessment methods are presented in Appendix A.

6.9.1 Aquatic Habitats

The PAOCs at J-Field include Site X1, Area A, Area B, Area C, the Ruins Site, and Area D plus the craters, as identified in the RI report (Yuen et al. 1999).

Site X1 has a few shallow depressions that contain standing water during wet seasons. The aquatic habitats in this PAOC have not been evaluated, but they seem similar to many other ephemeral pools that develop at J-Field during wet times of the year.

Area A is in a swampy portion of J-Field and contains several water-filled trenches that may have been constructed to help drain water away from other areas (Yuen et al. 1999). Much of this area contains standing water throughout the year, but the aquatic habitat has not been evaluated in detail.

No aquatic habitats were identified in Area B, although the Bush River is located directly east of this PAOC.

The only aquatic habitats near Area C consist of small bomb craters that hold water for short periods during wet seasons of the year. Although no ecological evaluation of these craters has been conducted, they are expected to support communities similar to those in the ephemeral habitats described in earlier sections and in the other craters described later in this section.

The Ruins Site contains several bomb craters and two small ponds connected by a ditch. Some craters contain water throughout the year, and others contain water only during wet periods. The habitat in the Ruins Site craters is discussed below, with that of other craters. The aquatic habitats in the small ponds have not been evaluated in detail. However, these ponds are shallow and contain both hard- and soft-bottom areas. They contain *Lemna*, and emergent vegetation grows in some areas.

The principal aquatic habitat in Area D is bomb craters. The aquatic habitats present in these craters are discussed below.

J-Field contains many craters. These craters, which are scattered throughout the site, have resulted from both in-place detonation of ordnance and bomb impacts. Most are small (generally less than 10 ft in diameter) and contain water only during wet periods. However, some craters, notably DG-1 and DG-2 in the Ruins Site (Figure 6.1), the large crater in the SBDG AOC (Section 6.5), and some craters in Area D, hold water throughout the year and contain emergent and floating vegetation, such as *Phragmites* and *Lemna*.

6.9.1.1 Aquatic Invertebrates and Fish

Aquatic communities of phytoplankton, zooplankton, and aquatic forms of insects are expected to be found in most crater habitats. Although no invertebrates have been collected from any of the PAOCs, a variety of taxa, including cladocerans, copepods, midge and mosquito larvae, amphipods, and water mites, were observed during other sampling activities.

No fish have been observed in any of the PAOCs, except the mosquito fish (*Gambusia affinis*), which has been collected from the swampy areas in Area A and may also be found in some trenches in this area. No fish were collected in minnow traps placed overnight in craters in the Ruins Site PAOC (DG-1 and DG-2) or the SBDG AOC.

6.9.1.2 Aquatic Toxicity

Only the craters were included in toxicity testing. Table 6.66 presents the results of toxicity testing of surface water and sediments from two craters in the Ruins Site PAOC (locations DG-1 and DG-2) and two bomb craters in the woods south of the TBP AOC locations (TBC-A and TBC-B). Figure 6.1 shows the sample locations. Section 6.5.1.2 presents the results of toxicity testing for the crater at the SBDG AOC. No toxicity from surface water or sediment from these sample locations was detected in Microtox tests. Exposure to surface water resulted in no significant reduction in

TABLE 6.66 Results of Toxicity Testing with Media Collected from Craters and Other Locations at J-Field^a

Toxicity Test (medium, endpoint)	Craters				Other
	DG-1	DG-2	TBC-A	TBC-B	DG-3
<i>Acute Tests</i>					
Microtox, water (inhibition)	-	-	-	-	-
Microtox, sediment (inhibition)	-	-	-	-	-
<i>Daphnia</i> (48-hour survival)	-	-	-	-	-
<i>Rana</i> (48-hour survival)	-	-	-	-	-
<i>Chronic Tests</i>					
<i>Lemna</i> (96-hour production)	-	+	-	-	-
<i>Selenastrum</i> (96-hour production)	+	+			+

^a - = test results indicated media were not toxic; + = test results indicated media were toxic; blank cell indicates not tested.

survival of *Daphnia* or *Rana* larvae after 48 hours. *Lemna* production after 96 hours in water from location DG-2 was significantly lower than that in controls, but was not significantly affected by water from location DG-1. *Selenastrum* production after 96 hours in water from both sample locations was significantly lower than that in laboratory controls. Toxicity of sediments to *Hyalella* was not tested.

6.9.2 Vertebrate Surveys

6.9.2.1 Amphibians

Many amphibian species use fishless bodies of water, including ephemeral habitats, for reproduction. Thus, it is not surprising that eggs, larvae, and adults of amphibian species were observed in many J-Field craters (Johnson 1995). Section 6.5.3.1 discusses the amphibian species found in the crater in the SBDG AOC (CRTR-1 in Figure 6.7). Johnson (1995) surveyed amphibians associated with several craters (Figure 6.7). At least five species of amphibians were detected near craters (Table 6.67), including spotted salamanders, red-spotted newts, spring peepers, green frogs, and southern leopard frogs.

6.9.2.2 Birds

Bird surveys were conducted along Ford's Point Road, which is near Areas A, B, and C. More than 60 of the bird species likely to occur at J-Field (Table 6.22), were detected, including bald eagle, osprey, red-shouldered hawk, double-crested cormorant, great blue heron, northern bobwhite, mourning dove, yellow-billed cuckoo, ruby-throated hummingbird, red-bellied woodpecker, pileated woodpecker, Carolina chickadee, tufted titmouse, Carolina wren, Swainson's thrush, hermit thrush, wood thrush, American robin, many warbler species, scarlet tanager, rose-breasted grosbeak, indigo bunting, and northern oriole.

No nest boxes were placed in the PAOCs near Ford's Point Road. A pair of Carolina chickadees produced six eggs in a nest box placed near the Ruins Site. However, no young were fledged; the cause for the nest failure was not determined (Johnson 1995).

6.9.2.3 Small Mammals

No small mammal trapping was conducted at any of the PAOCs. However, the mammal species likely to be found at this site are similar to those described in Section 6.1.6.3.

FIGURE 6.7 Approximate Locations of Craters where Amphibian Surveys Were Conducted

TABLE 6.67 Amphibian Species Seen or Heard near Craters at J-Field^a

Location	<i>Ambystoma maculatum</i>	<i>Notophthalmus viridescens</i>	<i>Pseudacris crucifer</i>	<i>Rana clamitans</i>	<i>Rana utricularia</i>	Unidentified Species
<i>Ruins Site</i>						
DG-1		X	X		X	X
DG-2				X	X	X
<i>SBDG AOC</i>						
Crater-1		X				X
<i>TBP AOC</i>						
Crater-2 ^b						
Crater-3					X	
Crater-4 ^b						
TBC-A ^b						
TBC-B ^b						
<i>RPDG AOC</i>						
Crater-5	X	X	X	X		X
Crater-6				X	X	X
<i>Area D</i>						
Crater-7	X				X	X
Crater-8				X	X	X
Crater-9	X		X	X	X	X
Crater-10						X
Crater-11						X
<i>RPTS AOC</i>						
Crater-12					X	X

^a X indicates species has been seen or heard near specified crater.

^b The absence of species in these craters may be due to the lack of standing water during the survey period.

Source: Johnson (1995).

6.9.3 Summary

Only limited assessments were performed at the PAOCs, and assessment activities were confined to toxicity testing of surface water and sediment from craters, pits, and other depressions and qualitative surveys of amphibian and bird populations. Soil biota and soil processes were not investigated.

The PAOCs contain few permanent aquatic habitats. Most habitats consist of ephemeral surface waters that support few fauna. Permanent habitats, consisting of ponds and trenches, are present at Area A and the Ruins Site. Mosquito fish were collected from the swampy areas in Area A, but no fish were collected in minnow traps set at the Ruins Site.

Surface water and sediment had no acute toxic effects on bacteria (*Microtox*) or zooplankton. *Rana* larvae suffered no acute toxic effects from surface water. One of the two ponds at the Ruins Site showed chronic toxicity of surface water to the green alga *Selenastrum* and the vascular plant *Lemna*.

Surveys of amphibians found five species among the various crater and pit habitats in the PAOCs, including three frogs and two salamanders. More than 60 species of birds were observed or heard during qualitative surveys along Ford's Point Road near Areas A, B, and C. These species included bald eagle, osprey, waterfowl, warblers, and thrushes. A pair of Carolina chickadees used a nest box placed near the Ruins Site for nesting, but no young were fledged. The cause of the nest failure is unknown, but it may have been due to factors unrelated to contaminant conditions.

7 RISK CHARACTERIZATION

7.1 RISK CHARACTERIZATION METHODOLOGY

Risks to ecological resources at J-Field were characterized by two approaches: the hazard quotient (HQ) and evaluation of the weight of evidence (EPA 1992; Davis 1994; EPA 1997). These approaches are described in Sections 7.1.1 and 7.1.2, respectively.

7.1.1 Hazard Quotient

After the ADD was estimated for a receptor species (Section 5.2.4), the potential for adverse ecological effects on the receptor species was estimated by examining the ratio between the exposure concentration (either a media concentration or ADD) and a contaminant-specific benchmark value representing a no-effect exposure. This ratio is called the HQ. The HQ is calculated by using the following equation:

$$\text{HQ} = (\text{exposure concentration or dose}) \div (\text{Benchmark concentration or dose})$$

where

HQ = hazard quotient,

Exposure concentration or dose = environmental media concentration or the estimated ADD, and

Benchmark = environmental media concentration or ADD reported to produce no adverse effect in the receptor species.

The HQ values may vary from zero to infinity. Values greater than 1.0 show a potential risk to the receptor from the exposure; values between 1.0 and 10.0 show a low potential risk of adverse effects; values between 10.0 and 50.0 show a moderate risk; values between 50.0 and 100.0 show high potential risk; and values greater than 100 show extreme risk (Davis 1994). It is important to note that these values indicate only potential for adverse risks; they do not indicate actual impacts. Only the effects assessment results document actual measurable adverse impacts (if present).

Estimating the HQ requires benchmark values that represent contaminant concentrations considered acceptable ("safe") to biota. Benchmark values are contaminant- and species-specific, they typically represent no-observable-adverse-effects level (NOAEL) concentrations, and they may include media concentrations, food concentrations, tissue concentrations, or dose estimates. Unless

otherwise identified, benchmark values used in this ERA for estimating the HQ were dose estimates given in Sample et al. (1996). If no benchmark value was available for a specific receptor species but information for a similar species was available, a benchmark value was extrapolated by using the following equation (Sample et al. 1996):

$$\text{NOAEL}_B = \text{NOAEL}_A * (\text{BW}_A \div \text{BW}_B)^{1/3}$$

where

NOAEL_B = benchmark NOAEL for target species B,

NOAEL_A = known benchmark NOAEL for closely related species A, and

BW = body weight of the target species (B) and the related species (A).

Risk estimation by the HQ approach was constrained by the limited availability of some contaminant-specific benchmark values. Suitable benchmark values were available for the most abundant and widespread PCOECs, including most of the heavy metals. The benchmarks and their sources are listed in Appendix B.

7.1.2 Weight-of-Evidence Approach

The potential for adverse impacts on ecological resources was also characterized by using a weight-of-evidence approach (EPA 1992; Davis 1994; EPA 1997). The results of the effects assessments (Section 6) were evaluated together with measured tissue and environmental media concentrations, contaminant uptake estimates, and HQ-based risk predictions. Risks to ecological resources were then estimated by bringing together these multiple lines of evidence and evaluating the results, predictions, and observed impacts. The more the results of these evaluations indicate actual or predicted adverse ecological effects, and the greater the confidence in these results, the greater is the potential for adverse risks to ecological resources at the site.

For example, if the results of the evaluation indicated current adverse effects on only a few ecological parameters and the effects were relatively minor, and the HQs indicated low risks to only a few receptors, the AOC was considered to pose a low risk to ecological resources. In contrast, if the evaluation identified adverse effects on many ecological parameters, the effects were severe and widespread across the site or affected many receptors, and the HQs identified high or extreme risks to several receptors, the risk estimation concluded that conditions at the AOC pose a high risk to ecological resources.

7.2 RISK ESTIMATES

7.2.1 Toxic Burning Pits Area of Concern

On the basis of both the HQ and weight-of-evidence approaches for risk estimation, the TBP AOC poses a high risk for adverse ecological impacts. This risk is associated primarily with contaminated soils in the Pushout Area and pits and is related primarily to heavy-metal concentrations rather than PCBs, pesticides, VOCs, or SVOCs. The contaminated soils of the Pushout Area are also the probable primary source of the contamination and high risk identified in surface water and sediment along the marsh-Pushout Area boundary. Risk estimates for the TBP AOC using the HQ, and based on the weight of evidence, are discussed below.

7.2.1.1 Hazard Quotients

The HQs calculated by comparing exposure point concentrations for soil contaminants at the TBP AOC with benchmark NOAEL soil concentrations for terrestrial vegetation indicated some contaminants present at concentrations that could pose risks of adverse effects on terrestrial vegetation (Table 7.1). Antimony, arsenic, chromium, lead, and zinc were present at levels showing potentially extreme risk, and the HQs for copper, mercury, and silver indicated these contaminants were present at levels that could pose a moderate risk to grasses (Table 7.1). The barium, cadmium, cobalt, manganese, and selenium concentrations resulted in concentration-based HQs less than 10.0, which indicated a low risk. Although high concentrations of aluminum are present in soils at the TBP AOC, and no aluminum benchmark value was available for calculating an HQ, this metal is considered to pose an acceptable risk to vegetation at the AOC. Aluminum is generally not phytotoxic when soil pH is >4.5 , and soils at J-Field are neutral or alkaline ($\text{pH} \geq 7.0$).

For aquatic biota, the HQs were calculated by comparing exposure point concentrations for surface water at the TBP AOC (Table 5.16) with AWQC (EPA 1986) values and appropriate ecological benchmarks. The HQs indicated that some contaminants in surface water could pose a risk to aquatic organisms (Table 7.2). The exposure point concentrations of iron and lead could pose moderate to high risk, respectively. The exposure point concentrations of aluminum, copper, and zinc could pose moderate risks of adverse effects, while low potential risks to aquatic receptors were estimated for antimony, cadmium, chromium, calcium, mercury, sodium, and TCLEA. However, the pond at the TBP AOC supports an apparently healthy aquatic community, and no toxicity is evident in the surface waters from the pond proper. Furthermore, surface water toxicity is limited to the boundary between the marsh and the Pushout Area, and this is the only location where the AWQC were exceeded at individual sampling locations. In addition, the lowest aquatic macroinvertebrate species diversity and richness measured at the TBP AOC pond was at the sampling location nearest to the marsh-Pushout Area boundary.

TABLE 7.1 Hazard Quotients for Grasses Based on Exposure Point Concentrations of Contaminants in Soil at J-Field Areas of Concern^a

Contaminant	Toxic Burning Pit	White Phosphorus Pits	Riot Control Pit	South Beach Trench	Robins Point Demolition Ground	Robins Point Tower Site	Prototype Building	Ruins Site
Antimony	100.2	0.6	0.4	- ^b	0.2	-	0.4	-
Aroclor 1248	0.1	-	-	-	-	-	-	-
Arsenic	144.0	-	-	-	-	-	-	-
Barium	1.6	-	-	-	-	-	-	-
Cadmium	3.6	0.3	0.7	0.3	-	-	0.4	-
Chromium	250.9	10.3	54.6	-	3.5	-	-	-
Cobalt	4.3	-	-	-	-	-	-	-
Copper	43.2	0.7	17.7	0.3	0.1	-	0.7	-
Fluorine	0.1	-	-	-	-	-	-	-
Lead	942.0	2.3	10.7	0.3	0.3	2.3	0.6	0.2
Manganese	1.9	-	-	-	0.3	0.9	1.3	-
Mercury	12.0	0.4	0.4	-	0.3	0.4	0.4	0.2
Nickel	-	0.9	1.0	0.6	0.4	8.7	0.7	3.2
Selenium	3.6	-	-	-	-	-	-	-
Silver	21.0	-	4.5	-	5.1	-	-	-
Zinc	1,780.0	58.8	38.5	10.5	8.2	58.8	19.0	2.9

^a Exposure point concentrations used to estimate the hazard quotient are provided in Section 5.2.1; benchmark values are presented in Appendix B. Only PCOECs for which a benchmark value was available are included in this table.

^b - = contaminant was not a PCOEC in soil at the area of concern.

TABLE 7.2 Hazard Quotients for Aquatic Biota Based on Concentrations of Contaminants of Environmental Concern in Surface Water at the Toxic Burning Pits Area

Contaminant	Surface Water Exposure Point Concentration ^a (µg/L)	Aquatic Benchmark (µg/L)	HQ
Aluminum	18,000	460 ^b	39.1
Antimony	32.9	30 ^c	1.1
Cadmium	13.4	3.5 ^{d,e}	3.8
Calcium	205,000	116,000 ^b	1.8
Chromium	64.8	11 ^{e,f}	5.9
Copper	525	40.5 ^{d,e}	13.0
Iron	181,100	1,000.0 ^e	18.1
Lead	1,590	19.9 ^{c,d}	79.9
Mercury	1.7	1.3 ^g	1.3
Sodium	958,000	680,000 ^b	1.4
Zinc	4,040	358.9 ^{d,e}	11.3
TCLEA	4,348	2,400 ^c	1.8

^a Exposure point concentration is the 95% UCL; all other values are maximum reported concentrations.

^b Lowest chronic value for aquatic organisms from Suter and Tsao (1996).

^c Water quality benchmark value from EPA Region III BTAG screening guidelines (EPA 1996b).

^d This AWQC is a function of water hardness, which was estimated to be 422 mg CaCO₃/L by using the mean concentrations of calcium and magnesium.

^e Freshwater AWQC chronic value for the protection of aquatic biota (EPA 1986).

^f Benchmark for chromium VI; chronic benchmark for chromium III would be approximately 643 µg/L using the calculated mean hardness for the TBP AOC (422 mg CaCO₃/L) and would result in a hazard quotient of 0.1.

^g EPA ecotox threshold value (EPA 1996a).

Mammalian benchmark ADD values (Table B.4 in Appendix B) were available for 22 PCOECs, and avian ADD benchmark values were available for 14 PCOECs identified in the TBP AOC (Table 3.29). Table 7.3 presents the results of the HQ risk evaluation for the TBP. The TBP AOC poses acceptable risk ($HQ < 1$) to the great blue heron, tree swallow, red-tailed hawk, and red fox from any contaminant for which benchmark ADDs were available. Thirteen contaminants (2 organics and 11 inorganics) had HQs > 1 for at least one receptor species. Cyanide poses a low risk to the white-footed mouse and to the eastern cottontail; TRCLE poses a low risk to the muskrat, white-footed mouse, and eastern cottontail.

Among the metals, aluminum, antimony, arsenic, lead, mercury, and zinc were each found to pose an extreme risk ($HQ > 100$) for at least one modeled receptor. Of all the contaminants for which HQs were calculated, lead poses a risk to the largest number of receptors (7 out of 11 species) and had the largest HQ of any contaminants ($HQ = 3,007$ for the American robin). Lead contamination at the TBP poses an extreme risk to the American robin, white-footed mouse, and eastern cottontail. Lead poses a low risk (HQ between 1 and 10) to the American kestrel, mallard, and muskrat, and a moderate risk to the white-tailed deer. The HQs for zinc indicated extreme risk to the American robin, moderate risk to the eastern cottontail, and low risk to the mallard and white-footed mouse. Arsenic poses an extreme risk to the white-footed mouse and eastern cottontail and a moderate risk to the American robin. Aluminum poses an extreme risk to the muskrat, white-footed mouse, and eastern cottontail and a moderate risk to the American robin. Finally, mercury presents an extreme risk to the American robin; a moderate risk to the muskrat and eastern cottontail, and low risk to the mallard and white-footed mouse.

On the basis of the results of the ADD modeling and the HQ-based risk estimates, contamination at the TBP appears to pose a substantial risk to several receptors. However, the exposure point concentrations used to model the uptake of particular contaminants were frequently based on the maximum detected concentrations for the site. In actuality, the concentrations to which receptors would be exposed at the site likely range from levels much lower than the exposure point concentrations (e.g., minimum detected values) to the maximum detected concentration. The results present a conservative view of risks likely to be incurred from contamination at the site (i.e., more likely to detect risks). It should also be noted that among the contaminants for which an extreme risk was indicated, background concentrations exceeded ecological screening values for all but arsenic (Table 3.22).

7.2.1.2 Weight of Evidence

The results of the effects assessments show 19 of 32 evaluated variables to be adversely affected at the TBP AOC. On the basis of this weight of evidence indicating adverse effects, the contaminated media at this AOC pose a high risk to biota at the site.

TABLE 7.3 Hazard Quotients^a for Avian and Mammalian Receptors at the Toxic Burning Pits Area

Contaminant	Mallard	Great Blue Heron	American Robin	Tree Swallow	American Kestrel	Red-Tailed Hawk	Muskrat	White-Footed Mouse	Eastern Cottontail	White-Tailed Deer	Red Fox
1,1-Dichloroethene	- ^b	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1
Acetone	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1
Aluminum	0.2	<0.1	12.6	<0.1	<0.1	<0.1	894.9	99.6	287.2	7.1	0.5
Antimony	-	-	-	-	-	-	7.3	51.8	114.1	3.7	0.2
Aroclor 1248	<0.1	0.0	0.2	<0.1	<0.1	<0.1	0.0	<0.1	0.1	<0.1	<0.1
Arsenic	<0.1	<0.1	19.8	<0.1	<0.1	0.1	8.2	116.3	323.4	10.2	0.5
Barium	<0.1	<0.1	5.7	<0.1	<0.1	<0.1	5.1	1.4	4.7	0.2	<0.1
Cadmium	<0.1	0.1	15.7	0.1	<0.1	<0.1	14.1	2.7	4.7	0.3	<0.1
Chloroform	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	<0.1	<0.1	61.0	0.1	<0.1	<0.1	0.8	1.5	4.0	0.1	<0.1
Copper	<0.1	<0.1	17.1	<0.1	<0.1	<0.1	1.0	5.1	11.5	0.7	<0.1
Cyanide	-	-	-	-	-	-	<0.1	5.7	5.3	0.4	<0.1
Diethyl phthalate	-	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	1.8	<0.1	3,006.6	0.1	2.1	<0.1	6.5	129.0	322.8	16.6	0.4
Manganese	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.3	0.1	0.1	<0.1	<0.1
Mercury	1.4	<0.1	229.4	<0.1	0.3	<0.1	37.6	4.6	10.2	0.7	<0.1
Nickel	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	<0.1	<0.1	29.0	0.8	0.1	0.1	0.4	10.6	10.1	0.7	<0.1
TRCLE	-	-	-	-	-	-	3.0	1.4	1.2	0.1	<0.1
Vinyl chloride	-	-	-	-	-	-	0.4	0.1	<0.1	<0.1	<0.1
Zinc	5.4	<0.1	532.6	0.7	0.6	<0.1	0.7	4.9	10.8	0.7	<0.1

^a The hazard quotient (HQ) is the ratio of the modeled ADD value to the benchmark ADD value. HQ values <1.0 indicate acceptable risk to the receptor from the estimated daily contaminant dose. HQ values between 1.0 and 10.0 indicate a low potential risk for adverse effects to the receptor, values between 10.0 and 50.0 indicate a moderate potential risk, values between 50.0 and 100.0 indicate a high risk, and values exceeding 100 indicate extreme risk. Exposure point concentrations used to estimate the ADD are provided in Section 5.2.1; benchmark values are presented in Appendix B.

^b - = no benchmark ADD was available, and no HQ was calculated.

The effects assessment for the TBP AOC evaluated 17 different aquatic variables and 15 terrestrial variables. The results of these assessments are presented in Section 6 and summarized in Table 7.4. Adverse effects were indicated for 7 of the 17 aquatic variables, related primarily to acute and chronic toxicity of sediment and surface water collected from along the marsh-Pushout Area boundary. Surface waters from these locations also exceeded AWQC concentrations for some contaminants.

One effects assessment that indicated chronic surface water toxicity used the green alga *Selenastrum* as a test organism. Media toxicity to this test organism was indicated at virtually every AOC evaluated at J-Field, but no toxicity was indicated for other test organisms at most of these locations. Thus, *Selenastrum* may be an overly sensitive test species, and test results based on this species may not accurately represent the toxicity of the media evaluated.

However, even if results of the *Selenastrum*-based toxicity tests are excluded, 6 of the 16 effects assessments for aquatic variables identified adverse effects. The results of these assessments indicated reduced survival in amphipods and fish; and reduced growth in algae, vegetation, amphipods, and fish in surface water and sediment from along the marsh-Pushout Area boundary. Among the three areas in the marsh and pond where macroinvertebrate surveys were conducted, the lowest diversity was reported for the sample location nearest the Pushout Area. Thus, surface water and sediment along the marsh-Pushout Area boundary appear to pose a high potential for adverse risk to aquatic biota of the TBP AOC. No risks are identified for aquatic biota at other locations of the marsh or the pond. In those areas, no surface water or sediment toxicity was evident, macroinvertebrate species diversity was high, and a sizable fish population with no external signs of contaminant exposure was found to be present.

Of the 15 effects assessments that evaluated terrestrial media, biota, and habitats, 12 identified adverse ecological effects to soil micro- and macroinvertebrates and vegetation. Effects included reduced species diversity and abundance, reduced biomass of vegetation and soil microbiota, and alterations in parameters related to nutrient processing. The greatest impacts are associated with the Pushout Area and the main pits. On the basis of these results, the soils of the TBP AOC pose a high risk to terrestrial biota at the site.

The exposure assessment conducted at the TBP included direct measurement of tissue concentrations in vegetation, invertebrates, fish, amphibians, and small mammals, as well as contaminant uptake modeling for terrestrial vegetation and higher vertebrates. The results of the plant tissue analyses showed little or no evidence of uptake of the pesticides, PCBs, or SVOCs detected in soils at the site. Two SVOCs were measured in plant tissues from the site, but one was also detected in a laboratory blank and may reflect laboratory contamination. A single pesticide (beta-BHC) was detected in two of nine plant samples, at concentrations much below the levels reported in site soils. Contaminant tissue concentrations in insects were largely below detection

TABLE 7.4 Summary of the Ecological Effects Assessment of the Toxic Burning Pits Area

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Aquatic Parameters</i>			
Aquatic invertebrate surveys	Low abundance and species diversity; community dominated by only a few taxa	Relatively high abundance and diversity; several species from taxa known to be intolerant to contamination	No
Fish surveys	Low abundance; external conditions suggestive of contaminant exposure, such as lesions, tumors, and fin decay	Four species collected, one in large numbers typical of populations reported elsewhere; no obvious external signs of contaminant exposure	No
Microtox, surface water, acute toxicity	Bacterial inhibition indicating toxicity	Inhibition level not different from control	No
Microtox, sediment, acute toxicity	Bacterial inhibition indicating toxicity	Inhibition greater than control from two locations along the marsh-Pushout Area boundary	Yes
<i>Daphnia</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Pimephales</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Rana</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Hyalella</i> , sediment, 10-day acute toxicity	Reduced survival	Reduced survival observed at one location next to the Pushout Area	Yes
<i>Hyalella</i> , sediment, 10-day acute toxicity	Reduced growth	No reduction in growth	No
<i>Lemna</i> , surface water, 96-hour chronic toxicity	Reduced growth	Reduced growth from three locations, all adjacent to the Pushout Area	Yes
<i>Selenastrum</i> , surface water, 96-hour chronic toxicity	Reduced growth	Reduced growth at all locations except one from the pond	Yes
<i>Ceriodaphnia</i> , surface water, 7-day chronic toxicity	Reduced survival	No reduction in survival	No
<i>Ceriodaphnia</i> , surface water, 7-day chronic toxicity	Reduced reproduction	No reduction in reproduction	No
<i>Hyalella</i> , sediment, 28-day chronic toxicity	Reduced survival	No reduction in survival	No
<i>Hyalella</i> , sediment, 28-day chronic toxicity	Reduced growth	Reduced growth detected at one location next to the Pushout Area	Yes
<i>Pimephales</i> , surface water, 7-day chronic toxicity	Reduced survival	Reduced survival from one location next to the Pushout Area	Yes
<i>Pimephales</i> , surface water, 7-day chronic toxicity	Reduced growth	Reduced growth from two locations, both near the Pushout Area	Yes

TABLE 7.4 (Cont.)

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Terrestrial Parameters</i>			
Terrestrial vegetation surveys	Reduced species diversity	Species diversity greatly reduced in the Pushout Area and other areas with high total metal concentrations in soil	Yes
Determination of terrestrial vegetation biomass	Reduced plant biomass	Biomass reduced in AOC, particularly in Pushout Area; areas with low biomass associated with high total metal concentrations in soil	Yes
Soil-dwelling macro-invertebrate surveys	Reduced abundance and diversity	Reduced abundance and diversity	Yes
Soil nematode surveys	Reduced abundance and altered trophic structure in disturbed areas	Reduced abundance and altered trophic structure	Yes
Soil microbial biomass	Reduced biomass in disturbed areas	Reduced bacterial and fungal biomass; negatively correlated with total soil metal concentration	Yes
Soil respiration rates	Reduced rates in disturbed areas	Reduced respiration rate	Yes
Concentration of microbial biomass nitrogen	Reduced amount of biomass nitrogen in soils from disturbed areas	No reduction in biomass nitrogen	No
Nutrient-acquiring enzyme activity	Reduced enzyme activity in disturbed areas	Significantly lower enzyme activity; activity significantly and negatively correlated with total heavy metal content of soil	Yes
<i>In situ</i> litter decomposition rates	Decomposition rates reduced in disturbed areas	Significantly altered (higher) decomposition rates in pits; may lead to increased nutrient leaching	Yes
Soil nutrient and carbon dynamics	Reduction in soil nitrogen mineralization rate	Mineralization rate significantly reduced	Yes
Screening soil toxicity testing with earthworms	Reduced survival and/or growth in contaminated soils	Reduced survival and growth in soils from the Pushout Area and Main Southern Pit	Yes
Definitive soil toxicity test with earthworms	Reduced survival and/or growth in test soils with high proportion of contaminated soil	Significant weight loss in all test soils with >25% contaminated soil	Yes
Soil toxicity test with lettuce seeds	Reduced seed emergence rate (SER) and/or seedling survival and/or seedling growth	0-25% SER for soils from the Pushout Area and Southern Main Pit; SER < 75% from other areas of AOC; 100% SER but 0% survival for soils from VX Pit	Yes
Qualitative avian surveys	Reduced species diversity	High species diversity, with more than 110 species recorded in AOC and immediate vicinity	No
Evaluation of bird nesting success with nest boxes	No nesting or successful fledging of young	One of two nest boxes used by eastern bluebirds; 9 birds fledged	No

limits for most SVOCs, pesticides, and PCBs. Several metals were detected in plant and insect tissues, but all at levels below measured soil concentrations. Thus, significant bioconcentration or biomagnification by vegetation or insects is not evident. Similar tissue results were obtained for fish and amphibians. Tissue analyses of small mammals collected from the AOC showed tissue levels of most contaminants to be below detection limits. The PCB Aroclor 1260 was detected only in a single specimen, and 5 metals were detected in all 10 animals analyzed. The metals were present at levels that did not differ significantly from levels measured in mice from a reference site.

Risk estimation from concentration-based HQs indicate extreme or moderate risks to terrestrial vegetation from seven soil contaminants (all metals) and to aquatic biota from five surface water contaminants (all metals).

Contaminant uptake modeling and risk estimation based on the ADD-based HQ identified moderate to extreme risk to a variety of terrestrial receptors from 10 contaminants. Extreme risks were identified for four receptor species from five metals, while moderate to high risks were identified for four receptor species from eight contaminants (all metals). The number of receptors for which high or extreme risks were identified, together with the results of the effects assessment, supports the risk characterization that the TBP AOC poses a high risk to ecological resources.

7.2.1.3 Ecological Significance

The risks identified for the TBP AOC may be significant at a local scale for most terrestrial wildlife that use the site. Adverse impacts were identified for several ecological variables and across multiple taxa and trophic levels. However, these impacts should largely be restricted to biota that occur within the AOC boundaries and not extend to other areas of J-Field or APG. Potential impacts on wide-ranging biota may affect wildlife populations that are not restricted to the J-Field boundary. The use of the site by waterfowl and avian predators such as the red-tailed hawk and American kestrel is of particular concern given the potential importance of the surrounding marsh to waterfowl and the implication that impacts on raptor populations could decrease control of prey populations in the J-Field area. However, only low or acceptable risks were identified to these receptors for most of the PCOECs. Thus, the overall significance of the risk this AOC poses to wide-ranging receptors is small.

7.2.2 White Phosphorus Burning Pits Area of Concern

On the basis of the risk characterization of the WPP AOC, this site poses a low risk for adverse ecological impacts. A potential low risk is associated primarily with contaminated soils of the presumed pushout area and the north pit. This risk estimate is based on the results of toxicity tests that evaluated earthworm survival and growth, lettuce SER, and seedling growth and survival;

HQ estimates based on concentrations of contaminants in soil and surface water and on the modeled uptake of contaminants by vertebrate receptors. Because the WPP AOC continues to be used for open detonation operations, additional contamination of the site is possible and may increase the potential for adverse impacts to ecological resources in the future. Risk estimates for the WPP AOC using the HQ, and based on the weight of evidence, are discussed below.

7.2.2.1 Hazard Quotient

Concentration-based HQs (Table 7.1) indicate that zinc in the soil at the WPP AOC poses a high risk of adverse effects to terrestrial vegetation, while lead poses only low risk to terrestrial vegetation and chromium only a moderate level of risk.

The HQs based on exposure point concentrations of surface water at the WPP (Table 5.17) and benchmark NOAEL and AWQC concentrations (Table 7.5) suggest that aluminum and iron could pose a moderate risk to aquatic organisms; a low risk was indicated for copper, chromium, lead, and zinc.

TABLE 7.5 Hazard Quotients for Aquatic Biota Based on Concentrations of Contaminants of Environmental Concern in Surface Water at the White Phosphorus Burning Pits Area

Contaminant	Surface Water Exposure Point Concentration (µg/L)	Aquatic Benchmark (µg/L)	HQ
Aluminum	8,390	460 ^a	18.2
Chromium	16.0	11.0 ^{b,c}	1.45
Copper	52.3	26.5 ^{b,d}	1.97
Iron	28,400	1,000.0 ^e	28.4
Lead	76.1	10.6 ^{b,d}	7.18
Mercury	0.10	1.3 ^e	0.08
Zinc	411.0	236.2 ^{b,d}	1.74

^a Lowest chronic value for aquatic organisms from Suter and Tsau (1996).

^b Freshwater AWQC chronic value (EPA 1986).

^c AWQC for chromium VI; chronic AWQC for chromium III would be approximately 429.4 µg/L using a mean calculated hardness of 258 mg CaCO₃/L, and would result in an HQ of <0.1.

^d This AWQC is a function of water hardness, which was estimated to be 258 by using the mean concentrations of calcium and magnesium.

^e EPA ecotox threshold value (EPA 1996a).

Table 7.6 presents the results of the ADD-based HQ risk evaluation for terrestrial wildlife at the WPP AOC. The WPP AOC poses acceptable risk to the mallard, American kestrel, and the red-tailed hawk for all PCOECs for which benchmark ADDs were available, and a low risk from two contaminants to the tree swallow (from zinc and lead) and from a single contaminant for the red fox (from aluminum). Potential risk from lead and antimony (and possibly mercury: HQ = 1.0) to the eastern cottontail is low. There is a moderate risk to the American robin from lead, aluminum, and zinc. An extreme risk from aluminum was indicated for the white-footed mouse and the eastern cottontail; aluminum poses a moderate risk to the American robin and white-tailed deer.

7.2.2.2 Weight of Evidence

A total of 23 ecological variables were evaluated as part of the effects assessment of the WPP AOC to evaluate whether existing site conditions are adversely affecting aquatic and terrestrial ecological resources. Table 7.7 summarizes the results. The evaluations show 3 of 23 ecological variables to be adversely affected at the WPP AOC. On the basis of these results, the contaminated media at the WPP AOC pose a very low risk to ecological receptors at the site; any risks would be associated with contaminated soils.

A total of 11 aquatic variables were evaluated as part of the effects assessment at the WPP AOC. Assessment methods included media toxicity tests and surveys of fish and invertebrates. Only chronic surface water toxicity tests with the green alga *Selenastrum* indicated adverse effects to aquatic biota. As previously discussed, *Selenastrum* may be an overly sensitive test organism for the natural water conditions at the site, and the results for this alga may overestimate surface water toxicity. Low risks were identified for chromium, copper, and zinc; moderate risks for iron and lead; and a high risk for aluminum.

A total of 12 terrestrial variables were used to evaluate existing adverse effects at the WPP AOC associated with terrestrial media, biota, and habitats (Table 7.7). The effects assessment evaluated the abundance and diversity of soil invertebrates and vegetation, soil nutrient cycling processes, soil toxicity to vegetation and invertebrates, surveys of amphibian and bird species, and bird nesting success. Only 2 of the 12 evaluations identified adverse effects. The effects included reduced growth but not reduced survival in earthworms and reduced seedling emergence and growth but not reduced survival in soils collected from the presumed pushout area and north pit. On the basis of these results, contaminated soils at the WPP AOC pose a low risk to terrestrial biota.

Tissue analyses for contaminants were limited to amphibians. Two frogs were analyzed for whole-body burdens of PCBs, pesticides, explosives, and heavy metals. Only chromium was detected.

TABLE 7.6 Hazard Quotients^a for Avian and Mammalian Receptors at the White Phosphorus Burning Pits Area

Contaminant	Receptor								
	Mallard	American Robin	Tree Swallow	American Kestrel	Red-Tailed Hawk	White-Footed Mouse	Eastern Cottontail	White-Tailed Deer	Red Fox
Aluminum	<0.1	13.6	<0.1	<0.1	<.01	104.1	800.1	40.9	2.7
Antimony	- ^b	-	-	-	-	0.3	1.7	0.1	<0.1
Benzo(a)anthracene	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	-	-	-	-	-	<0.1	<0.1	<0.1	<0.1
Benzo(b)fluoranthene	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	-	-	-	-	-	-	-	-	-
bis(2-ethylhexyl)phthalate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	<0.1	1.7	0.2	<0.1	<0.1	0.4	0.9	0.1	<0.1
Chromium	<0.1	2.6	<0.1	<0.1	<0.1	<0.1	0.4	<0.1	<0.1
Chrysene	-	-	-	-	-	-	-	-	-
Copper	<0.1	0.4	<0.1	<0.1	<0.1	0.2	0.5	<0.1	<0.1
Fluoranthene	<.01	<.01	<.01	<.01	<.01	<0.1	-	-	-
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	<0.1	-	-	-
Iron	-	-	-	-	-	-	-	-	-
Lead	<0.1	33.6	3.1	0.2	<.01	0.6	2.3	0.2	<0.1
Magnesium	-	-	-	-	-	-	-	-	-
Mercury	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	1.0	0.1	<0.1
Nickel	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-
Zinc	<0.1	27.1	3.6	0.3	<0.1	0.3	0.9	0.1	<0.1

^a The HQ is the ratio of the modeled ADD value to the benchmark ADD value. HQ values <1.0 indicate acceptable risk to the receptor from the estimated daily contaminant dose. HQ values between 1.0 and 10.0 indicate a low risk for adverse effects to the receptor, values between 10.0 and 50.0 indicate a moderate risk, values between 50.0 and 100.0 indicate a high risk, and values exceeding 100 indicate extreme risk. Exposure point concentrations used to estimate the ADD are provided in Section 5.2.1; benchmark values are presented in Appendix B.

^b - = no benchmark ADD was available, and no HQ was calculated.

TABLE 7.7 Summary of Ecological Effects Assessment of the White Phosphorus Burning Pits Area

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Aquatic Parameters</i>			
Aquatic invertebrate surveys	Low abundance and species diversity; community dominated by only a few taxa	Variety of invertebrate taxa present	No
Fish surveys	Low abundance; external conditions suggestive of contaminant exposure, such as lesions, tumors, and fin decay	No fish collected; absence likely due to isolated nature of habitat and probable complete drying of pond during drought	No
Microtox, surface water, acute toxicity	Bacterial inhibition indicating toxicity	Inhibition level not different from control	No
Microtox, sediment, acute toxicity	Bacterial inhibition indicating toxicity	Inhibition level not different from control	No
<i>Daphnia</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Pimephales</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Rana</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Hyalella</i> , sediment, 10-day acute toxicity	Reduced survival	No reduction in survival	No
<i>Hyalella</i> , sediment, 10-day acute toxicity	Reduced growth	No reduction in growth	No
<i>Lemna</i> , surface water, 96-hour chronic toxicity	Reduced growth	No reduction in growth	No
<i>Selenastrum</i> , surface water, 96-hour chronic toxicity	Reduced growth	Reduced growth at all sampling locations	Yes
<i>Terrestrial Parameters</i>			
Terrestrial vegetation surveys	Reduced species diversity and richness	Species diversity and richness similar to or greater than those at reference site	No
Soil-dwelling macro-invertebrate surveys	Reduced abundance and diversity	No reduction in abundance and diversity	No
Soil respiration rates	Reduced rates in disturbed areas	No reduction in soil respiration rate	No
Concentration of microbial biomass nitrogen	Reduced biomass nitrogen in soils from disturbed areas	No reduction in biomass nitrogen	No
<i>In situ</i> litter decomposition rates	Reduced decomposition rates in disturbed areas	No reduction in litter decomposition rates	No
Soil nutrient dynamics	Reduced rates of nitrogen mineralization	No reduction in net nitrogen mineralization for soils from the pit area	No
Screening soil toxicity testing with earthworms	Reduced survival and/or growth in contaminated soils	No reduction in survival (93-100% at all sites); reduced growth for sample from the presumed pushout area; no growth reduction from other locations	Yes

TABLE 7.7 (Cont.)

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Terrestrial Parameters (Cont.)</i>			
Soil toxicity test with lettuce seeds	Reduced seed emergence rate (SERs), seedling survival, and/or seedling growth	70% SER for soils from north pit and the presumed pushout area; 50% reduction in growth for the presumed pushout area; no growth reduction evident for other locations	Yes
Soil nematode surveys	Reduced abundance and altered trophic structure	No reduction in abundance; no altered trophic structure	No
Qualitative amphibian surveys	Low diversity and limited use of habitats	5 amphibian species reported; presence of eggs and larvae indicates habitats used for reproduction	No
Qualitative avian surveys	Low diversity and limited use of habitats	Many species observed in the immediate vicinity of the site, including bald eagle, osprey, and waterfowl	No
Evaluation of bird nesting success in nest boxes	No nesting or successful fledging of young	Single nest box placed at site used by eastern bluebirds; 4 birds fledged	No

Low and moderate risks to terrestrial vegetation from chromium and zinc, respectively, and low to moderate risks to aquatic organisms from copper, iron, lead, and zinc were indicated by concentration-based HQ values for soil and surface water.

Contaminant uptake modeling and risk estimation using the ADD-based HQ approach also identified predominantly acceptable and low risks of adverse effects to selected avian and mammalian receptors. Except for the moderate risks identified for the American robin from aluminum, lead, and zinc, a moderate risk to the white-tailed deer from aluminum and an extreme risk to the white-footed mouse and eastern cottontail from aluminum, all risk estimates were low.

7.2.2.3 Ecological Significance

The impacts and risks identified for the WPP AOC are generally low, and limited to biota that would use the pits and the presumed pushout area. Because of the small size of and limited habitat in these areas, relatively few wildlife species are expected to use these locations. Any adverse impacts should be restricted to biota found within the AOC boundaries and not extend to other areas of J-Field or APG. Thus, the overall significance of the risk this AOC poses to ecological resources is small.

7.2.3 Riot Control Pit Area of Concern

The results of the effects assessments, tissue analyses, HQ risk estimates, and the extent and magnitude of the measured effects suggest that the contaminated media at the RCP AOC pose only a low risk to ecological resources. Little evidence exists that surface water at the site poses a risk to aquatic biota, particularly given the very limited aquatic habitat present at the site. Identified risks at the site are related to soil contamination. However, the magnitude of some impacts (slight reduction in earthworm weight) is minor, while impacts on plant biomass may be due more to factors unrelated to contamination (i.e., physical habitat disturbance from excavation). In addition, the adverse effects identified at the site were largely limited to the immediate vicinity of the trench and are not widespread across the AOC. Thus, the overall risk posed by the site is low, limited to terrestrial biota and soil processes, and largely restricted to the immediate vicinity of the trench. Risk estimates for the RCP AOC using the HQ, and based on the weight of evidence, are discussed below.

7.2.3.1 Hazard Quotient

The HQs for soil contaminants suggest that concentrations of chromium, copper, lead, zinc and possibly nickel ($HQ = 1.0$) in the soils of the RCP AOC pose a moderate risk of adverse effects to terrestrial vegetation (Table 7.1).

The HQs for surface water contaminants indicate low or acceptable risk to aquatic biota, with values ranging from 0.9 for aluminum to 1.5 and 1.6 for iron and sodium, respectively.

Table 7.8 presents the results of the ADD-based HQ risk evaluation for wildlife receptors at the RCP AOC. Risk estimates exceeding 1.0 were determined for five receptors from six metals. The RCP AOC poses only a low risk from aluminum to the white-tailed deer and the red fox. The HQ values indicated that cadmium poses a low risk for the American robin and eastern cottontail, and aluminum, chromium, lead, and zinc present moderate risks to the American robin. Copper presents a low potential risk to the American robin and eastern cottontail. An extreme risk is indicated for aluminum to the white-footed mouse and eastern cottontail.

7.2.3.2 Weight of Evidence

The effects assessment at the RCP AOC evaluated 25 ecological variables for possible adverse impacts from site contamination. The results of these assessments are presented in Section 6

TABLE 7.8 Hazard Quotients^a for Avian and Mammalian Receptors at the Riot Control Pit Area

Contaminant	Receptor				
	American Robin	White-Footed Mouse	Eastern Cottontail	White-Tailed Deer	Red Fox
Aluminum	14.6	111.5	589.1	14.3	1.1
Antimony	^b	0.2	0.9	<0.1	<0.1
Cadmium	4.2	0.9	1.6	0.1	<0.1
Chromium	13.1	0.3	1.5	<0.1	<0.1
Copper	3.0	0.9	2.8	0.1	<0.1
Lead	58.4	0.6	3.5	0.1	<0.1
Magnesium	-	-	-	-	-
Mercury	0.2	<0.1	0.6	<0.1	<0.1
Nickel	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	0.1	0.1	-	-	-
Zinc	13.6	0.2	0.1	<0.1	<0.1

^a The HQ is the ratio of the modeled ADD value to the benchmark ADD value. HQ values <1.0 indicate acceptable risk to the receptor from the estimated daily contaminant dose. HQ values between 1.0 and 10.0 indicate a low risk for adverse effects to the receptor, values between 10.0 and 50.0 indicate a moderate risk, values between 50.0 and 100.0 indicate a high risk, and values exceeding 100 indicate extreme risk. Exposure point concentrations used to estimate the ADD are provided in Section 5.2.1; benchmark values are presented in Appendix B.

^b - = no benchmark ADD was available, and no HQ was calculated.

and summarized in Table 7.9. The results of the assessment indicated 8 out of 25 variables to be adversely affected. On the basis of these adverse effects, the contaminated media at the RCP AOC appear to pose a high risk to ecological resources at the site. However, some reported effects may not adequately represent contamination effects. The nature and consequences of these effects are discussed below.

A total of 12 aquatic variables were evaluated at the RCP AOC in media toxicity tests and surveys of invertebrates and fish. Reduced growth in the green alga *Selenastrum* was the only adverse effect indicated. No impacts on survival, growth, and reproduction were detected for zooplankton, amphipods, vascular plants, or amphibians. HQ risk estimates identified low risks for iron and sodium. Thus, the surface waters and sediment at the RCP AOC are considered to pose acceptable risk to aquatic biota.

TABLE 7.9 Summary of the Ecological Effects Assessment of the Riot Control Pit Area

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Aquatic Parameters</i>			
Aquatic invertebrate surveys	In permanent habitats, low abundance and species diversity; community dominated by only a few taxa	Limited community typical of ephemeral habitats	- ^a
Fish surveys	In permanent habitats, low abundance; external conditions suggestive of contaminant exposure, such as lesions, tumors, and fin decay	No fish collected; none expected because habitats are ephemeral	-
Microtox, surface water, acute toxicity	Bacterial inhibition indicating toxicity	Inhibition level not different from control	No
Microtox, sediment, acute toxicity	Bacterial inhibition indicating toxicity	Inhibition level not different from control	No
<i>Daphnia</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Rana</i> , surface water, 96-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Hyalella</i> , sediment, 28-day chronic toxicity	Reduced survival	No reduction in survival	No
<i>Hyalella</i> , sediment, 28-day chronic acute toxicity	Reduced growth	No reduction in growth	No
<i>Lemna</i> , surface water, 96-hour chronic toxicity	Reduced growth	No reduction in growth	No
<i>Selanastrum</i> , surface water, 96-hour chronic toxicity	Reduced growth	Reduced growth	Yes
<i>Ceriodaphnia</i> , surface water, 7-day chronic toxicity	Reduced survival	No reduction in survival	No
<i>Ceriodaphnia</i> , surface water, 7-day chronic toxicity	Reduced reproduction	No reduction in reproduction	No
<i>Terrestrial Parameters</i>			
Terrestrial vegetation surveys	Reduced species diversity	No reduction in species diversity	No
Terrestrial plant biomass	Reduced plant biomass	Lower biomass at 3 locations than at other areas	Yes
Epigeic invertebrate activity	Reduced activity and diversity	No reduction in activity	No
Soil nematode surveys	Reduced abundance and altered trophic structure in disturbed areas	Reduced abundance and altered trophic structure	Yes
Soil microbial biomass	Reduced biomass in disturbed areas	No reduction in active bacterial and fungal biomass; reduction in total fungal biomass	Yes
Soil respiration rates	Reduced rates in disturbed areas	No reduction in respiration rate	No
Concentration of microbial biomass nitrogen	Reduced amount of biomass nitrogen in soils from trench	50% reduction in biomass nitrogen	Yes

TABLE 7.9 (Cont.)

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Terrestrial Parameters (Cont.)</i>			
Nutrient-acquiring enzyme activity	Reduced enzyme activity in soils from trench	No reduction in enzyme activities	No
Determination of <i>in situ</i> litter decomposition rates	Decomposition rates reduced in disturbed areas	Litter decomposition significantly lower in trench than local background	Yes
Evaluation of nutrient dynamics	Reduced nitrogen mineralization	Net nitrogen mineralization greater at local background than at trench	Yes
Screening soil toxicity testing with earthworms	Reduced survival and/or growth in contaminated soils	100% survival in all site samples; 6% weight loss for trench soils	No
Soil toxicity test with lettuce seeds	Reduced seed emergence rates (SERs), seedling survival, height, and/or weight	0% SER for soils from north site, 78-87% from other areas of AOC; no reduction in seedling height or weight for trench soils	Yes
Evaluation of bird nesting success in nest boxes	No nesting or successful fledging of young	Single nest box used by eastern bluebird; 4 young fledged	No

^a - = the results are equivocal; aquatic biota absent or limited in abundance due to ephemeral nature of the aquatic habitat.

A total of 13 terrestrial variables were evaluated at the RCP AOC, including invertebrate abundance and activity, soil respiration rates, litter decomposition rates, nutrient-cycling dynamics, soil toxicity to invertebrates and vegetation, plant diversity and biomass, and avian fledging success. The effects assessment showed 7 of the 13 variables were affected, suggesting a high potential risk to terrestrial ecological resources at the site. Three variables are related to soil nutrient cycling dynamics; litter decomposition, nitrogen mineralization, and biomass nitrogen. The results of the soil toxicity test were somewhat contradictory. In toxicity tests, earthworms experienced 100% survival in soils from all sites, a slight weight loss in soils from the trench, and a slight increase in growth in soils from the northern portion of the site. However, the weight loss was slight and not statistically significant from controls. In contrast, no seedlings emerged in soils from the northern (downgradient) portion of the site, but the SER was not reduced in soils from other locations. Seedling height and weight were not affected in soils from the trench. Plant biomass was significantly reduced at some locations.

It is not clear to what extent site contamination may be responsible for the adverse effects indicated for the RCP AOC. The locations with reduced plant biomass and altered nutrient cycling dynamics are also areas where the A soil horizon is largely absent, probably because of the original

excavation of the trench. The A horizon is the nutrient-rich soil layer, and the absence of this soil layer may be more responsible for the observed adverse effects than is any soil contamination.

Tissue analyses of vegetation, insects, and mice from the site yielded results similar to those from the TBP AOC. No pesticides or PCBs were detected in vegetation or insects. Although no SVOCs were detected in insects or mice, two were detected in plant tissue. One SVOC, however, was also detected in the laboratory blank and probably reflects laboratory contamination. The pesticide p,p'-DDE was detected in one mouse, and Aroclor 1260 was detected in two mice. Several metals were also detected in the mice, but at levels similar to or less than those measured in mice from the reference site.

The HQ values for concentrations of contaminants in soil indicated that chromium, copper, lead, nickel, and zinc pose a moderate risk to terrestrial vegetation. Contaminant uptake modeling and risk estimation based on the HQ identified extreme risks to two receptors from aluminum and a moderate risk to a single receptor from lead; most risk estimates were below 10.0. On the basis of the HQ risk estimates, the results of the effects assessments, and the relatively small size of the RCP AOC, the overall risk posed by this AOC is considered to be low.

7.2.3.3 Ecological Significance

On the basis of the effects assessments and the uptake modeling, the RCP AOC poses a low risk to ecological resources. Because of the small size of the trench to which the adverse effects and high HQ risk estimates were limited and the limited habitat the trench provides for wildlife at J-Field, the overall ecological significance of any risks the RCP AOC poses to ecological resources is considered minor.

7.2.4 South Beach Trench Area of Concern

On the basis of the HQ and weight-of-evidence approaches, the SBT AOC poses little risk to ecological resources. No adverse effects to ecological parameters were identified for surface water and sediment from the AOC. For soils, adverse effects included reduced plant biomass and seedling germination. These effects, however, were limited to the soils directly in the trench and did not extend beyond the boundaries of the trench. The HQ risk estimates identified a moderate risk to two receptors from aluminum and low risks from cadmium, lead, and zinc to a single receptor. Risk estimates for the SBT AOC using the HQ, and based on the weight of evidence, are discussed below.

7.2.4.1 Hazard Quotient

Eight contaminants were considered PCOECs for soils at the SBT AOC (Table 3.29). Of these, HQ risk estimation indicated moderate potential risks to terrestrial vegetation only from zinc (Table 7.1). Acceptable risks (HQs <1.0) were indicated for other PCOECs.

Aluminum, iron, silver, and zinc were the contaminants retained after the screening process for surface water at the SBT AOC. Comparisons of ambient concentrations of these contaminants with AWQC indicate low potential risks to aquatic biota from iron and zinc.

Table 7.10 presents the results of the HQ risk evaluation for the SBT AOC. The exposure point concentration of aluminum at the SBT AOC poses a moderate potential risk to the white-footed mouse and the eastern cottontail and a low potential risk to the American robin. Cadmium, lead, and zinc were found to pose low risks to the American robin. Acceptable risk was indicated for the white-tailed deer and red fox for all PCOECs.

TABLE 7.10 Hazard Quotients^a for Avian and Mammalian Receptors at the South Beach Trench Area

Contaminant	American Robin	White-Footed Mouse	Eastern Cottontail	White-Tailed Deer	Red Fox
Aluminum	3.0	41.0	37.5	0.9	<0.1
Cadmium	1.1	0.4	0.1	<0.1	<0.1
Iron	^b	-	-	-	-
Lead	2.2	0.1	<0.1	<0.1	<0.1
Magnesium	-	-	-	-	-
Nickel	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	2.7	0.1	<0.1	<0.1	<0.1

^a The HQ is the ratio of the modeled ADD value to the benchmark ADD value. HQ values <1.0 indicate acceptable risk to the receptor from the estimated daily contaminant dose. HQ values between 1.0 and 10.0 indicate a low risk for adverse effects to the receptor, values between 10.0 and 50.0 indicate a moderate risk, values between 50.0 and 100.0 indicate a high risk, and values exceeding 100 indicate extreme risk. Exposure point concentrations used to estimate the ADD are provided in Section 5.2.1; benchmark values are presented in Appendix B.

^b - = no benchmark was available and no HQ was calculated.

7.2.4.2 Weight of Evidence

A total of 24 ecological variables were evaluated as part of the effects assessments at the SBT AOC. Table 7.11 summarizes the results. Adverse effects were indicated for 3 of the 24 variables. Low risks to aquatic biota were identified for iron and zinc. Only 1 of the 13 variables, growth of the green alga *Selenastrum*, was adversely affected. Other evaluations included toxicity tests with zooplankton, vascular plants, amphipods, amphibians, and fish. Except for fish, each of these groups is represented by biota at the site. On the basis of these results, the SBT AOC poses an acceptable risk to aquatic biota at the site.

A total of 11 variables were evaluated by the terrestrial-based effects assessment at the site; adverse effects were identified for only 2 variables. These effects included reduced SERs (but no evidence of complete emergence failure) in soils from the pit and reduced plant biomass in the pit. No adverse effects were identified for any locations outside the pit. The observed effects are probably related, because a reduced germination rate would result in fewer plants and lower biomass. The observed effects, however, are limited in magnitude and confined to the pit itself. Thus, the soils of the SBT AOC are considered to pose a low to moderate risk to ecological resources, primarily vegetation found in the pit.

No tissue analyses were conducted for this AOC. Uptake modeling and risk estimation based on the HQ identified a moderate potential risk to the white-footed mouse and the eastern cottontail from aluminum exposure. On the basis of the HQ risk estimate and the results of the effects assessments, the weight of evidence indicates that the SBT AOC poses little risk to ecological resources.

7.2.4.3 Ecological Significance

On the basis of the limited evidence of adverse effects, the highly localized nature of impacts measured at the site, the low modeled uptake of all contaminants except aluminum, and the small size of the trench, the ecological significance of risks posed by the SBT AOC is minor. Any impacts are expected to be largely restricted to biota that occur within the trench itself and not to extend to other areas of J-Field or APG.

7.2.5 South Beach Demolition Ground Area of Concern

Most of the SBDG AOC is located offshore of the current J-Field shoreline and is typically under water throughout the year. Thus, ERA activities at the SBDG AOC were limited almost exclusively to surface water and sediment within a single large detonation crater located in the northern portion of the AOC. The results of the contaminant screening process identified aluminum,

TABLE 7.11 Summary of the Ecological Effects Assessment of the South Beach Trench Area

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Aquatic Parameters</i>			
Microtox, surface water, acute toxicity	Bacterial inhibition indicating toxicity	Inhibition level not different from control	No
Microtox, sediment, acute toxicity	Bacterial inhibition indicating toxicity	Inhibition level not different from control	No
<i>Daphnia</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Pimephales</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Rana</i> , surface water, 96-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Hyalella</i> , sediment, 10-day acute toxicity	Reduced survival	No reduction in survival	No
<i>Hyalella</i> , sediment, 10-day acute toxicity	Reduced growth	No reduction in growth	No
<i>Ceriodaphnia</i> , surface water, 7-day chronic toxicity	Reduced survival	No reduction in survival	No
<i>Ceriodaphnia</i> , surface water, 7-day chronic toxicity	Reduced growth	No reduction in growth	No
<i>Lemna</i> , surface water, 96-hour chronic toxicity	Reduced production	No reduction in production	No
<i>Selenastrum</i> , surface water, 96-hour chronic toxicity	Reduced production	55% inhibition in production	Yes
<i>Hyalella</i> , sediment, 28-day chronic toxicity	Reduced survival	No reduction in survival	No
<i>Hyalella</i> , sediment, 28-day chronic toxicity	Reduced growth	No reduction in growth	No
<i>Terrestrial Parameters</i>			
Terrestrial vegetation biomass	Reduced plant biomass	Significantly lower biomass in the trench than at other locations in the AOC	Yes
Abundance of soil-dwelling macroinvertebrates	Reduced abundance and/or diversity	No reduction in abundance or diversity	No
Activity of epigeic macroinvertebrates	Reduced activity	No reduction in activity	No
Soil nematode surveys	Reduced abundance and altered trophic structure	No reduction in abundance; no alteration of trophic structure	No
Soil microbial biomass	Reduced biomass	No reduction in fungal and bacterial biomass	No

TABLE 7.11 (Cont.)

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Terrestrial Parameters (Cont.)</i>			
Abundance of soil-dwelling protozoans	Reduced abundance	No reduction in abundance	No
Nutrient-acquiring enzyme activity	Reduced enzyme activity	No reduction in activity	No
Soil respiration rates	Reduced respiration rate	No reduction in respiration rate	No
Soil toxicity with lettuce seeds	Reduced seed emergence rates (SERs)	Reduced SER for soils from the trench	Yes
Amphibian surveys	Reduced species diversity or use of available habitat	One species identified, but few amphibians expected because aquatic habitats are ephemeral	^a
Avian nesting success with nest boxes	Reduced fledging success	No birds used the single nest box placed at AOC	^b

^a The results are equivocal because of the ephemeral nature of the habitats.

^b Because no birds used the nest box, it was not possible to evaluate fledging success. Thus, the results are equivocal.

iron, lead, and zinc as PCOECs for this AOC. Uptake modeling and HQ risk estimation were performed for these PCOECs using the SBDG crater as a drinking water source. No soil-based evaluations were conducted at the site. Terrestrial plant biomass evaluations were conducted near the AOC; these are addressed as part of the SBT AOC assessment. On the basis of the toxicity tests, amphibian surveys, tissue analyses, and dose modeling, the crater north of the SBDG AOC appears to pose very little risk to aquatic biota. The HQ risk estimates and the weight-of-evidence evaluation are discussed below.

7.2.5.1 Hazard Quotients

The HQs calculated by comparing concentrations of surface water PCOECs to water quality benchmarks indicated a low potential risk to aquatic receptors from iron. Uptake modeling and the resulting HQ estimation for mammalian and avian receptors indicated no potential for adverse effects (all HQs less than 1.0) from the concentrations of PCOECs in the surface water at the SBDG crater.

7.2.5.2 Weight of Evidence

The effects assessment of the crater evaluated six variables. Adverse effects were indicated for two of the six parameters evaluated, suggesting that the site likely poses a risk to ecological resources of the AOC. Table 7.12 summarizes the results. Exposure to sediments from the crater reduced both growth and survival in the amphipod *Hyaella*. No effects on zooplankton, amphibians, or vascular plants (*Lemna* sp.) were indicated by the other toxicity tests. A variety of aquatic invertebrates, including amphipods, were observed in the pond. In addition, a variety of amphibians were found using the crater; the presence of frog larvae and salamander adults indicates several species use the pond for reproduction.

Little evidence exists of contaminant uptake by amphibians that use the crater. Analyses of frog tissue for pesticides, explosives residues, and heavy metals found only chromium and p,p'-DDE at concentrations above detection limits. These results, however, are based on the analysis of only a single individual.

TABLE 7.12 Summary of the Ecological Effects Assessment of the South Beach Demolition Ground Area

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Ceriodaphnia</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Rana</i> , surface water, 96-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Lemna</i> , surface water, 96-hour chronic toxicity	Reduced production	No reduction in production	No
<i>Hyaella</i> , sediment, 28-day chronic toxicity	Reduced survival	Reduced survival	Yes
<i>Hyaella</i> , sediment, 28-day chronic toxicity	Reduced growth	Reduced growth	Yes
Amphibian survey	Few or no species present	<i>Rana</i> adults and larvae present, indicating reproduction; red-spotted newt and spotted salamanders observed, indicating use of crater for reproduction	No

7.2.5.3 Ecological Significance

On the basis of the results of the effects assessments and the contaminant screening process, the detonation crater located immediately north of the SBDG AOC poses only a very low risk to ecological resources at the AOC and no ecologically significant risk to resources at the J-Field site.

7.2.6 Robins Point Demolition Ground Area of Concern

The effects assessment at the RPDG AOC identified adverse effects for several ecological variables, primarily related to surface water toxicity and biologically mediated soil processes. Risk estimation based upon the HQ identified potential risks to aquatic organisms from 9 of the 11 PCOECs for the RPDG. In addition, potential risks to terrestrial vegetation were identified for two soil contaminants, and potential risks to three wildlife receptors were indicated for three of the PCOECs for the site. The risks were primarily associated with the soils and ponded surface water in the clear area of the site. The assessment of the RPDG AOC did not address the active portion of the site. However, contaminant transport by runoff percolation through the berm separating the active and inactive portions of the site is considered the most likely source of surface water contamination in the clear area. The HQ risk estimation and the weight-of-evidence evaluation for this AOC are presented in the following sections.

7.2.6.1 Hazard Quotient

Twelve PCOECs were identified for soils at the RPDG AOC. Eleven contaminants were identified as PCOECs for surface water (Table 5.20). The HQ risk estimation for terrestrial vegetation indicated low potential risks of adverse effects from chromium, silver, and zinc in soils at this AOC (Table 7.1).

Comparison of aquatic benchmark values with the exposure point concentrations of contaminants in surface water at the RPDG AOC (Table 7.13) resulted in HQs that indicate extreme risk for adverse impacts from iron, a high risk from aluminum, and a moderate risk from lead. A low potential risk to aquatic organisms was indicated from cadmium, chromium, copper, mercury, sodium, and zinc.

The HQ risk estimates for avian and mammalian receptors at the RPDG indicated moderate potential risks from the exposure point concentrations of aluminum to the white-footed mouse and the eastern cottontail (Table 7.14). In addition, low potential risks from aluminum, lead, and zinc were identified for the American robin. No risks (HQs <1.0) were identified for the tree

TABLE 7.13 Hazard Quotients for Aquatic Biota Based on Concentrations of Contaminants of Environmental Concern in Surface Water at the Robins Point Demolition Ground Area

Contaminant	Surface Water Exposure Point Concentration ($\mu\text{g/kg}$)	Aquatic Benchmark ($\mu\text{g/L}$)	HQ
Aluminum	30,300	460 ^a	65.9
Cadmium	4.54	2.90 ^{b,c}	1.6
Chromium	39.30	11.00 ^{b,d}	3.6
Copper	75.10	32.79 ^{b,c}	2.3
Iron	191,000	1,000 ^b	191
Lead	228.00	14.54 ^{b,c}	15.7
Mercury	1.00	0.23 ^a	4.3
RDX	3.80	- ^e	-
Silver	1.67	31.63 ^f	0.05
Sodium	844,000	680,000 ^a	1.2
Zinc	582.00	291.32 ^{b,c}	2.0

^a Lowest chronic value for all aquatic organisms reported by Suter and Tsao (1996).

^b Freshwater AWQC chronic value (EPA 1986).

^c This AWQC is a function of water hardness, which was estimated to be 330 mg CaCO_3/L using the mean concentrations of calcium and magnesium from the RPDG AOC.

^d AWQC for chromium VI; chronic AWQC for chromium III would be approximately 525.7 $\mu\text{g/L}$ using the mean hardness for the RPDG AOC (330 mg CaCO_3/L) and would result in an HQ of <0.1.

^e - = appropriate benchmark unavailable.

^f Freshwater AWQC acute value; no chronic AWQC is available (EPA 1986).

swallow, American kestrel, red-tailed hawk, white-tailed deer, or red fox from the exposure point concentrations of any of the PCOECs at the RPDG.

7.2.6.2 Weight of Evidence

The effects assessments at the RPDG included the evaluation of 22 variables. Of these variables, eight indicated adverse effects. Table 7.15 summarizes the results. Effects on aquatic biota

TABLE 7.14 Hazard Quotients^a for Avian and Mammalian Receptors at the Robins Point Demolition Ground Area

Contaminant	American Robin	Tree Swallow	American Kestrel	Red-Tailed Hawk	White-Footed Mouse	Eastern Cottontail	White-Tailed Deer	Red Fox
2,4-Dinitrotoluene	^b	-	-	-	-	-	-	-
Aluminum	2.1	<0.1	<0.1	<0.1	38.2	26.0	0.8	<0.1
Antimony	-	-	-	-	0.1	<0.1	<0.1	<0.1
Cadmium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Iron	-	-	-	-	-	-	-	-
Lead	1.9	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Magnesium	-	-	-	-	-	-	-	-
Manganese	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury	0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Nickel	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
RDX	-	-	-	-	-	-	-	-
Silver	0.1	<0.1	<0.1	<0.1	0.2	-	-	-
Zinc	1.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

^a The HQ is the ratio of the modeled ADD value to the benchmark ADD value. HQ values <1.0 indicate acceptable risk to the receptor from the estimated daily contaminant dose. HQ values between 1.0 and 10.0 indicate a low risk for adverse effects to the receptor, values between 10.0 and 50.0 indicate a moderate risk, values between 50.0 and 100.0 indicate a high risk, and values exceeding 100 indicate extreme risk. Exposure point concentrations used to estimate the ADD are provided in Section 5.2.1; benchmark values are presented in Appendix B.

^b - = no benchmark ADD value was available and no HQ was calculated.

were evaluated with eight toxicity tests; the results of three tests indicated surface water or sediment toxicity. Microtox toxicity screening indicated sediment toxicity. Surface water toxicity to *Daphnia* was indicated at a single location and to *Selenastrum* at two locations. Potential problems with the use of *Selenastrum* were discussed previously, and the test results should be viewed with caution. Although toxicity to *Daphnia* was indicated for one of the two locations where positive results (i.e., toxicity) were obtained with *Selenastrum*, no toxicity of surface water was indicated at these locations for a different zooplankton test organism (*Ceriodaphnia* in a chronic test), *Rana*, or *Lemna*.

A total of 14 variables were evaluated as part of the effects assessment for the terrestrial portion of the ecosystem at the RPDG AOC. The effects assessments evaluated soil invertebrate abundance and diversity, microbial biomass, processes related to nutrient cycling, soil toxicity, vertebrate abundance, avian nesting success, and gross abnormalities in small mammals. Five of the 14 evaluations identified adverse effects. These effects included reductions in microbial biomass,

TABLE 7.15 Summary of the Ecological Effects Assessment of the Robins Point Demolition Ground Area

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Aquatic Parameters</i>			
Microtox, surface water, acute toxicity	Bacterial inhibition indicating toxicity	Inhibition level not different from control	No
Microtox, sediment, acute toxicity	Bacterial inhibition indicating toxicity	Bacterial activity significantly inhibited in sediments from clear area	Yes
<i>Daphnia</i> , surface water, 48-hour acute toxicity	Reduced survival	Significant reduction in survival at DGD-1, but not at DGD-2	Yes
<i>Rana</i> , surface water, 96-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Lemna</i> , surface water, 96-hour chronic toxicity	Reduced production	No reduction in production	No
<i>Selenastrum</i> , surface water, 96-hour chronic toxicity	Reduced growth	Significant reduction in growth at DGD-1 and DGD-2	Yes
<i>Ceriodaphnia</i> , surface water, 7-day chronic toxicity	Reduced survival	No reduction in survival	No
<i>Ceriodaphnia</i> , surface water, 7-day chronic toxicity	Reduced reproduction	No reduction in reproduction	No
<i>Terrestrial Parameters</i>			
Terrestrial vegetation surveys	Reduced species diversity	No difference in diversity between AOC and the reference site	No
Terrestrial vegetation biomass	Reduced biomass	No significant difference in biomass between AOC and the reference site	No
Abundance of soil-dwelling macroinvertebrates	Reduced abundance and/or diversity	No reduction in abundance or diversity	No
Activity of epigeic macroinvertebrates	Reduced activity	No reduction in activity	No
Soil nematode surveys	Reduced abundance and altered trophic structure	No reduction in abundance; no change in trophic structure	No
Soil microbial biomass	Reduced biomass	No reduction in total fungal and bacterial biomass; significant reduction in active fungal and bacterial biomass	Yes
Soil protozoan surveys	Reduced abundance of soil-dwelling protozoans	Reduced abundance of flagellates and ciliates	Yes

TABLE 7.15 (Cont.)

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
<i>Terrestrial Parameters (Cont.)</i>			
Nutrient-acquiring enzyme activity	Reduced enzyme activity	Significant reduction in dehydrogenase activity; no reduction in activity of other enzymes	Yes
Soil respiration rates	Reduction in soil respiration rate	Significant reduction in soil respiration rate	Yes
Soil toxicity test with lettuce seeds	Reduced seedling emergency rates (SERs)	Reduced SERs for soils from two locations in clear area	Yes
Amphibian surveys	Few species present and limited use of available habitats	Three frog species and two salamander species observed; salamander egg masses indicate habitat used for reproduction; successful hatching of salamander egg masses reported	No
Avian surveys	Few species present and limited use of available habitats	More than 25 species reported	No
Avian nesting success with nest boxes	Reduced fledging success	Nests established in two of four nest boxes; no fledging of young; nest failure may be due to fire and ant predation rather than contaminant effects	No
Necropsy of small mammals collected for tissue analysis	Evidence of gross internal and external abnormalities, such as lesions, tumors, high degree of disease, or parasitism	No evidence of internal or external conditions indicative of adverse contaminant effects	No

abundance of soil protozoa, activity of extracellular nutrient-acquiring enzymes, soil respiration rates, and SERs.

Nests were established in two of four nest boxes placed in the RPDG AOC. Although both nests failed, the failures are attributed to fire at one nest and ant predation at the other. No adverse effects were identified for the other parameters evaluated at the site.

Tissues of mice collected from the site were analyzed for pesticides, PCBs, and heavy metals. The concentrations of most contaminants were below detection limits. The PCB Aroclor 1248 was detected in one mouse, the pesticide p,p'-DDE in one mouse, and several metals in many specimens. However, the concentrations of pesticides and metals were comparable to levels

measured in mice collected from a reference site (Whaley 1996), and the PCB concentration was low. Thus, there appears to be little uptake of contaminants by white-footed mice that use the site.

Risk estimation using concentration-based HQ values indicated low risk to terrestrial vegetation from silver and zinc, a potential extreme risk for adverse effects to aquatic biota from iron, a high potential risk from aluminum, and a moderate risk from lead. However, the apparently successful reproduction of amphibians in the surface water from this AOC suggests that at least some species are tolerant of the conditions present. Uptake modeling and risk estimation using the ADD-based HQ approach identified a moderate risk from aluminum to the eastern cottontail and the white-footed mouse, and low risks to the American robin from lead and zinc. No other risks were identified for the receptors modeled. On the basis of the weight of evidence, the RPDG AOC is considered to pose a low risk to ecological resources.

7.2.6.3 Ecological Significance

On the basis of the low HQ risk estimates for all PCOECs except aluminum, the nature and magnitude of the measured adverse effects, and the limited availability of habitat in the clear area of the RPDG AOC, the ecological significance of the predicted risks of this AOC is expected to be minor. Impacts would be limited to only a few biota, primarily those found directly in the clear area. These impacts are not expected to extend to other areas of J-Field or APG.

7.2.7 Robins Point Tower Site Area of Concern

Screening of detected analytes for the RPTS AOC resulted in the identification of nine PCOECs for the site. Three of the 10 effects assessments conducted for the RPTS AOC indicated a potential for adverse effects from conditions at the site. In addition, HQ estimates based on comparison of aquatic benchmarks to concentrations of PCOECs in offshore surface water and HQ values based upon modeled doses of PCOECs to selected receptors indicate a potential for risks to some receptors from the exposure point concentrations calculated for the site.

7.2.7.1 Hazard Quotients

A high risk from zinc and low risks from lead and nickel were indicated for vegetation at the site (Table 7.1). Four surface water PCOECs were retained after completion of the contaminant screening process, and the exposure point concentrations for all four of these contaminants were found to exceed aquatic benchmark values (Table 7.16). Iron was present at a level indicating a low to moderate potential for adverse effects to aquatic organisms, while aluminum, lead, and zinc were present at levels indicating a low potential for adverse effects.

TABLE 7.16 Hazard Quotients for Aquatic Biota Based on Concentrations of Contaminants in Offshore Surface Water at the Robins Point Tower Site

Contaminant	Surface Water Exposure Point Concentration ($\mu\text{g/L}$)	Aquatic Benchmark ($\mu\text{g/L}$)	HQ
Aluminum	8,390.0	460 ^a	9.5
Iron	28,400.0	1,000.0 ^b	28.4
Lead	76.1	10.6 ^{b,c}	7.2
Zinc	411.0	236.2 ^{b,c}	1.7

^a Water quality benchmark from Suter and Tsao (1996).

^b Freshwater AWQC chronic value for the protection of aquatic biota (EPA 1986).

^c This AWQC is a function of water hardness, which was estimated to be 258 mg CaCO_3/L calculated using the mean concentrations of calcium and magnesium for the AOC.

Eight PCOECs were identified for soils at the RPTS (Table 3.29). Of these, modeled daily doses to avian and mammalian receptors indicated potential risks from aluminum, lead, and zinc. HQ values indicated extreme risks to the white-footed mouse and the eastern cottontail from aluminum, as well as a moderate risk to the American robin and the white-tailed deer (Table 7.17). The HQ values indicated that the exposure point concentration of lead posed a moderate risk to the American robin and a low risk to the eastern cottontail. A moderate risk to the American robin from zinc was indicated as well. Potential adverse risks to vegetation from soil contamination were identified only for zinc, nickel, and lead (Table 7.1).

7.2.7.2 Weight of Evidence

The effects assessments conducted at the RPTS AOC focused exclusively on surface soils because of the absence of suitable, permanent aquatic habitats at the site. A total of 11 variables were evaluated at the site, and adverse effects were indicated for 3 variables. Table 7.18 summarizes the results.

Adverse effects on the soil nematode community and vegetation biomass were identified, and soil toxicity (reduced seedling germination) was indicated at several locations. No effects on soil

TABLE 7.17 Hazard Quotients^a for Avian and Mammalian Receptors at the Robins Point Tower Site

Contaminant	American Robin	White-Footed Mouse	Eastern Cottontail	White-Tailed Deer	Red Fox
Aluminum	13.6	104.1	604.3	15.2	1.2
Benzo(b)fluoranthene	0.1	<0.1	- ^b	-	-
Lead	33.6	0.6	1.7	<0.1	<0.1
Manganese	<0.1	<0.1	0.1	<0.1	<0.1
Mercury	0.2	<0.1	0.7	<0.1	<0.1
Nickel	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	27.1	0.3	0.7	<0.1	<0.1

^a The HQ is the ratio of the modeled ADD value to the benchmark ADD value. HQ values <1.0 indicate acceptable risk to the receptor from the estimated daily contaminant dose. HQ values between 1.0 and 10.0 indicate a low risk for adverse effects to the receptor, values between 10.0 and 50.0 indicate a moderate risk, values between 50.0 and 100.0 indicate a high risk, and values exceeding 100 indicate extreme risk. Exposure point concentrations used to estimate the ADD are provided in Section 5.2.1; benchmark values are presented in Appendix B.

^b - = no benchmark value was available and no HQ was calculated.

macroinvertebrates, microbial biomass, soil protozoa abundance, nutrient-acquiring enzyme activity, or soil respiration rates were observed. A single frog collected from a crater at the site was analyzed for pesticides, PCBs, explosives residues, and heavy metals; all were below detection limits. Uptake modeling predicted low to high levels of contaminant uptake by higher receptors, and HQ risk estimates identified potential risks, including a potential for extreme risk from aluminum for two receptors, a high risk to vegetation from zinc, and a moderate risk to two receptors from lead and zinc. Thus, the weight of evidence suggests that some portions of the RPTS AOC pose a moderate to high risk to ecological resources.

7.2.7.3 Ecological Significance

On the basis of the results of the effects assessment, the single extreme HQ risk estimate for a single contaminant to two receptors, the moderate to high risks estimated for a single receptor, and the general condition of the habitats at this AOC, the risks the AOC poses to ecological resources is likely to be moderate to high, but limited to contaminant hot spots within the AOC. Potential risks would not be expected to extend to other areas of APG.

TABLE 7.18 Summary of the Ecological Effects Assessment of the Robins Point Tower Site

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
Terrestrial vegetation surveys	Reduced species diversity	No significant difference in diversity between AOC and reference site	No
Terrestrial vegetation biomass	Reduced biomass	Significantly lower biomass at AOC than at reference site	Yes
Activity of epigeic macro-invertebrates	Reduced activity	No reduction in activity	No
Soil nematode surveys	Reduced abundance and/or altered trophic structure	Abundance reduced by almost 50% compared with reference site	Yes
Soil microbial biomass	Reduced biomass	No reduction in total or active bacterial and fungal biomass; biomass of all categories greater at AOC than at reference site	No
Abundance of soil protozoa	Reduced abundance	No reduction in abundance of protozoa; greater abundance at AOC than at reference site	No
Nutrient-acquiring enzyme activity	Reduced enzyme activity	No reduction in enzyme activity	No
Soil respiration rates	Reduced respiration rate	No reduction in soil respiration rate	No
Soil toxicity test with lettuce seeds	Reduced seed emergence rate (SER)	Reduced SER measured at 4 of 10 locations	Yes
Avian surveys	Reduced species diversity and use of available habitat	30 species identified at AOC	No
Avian nesting success with nest boxes	Reduced fledging success	Four nest boxes established at AOC, but no nesting	^a

^a The nest boxes received little use, and no birds attempted nesting. Thus the results are equivocal.

7.2.8 Prototype Building Area of Concern

On the basis of results of the effects assessments, the PB AOC was initially judged to pose a moderate risk to terrestrial ecological resources at the site. Little evidence exists of contaminant uptake by biota at the site, although modeled uptakes identified low to extreme risks for four receptors from four contaminants. Risk estimates for the PB AOC using the HQ, and based on the weight of evidence, are discussed below.

7.2.8.1 Hazard Quotients

Fifteen contaminants were retained as PCOECs for soils at the PB AOC (Table 3.22). The HQ estimates of risk based upon comparison of the exposure point concentrations of soils with benchmark values for terrestrial vegetation indicated that zinc poses a moderate risk and manganese poses a low potential risk (Table 7.1). Acceptable risks to terrestrial vegetation were indicated for any of the other soil PCOECs.

The HQ values for birds and mammals (Table 7.19) indicated that aluminum concentrations posed an extreme risk to the eastern cottontail, a high risk to the white-footed mouse, and a moderate risk to the American robin and the white-tailed deer. The HQ values also indicated that the American robin was at moderate risk from exposure to zinc and at low risk from lead and cadmium. A low risk was indicated to the eastern cottontail from cadmium. The HQ values for all other combinations of receptors and PCOECs were less than 1.0, indicating acceptable risk.

7.2.8.2 Weight of Evidence

No aquatic habitat exists at the PB AOC; thus, the effects assessments targeted only terrestrial habitat. A total of eight variables were evaluated; adverse effects were indicated for five variables. Table 7.20 summarizes the results.

The results of the effects assessments identified reductions in abundance of soil-dwelling protozoa, activity of extracellular nutrient acquiring enzymes, soil respiration rates, plant biomass, and SERs. These results suggest that soil contamination at the site may be adversely affecting nutrient dynamics and plant production at the site. Plant production may also be affected by soil toxicity, which limits germination. However, the grassland areas of the site were mowed earlier in the growing season, and this may be responsible for the lower plant biomass estimates.

Insect tissues were analyzed for SVOCs, pesticides, PCBs, and metals. Several metals were detected in insect tissues, as would be expected, and none of the other contaminant groups were present at concentrations above detection levels. Uptake modeling results predict low levels of contaminant uptake by most of the modeled receptors, and risks estimates based on the HQ were low to extreme for several receptors, with aluminum posing the most risk. Although the HQ risk estimates identified a moderate to extreme risk to some terrestrial wildlife, these risks were limited to only two metals and three receptors. Other lines of evidence indicated adverse effects on some ecosystem components but no or positive effects on other ecosystem components. Thus, the weight of evidence suggests a moderate risk to terrestrial ecological resources at the PB AOC.

TABLE 7.19 Hazard Quotients^a for Avian and Mammalian Receptors at the Prototype Building Area

Contaminant	American Robin	Tree Swallow	American Kestrel	Red-Tailed Hawk	White-Footed Mouse	Eastern Cottontail	White-Tailed Deer	Red Fox
Acetone	. ^b	-	-	-	<0.1	<0.1	<0.1	<0.1
Aluminum	10.2	<0.1	<0.1	<0.1	80.2	182.5	14.0	0.9
Antimony	-	-	-	-	0.2	0.4	<0.1	<0.1
Benzo(k)fluoranthene	-	-	-	-	-	-	--	-
Cadmium	2.2	0.1	<0.1	<0.1	0.5	1.1	0.1	0.3
Copper	0.8	0.1	<0.1	<0.1	0.4	0.4	<0.1	<0.1
Cyanide	-	-	-	-	0.1	0.3	<0.1	<0.1
Endrin Aldehyde	-	-	-	-	-	-	-	-
Iron	-	-	-	-	-	-	-	-
Lead	6.6	<0.1	<0.1	<0.1	0.1	0.3	<0.1	<0.1
Magnesium	-	-	-	-	-	-	-	-
Manganese	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1
Mercury	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
Nickel	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	13.5	1.3	0.1	<0.1	0.2	0.3	<0.1	<0.1

^a The HQ is the ratio of modeled ADD value to the benchmark ADD value. HQ values <1.0 indicate acceptable risk to the receptor from the estimated daily contaminant dose; values between 1.0 and 10.0 demonstrate a low risk; values between 10.0 and 100.0 represent a moderate risk of adverse ecological effects; and values exceeding 100 indicate extreme risk. Exposure point concentrations used to estimate the ADD are provided in Section 5.2.1; benchmark values are presented in Appendix B.

^b - = no benchmark ADD was available, and no HQ was calculated.

7.2.8.3 Ecological Significance

Although a moderate risk was identified for the PB AOC, the magnitude of observed adverse effects is low. Potential impacts on biota would be limited to local populations in the immediate vicinity of the PB AOC, and mowing of the grassland habitats around the building probably impacts vegetation at the AOC and limits use by many wildlife receptors. The overall ecological significance of the risks posed by the PB AOC is considered minor.

7.2.9 Potential Areas of Concern

Estimating risk for the PAOCs is difficult because of the limited contaminant characterization (Yuen et al. 1999) and ecological effects assessments conducted at these areas.

TABLE 7.20 Summary of the Ecological Effects Assessment of the Prototype Building Area

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
Soil-dwelling macro-invertebrate surveys	Reduced abundance and diversity	No reduction in abundance; abundance greater at AOC than at reference site	No
Soil nematode surveys	Reduced activity	No reduction in activity	No
	Reduced abundance and altered trophic structure	No reduction in abundance and no alteration in trophic structure; abundance greater at AOC than at reference site	
Soil microbial biomass	Reduced biomass	No reduction in total bacterial biomass; total bacterial biomass greater at AOC than at reference site; active bacterial and fungal biomass at AOC less than at reference site	^a
Abundance of soil-dwelling protozoa	Reduced abundance	Reduced abundance of all protozoa groups evaluated	Yes
Nutrient-acquiring enzyme activity	Reduced enzyme activity	Reduced activity of dehydrogenase; no reduction in activity of other enzymes	Yes
Soil respiration rates	Reduced respiration rate	Reduced respiration rate	Yes
Soil toxicity test with lettuce seeds	Reduced seed emergence rate (SER)	Reduced SERs in soils from 4 of 8 sample locations	Yes
Terrestrial vegetation biomass	Reduced biomass	Reduced biomass, but may be due to mowing earlier in the growing season	Yes

^a - = results equivocal.

Because of the heterogeneous distribution of craters across the site and the unknown but probably highly variable types of munitions that produced the craters, it is difficult to extrapolate the results obtained in this ERA to craters across the entire J-Field site. Some amphibians collected from craters had slightly elevated lead levels. Potential risks to aquatic biota were indicated for surface waters in one or two craters at the Ruins Site, but no media toxicity was evident at other craters. Because of the limited data, no conclusions can be drawn about the potential risks craters pose to biota at J-Field. Any adverse risks would most likely be greatest to aquatic biota (aquatic invertebrates and amphibians) that may use an individual crater. Risk estimates for the PAOCs based on the weight of evidence are discussed below. No uptake modeling or HQ risk estimation was performed for wildlife species at the PAOCs. HQ risk estimates indicated low risks to vegetation at the Ruins Site from nickel and zinc (Table 7.1).

The limited effects assessment for the PAOCs consisted of toxicity evaluations of surface water and sediment collected from craters at several locations across the J-Field site. Surface water toxicity was evaluated with three acute and two chronic toxicity tests, while sediments were evaluated with Microtox. Table 7.21 summarizes the results. Two of the six tests indicated surface water toxicity for two craters at the Ruins Site. The *Selenastrum*-based toxicity test identified toxicity for both craters. Toxicity based on reduced growth in *Lemna* was identified for only one crater at the Ruins Site. On the basis of these results, little or no risk to aquatic biota is identified for most of the craters evaluated, except two in the Ruins Site. Surface water is toxic in at least one and possibly two craters at this site.

Amphibians (frogs) were collected from the Ruins Site, Area D, and 10 craters located throughout the J-Field site. The frogs were analyzed for heavy metals, pesticides, PCBs, and explosives residues. Overall, there was little contaminant uptake by frogs at most craters. For example, only barium was detected in frogs from the Ruins Site. Lead, barium, and two pesticides were the only contaminants detected in frogs collected from Area D. Frogs collected from the craters had the highest level of uptake: four metals, three nitroaromatic compounds, and two pesticides. However, arsenic, chromium, o,p'-DDE, and the three nitroaromatic compounds were detected only once each, and the nitroaromatic compounds were all collected from a single specimen. This individual was collected from a crater near the RPDG AOC. No other contaminants were detected at concentrations above detection limits.

TABLE 7.21 Summary of the Ecological Effects Assessments of the Potential Areas of Concern

Assessment Method	Expected Result if Adverse Effects Are Present	Observed Assessment Result	Adverse Effects
Microtox, surface water, acute toxicity	Bacterial inhibition	Inhibition level not different from control	No
Microtox, sediment, acute toxicity	Bacterial inhibition	Inhibition level not different from control	No
<i>Daphnia</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Rana</i> , surface water, 48-hour acute toxicity	Reduced survival	No reduction in survival	No
<i>Lemna</i> , surface water, 96-hour chronic toxicity	Reduced growth	Reduced growth in surface water from one of two craters at the Ruins Site PAOC	Yes
<i>Selenastrum</i> , surface water, 96-hour chronic toxicity	Reduced growth	Reduced growth in surface water from two craters at the Ruins Site PAOC	Yes

For the PAOCs evaluated, the identified risks are of little ecological significance except on a crater-level scale. For any particular crater, potential adverse impacts will largely be restricted to biota that directly use the crater (particularly invertebrates and amphibians) and are not expected to extend to other areas of J-Field or APG. It is not possible to make inferences regarding effects, impacts, and risks for other craters at the J-Field site at this time.

7.2.10 Sitewide Ecological Receptors

Potential risks to wide-ranging ecological receptors were estimated by calculating a total ADD based on the sum of the ADDs calculated for each AOC that a particular receptor could visit at J-Field. These total ADD values were then used to calculate an HQ risk estimate for each receptor species and PCOEC. Total ADDs were estimated for five receptors: tree swallow, American kestrel, red-tailed hawk, white-tailed deer, and red fox (Tables 5.59 through 5.63). Each of these receptors is a wide-ranging species, with a large home range (Section 5.2.3.1), that may visit several AOCs during normal foraging activities.

7.2.10.1 Hazard Quotients

Risks based on HQ estimates >1.00 were identified only for seven metals (Table 7.22). On the basis of these estimates, arsenic and lead were found to pose moderate risks, and aluminum a potential high risk, to white-tailed deer. A low risk was indicated to the white-tailed deer from antimony and selenium and possibly from barium and mercury ($HQs = 1.0$). The HQ risk estimates also indicated a low risk to the American kestrel from lead and to the tree swallow from mercury and zinc. In addition, the risk estimates indicated a low potential risk to the red fox from aluminum. No risk was indicated to the red-tailed hawk from any of the PCOECs.

Evaluation of the results of the ADD modeling of these sitewide receptors shows that most of the ADDs for contaminants with $HQ > 1$ were the result of contaminant uptake from the TBP AOC (Tables 5.59 through 5.63). Table 7.23 presents the results of HQ risk estimation for sitewide receptors without uptake from the TBP AOC. When the uptake related to the TBP AOC is excluded from the sitewide HQ risk estimation, acceptable risks are indicated to the American kestrel and red-tailed hawk and low risks are indicated to the red fox from aluminum and to the tree swallow from zinc and mercury. The risk estimates still indicated that aluminum could pose a high risk and selenium could pose a low risk to the white-tailed deer. Consequently, it appears that the predominant source of risk for sitewide receptors is the extensive contamination detected at the TBP AOC and the high aluminum soil concentrations found throughout the site. It is important to note that these aluminum concentrations are within the range of reported background concentrations.

TABLE 7.22 Sitewide Hazard Quotients^a for Wide-Ranging Avian and Mammalian Receptors for All Areas

Contaminant	Tree Swallow	American Kestrel	Red-Tailed Hawk	White-Tailed Deer	Red Fox
1,1-Dichloroethene	^b	-	-	<0.1	<0.1
Acetone	-	-	-	<0.1	<0.1
Aluminum	<0.1	0.1	<0.1	92.9	6.6
Antimony	-	-	-	3.9	0.2
Aroclor 1248	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	<0.1	<0.1	<0.1	10.8	0.6
Barium	0.3	<0.1	<0.1	1.0	<0.1
Cadmium	0.5	<0.1	<0.1	0.7	0.4
Chloroform	-	-	-	<0.1	<0.1
Chromium	0.2	0.1	<0.1	0.2	<0.1
Copper	0.2	<0.1	<0.1	0.9	<0.1
Cyanide	-	-	-	0.4	<0.1
Diethyl phthalate	-	-	-	<0.1	<0.1
Lead	1.0	2.1	0.1	17.0	0.5
Magnesium	-	-	-	-	-
Manganese	<0.1	<0.1	<0.1	0.1	<0.1
Mercury	2.6	0.4	<0.1	1.0	<0.1
N-Nitrosodiphenylamine	-	-	-	-	-
Nickel	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	1.5	0.1	<0.1	1.9	0.3
Trichloroethene	-	-	-	0.1	<0.1
Vinyl chloride	-	-	-	<0.1	<0.1
Zinc	5.7	0.9	<0.1	1.0	<0.1

^a The HQ is the ratio of the modeled ADD value to the benchmark ADD value. HQ values <1.0 indicate acceptable risk to the receptor from the estimated daily contaminant dose. HQ values between 1.0 and 10.0 indicate a low risk for adverse effects to the receptor, values between 10.0 and 50.0 indicate a moderate risk, values between 50.0 and 100.0 indicate a high risk, and values exceeding 100 indicate extreme risk. Exposure point concentrations used to estimate the ADD are provided in Section 5.2.1; benchmark values are presented in Appendix B.

^b - = no benchmark ADD was available and no HQ was calculated.

TABLE 7.23 Sitewide Hazard Quotients^a for Wide-Ranging Avian and Mammalian Receptors for All Areas of Concern Except the TBP AOC

Contaminant	Tree Swallow	American Kestrel	Red-Tailed Hawk	White-Tailed Deer	Red Fox
1,1-Dichloroethene	^b	-	-	<0.1	<0.1
Acetone	-	-	-	<0.1	<0.1
Aluminum	<0.1	0.1	<0.1	85.9	6.1
Antimony	-	-	-	0.2	<0.1
Aroclor 1248	0	0	0	0	0
Arsenic	<0.1	<0.1	<0.1	0.6	0.1
Barium	0.3	<0.1	<0.1	0.9	<0.1
Cadmium	0.4	<0.1	<0.1	0.4	0.4
Chloroform	-	-	-	<0.1	<0.1
Chromium	0.1	<0.1	<0.1	0.1	<0.1
Copper	0.1	<0.1	<0.1	0.2	<0.1
Cyanide	-	-	-	<0.1	<0.1
Diethyl phthalate	-	-	-	<0.1	<0.1
Lead	0.9	0.1	<0.1	0.4	<0.1
Manganese	<0.1	<0.1	<0.1	0.1	<0.1
Mercury	2.6	0.2	<0.1	0.3	<0.1
Nickel	<0.1	<0.1	<0.1	<0.1	<0.1
Selenium	0.7	0.1	<0.1	1.2	0.3
Trichloroethene	-	-	-	<0.1	<0.1
Vinyl chloride	-	-	-	<0.1	<0.1
Zinc	5.0	0.3	<0.1	0.2	<0.1

^a The HQ is the ratio of the modeled ADD value to the benchmark ADD value. HQ values <1.0 indicate acceptable risk to the receptor from the estimated daily contaminant dose. HQ values between 1.0 and 10.0 indicate a low risk for adverse effects to the receptor, values between 10.0 and 50.0 indicate a moderate risk, values between 50.0 and 100.0 indicate a high risk, and values exceeding 100 indicate extreme risk. Exposure point concentrations used to estimate the ADD are provided in Section 5.2.1; benchmark values are presented in Appendix B.

^b - = no benchmark ADD was available and no HQ was calculated.

7.2.10.2 Ecological Significance

This section discusses the ecological significance of risks to wide-ranging receptors at J-Field. The effects assessments did not directly evaluate these receptors, mainly because they tend to be large, difficult to capture and monitor, or protected by regulations. Consequently, the basis for evaluating risks to wide-ranging species was the ADD-based HQ estimates. There appears to be no extreme risk to any sitewide receptors, and a moderate risk from three contaminants (aluminum, arsenic, and lead) to only one receptor (white-tailed deer).

The only sitewide receptor at a moderate risk from contaminant exposure (only aluminum) at J-Field is the white-tailed deer. The deer population at J-Field and nearby fields farther north on the Edgewood peninsula appears to be large and is unlikely to be significantly affected by contaminants at J-Field. Consequently, the overall risk to the local deer population is considered minor. Because the other sitewide receptors were either not at risk or only at a low risk from a few contaminants at J-Field, populations of these species are not likely to be significantly affected.

The risk to the sitewide receptors appears to be primarily related to the concentrations of contaminants at the TBP AOC; therefore, with the exception of the white-tailed deer, these receptors would be at little or acceptable risk if the major contamination sources at TBP AOC were removed or contained. While the white-tailed deer could still be at moderate risk from exposure to aluminum at other AOCs at J-Field, aluminum concentrations at some AOCs are below background levels, and aluminum soil and surface water background concentrations typically exceed the ecological screening and benchmark values (see Tables 3.1-3.16 and 3.22).

7.3 UNCERTAINTY IN THE RISK CHARACTERIZATION PROCESS

The evaluation of risks to ecological resources at J-Field presented in this report is, by necessity, based in part on assumptions with inherent uncertainties. Uncertainties may be associated with each phase of the ERA, and they may influence the risk characterization and overall conclusions of the ERA. The following sections discuss the nature of the uncertainties associated with the ERA, identify measures used to address these uncertainties, and address the impact of the uncertainties on the risk characterization. Specific areas of uncertainty addressed are (1) conceptual model formulation; (2) identification of PCOECs; (3) exposure assessment assumptions, including modeling; and (4) ecological effects characterization.

7.3.1 Conceptual Model Formulation

A series of conceptual models developed for J-Field identify primary and secondary contaminant sources; contaminant fate and transport, including primary release mechanisms; primary

exposure routes; and potential receptors. The associated uncertainties are related primarily to the availability of characterization data and knowledge of site-specific contaminant transport pathways. The uncertainties could result in either identifying inappropriate or incorrect exposure pathways or incompletely identifying appropriate exposure points and exposure pathways.

Overall, the uncertainties associated with the conceptual models for the TBP, RCP, SBT, and WPP AOCs are considered low. For these AOCs, potential contaminant point sources were identified during the RI (Yuen et al. 1999) by a variety of approaches (e.g., interpretation of historic photographs and geophysical methods such as ground-penetrating radar), and AOC-specific characterization data were used to identify the primary and secondary contaminant sources. Furthermore, factors affecting fate and transport (e.g., groundwater flow, topography, surface hydrology patterns) at these locations are relatively well understood (Yuen et al. 1999).

The uncertainties for the conceptual models associated with the SBDG, RPTS, RPDG, and PB AOCs are somewhat higher but are still considered low. The higher uncertainties for these AOCs are related to the absence of clearly identifiable point sources of contamination; thus, exposure points are less certain. Uncertainties were kept low, however, by using AOC-specific characterization data to identify exposure points. Overall, the uncertainties associated with the conceptual models are considered not to have affected the risk characterization of J-Field.

7.3.2 Contaminants of Ecological Concern

The PCOECs were identified on the basis of the evaluation of site-specific contaminant characterization data and application of a screening process. Overall, uncertainties are related to the contaminant characterization data (particularly the appropriateness and adequacy of analytical methods and the adequacy of the data in defining the areal extent of contamination) and elements of the screening process. The uncertainties associated with each of these components are addressed in Sections 7.3.2.1 and 7.3.2.2.

7.3.2.1 Characterization Data

Environmental data have been collected at J-Field since the late 1970s, and extensive site characterization efforts have been underway since the late 1980s (Yuen et al. 1999). In addition, an RI was recently completed at J-Field (Yuen et al. 1999). The RI characterization data served as the basis for identifying the PCOECs in this ERA (Section 3.3). Uncertainties associated with these data would primarily be related to QA/QC issues regarding the accuracy, adequacy, and appropriateness of the data. The consequence of these uncertainties would be over- or underestimation of the true nature, extent, and magnitude of contamination at J-Field. Thus, the uncertainty could affect the final selection of PCOECs, dose modeling results, and risk estimates.

For this ERA, uncertainties associated with QA/QC issues are considered minor. All characterization data used in this ERA were collected as part of the J-Field RI (Yuen et al. 1999). Rigorous QA/QC procedures and protocols (presented in the QAPjP [Prasad et al. 1995]) were followed during all data collection and analysis activities. These procedures and protocols are discussed in Section 3.2. Thus, uncertainties related to data quality and accuracy are considered low and are not expected to affect PCOEC identification or the overall risk characterization.

Uncertainties associated with data adequacy and appropriateness deal primarily with sufficient characterization of the nature, extent, and magnitude of contamination. Because of the biased nature of the characterization sampling (Benioff et al. 1995b), some areas of contamination may have been missed. However, the sampling plan used during the RI characterization was designed on the basis of detailed evaluations of historic and current aerial photographs to identify open burning and detonation activities, disposal sites, and areas of discolored or otherwise disturbed soils. The results of these evaluations, along with information regarding past activities at the site (Benioff et al. 1995b), were used to select sampling locations that would most likely capture areas of contamination and include maximally contaminated locations. Sampling locations were also selected to reflect contaminant transportation from source areas. Although some areas at the site may have higher contaminant concentrations than those detected during the RI characterization, the overall sampling design is considered adequate to characterize the nature, extent, and magnitude of contamination at the AOCs. Thus, uncertainties associated with characterization adequacy are not expected to affect overall risk estimation.

7.3.2.2 Screening Process

The selection process for identifying the PCOECs was designed to focus the efforts of the risk assessment on the contaminants that pose the greatest potential threat to ecological resources at the site. An additional benefit of this process is a savings in costs and effort incurred by reducing the number of contaminants that must be carried through the entire risk assessment. The selection process contains several inherent uncertainties, however, which may eliminate from further consideration contaminants that do pose a risk or may lead to a detailed evaluation of contaminants present at environmental concentrations that pose no risk to ecological resources at J-Field.

The uncertainty associated with the selection process includes the adequacy of the characterization data used in the selection process. The selection process involves comparing reported concentrations with ecological screening or benchmark concentrations. Any uncertainties associated with the characterization data add to the overall uncertainty of the selection process. The magnitude and importance of this uncertainty to the selection process are identical to those identified in Section 7.4.2.2 regarding overall characterization data quality. Thus, the uncertainty is not expected to affect the selection process adversely.

The final major area of uncertainty in the selection process is related to the use of screening values for comparison with site contaminant concentrations. These screening values are contaminant concentrations derived in laboratory or field studies that represent a threshold environmental concentration above which adverse biological effects may occur. Although screening values represent actual media concentrations, few were available that were specific to the species present at J-Field. Thus, some uncertainty was added to the selection process because of the need to use screening values across multiple taxa. Furthermore, the toxicity and effects of contaminants are strongly influenced by environmental conditions (e.g., water hardness, soil organic carbon content, temperature), and few if any of the screening values were determined under environmental conditions that completely mimic those at J-Field. Thus, the reported screening values may not represent actual threshold environmental concentrations for J-Field biota. The principal concern would be that the benchmark value exceeds actual sensitivities of site biota. This uncertainty was minimized by using the lowest benchmark concentration found in the scientific literature.

7.3.3 Exposure Assessment

The greatest uncertainties in the exposure assessment process are related to (1) the exposure factors used to estimate ADD values, (2) the exposure pathways identified for each receptor, and (3) the assumptions regarding contaminant uptake and assimilation.

7.3.3.1 Receptor Exposure Factors

Modeling contaminant doses to ecological receptors requires information on species-specific ecological and physiological parameters, such as ingestion and inhalation rates, body weight, foraging area, and diet composition. In contrast to data for human health risk assessments, species-specific and population-specific data for the exposure factors are largely unavailable. Therefore, the exposure factors used in this ERA were (1) species-specific but not population-specific, (2) not species-specific but from related taxa, or (3) developed with empirically derived allometric equations. Each of these sources may add uncertainty to the overall risk assessment.

For many ecological receptors evaluated at J-Field, species-specific but not population-specific data were available. For example, some exposure factors used for the tree swallow were derived from populations in Alberta, Canada. Use of species data from populations other than those at J-Field adds uncertainty to the uptake estimates because individuals that inhabit different portions of the total geographic range of the species (e.g., Florida and Wisconsin for the eastern cottontail) differ in physiology (e.g., higher metabolic and ingestion rates, smaller body weights) and life history (e.g., larger home range, different diet composition, different habitat use).

An attempt was made to limit this type of uncertainty by using data from the geographically nearest populations as well as from populations inhabiting similar habitats.

In the absence of species-specific data, the uptake models used ecological and physiological data from a surrogate species. For example, the leopard frog was identified as an ecological receptor for J-Field, but the exposure factors used to model uptake by this species were for the related green frog. Uncertainty is added to the uptake estimate because of differences in physiology and genetics between the receptor and surrogate taxa. This uncertainty is smallest when closely related species (e.g., same genus) are used, and it increases with decreasing level of taxonomic similarity (e.g., same family but different species). For this ERA, the use of exposure factors for surrogate species was limited. The related uncertainty is considered low and is not expected to affect the overall risk characterization.

Additional uncertainty is added to uptake modeling through the use of empirically derived allometric equations for estimating body surface area and ingestion rates. For many receptors, no information was available for these parameters, and values were estimated by using reported body weights and allometric equations. These equations were developed with mean values for several species within a taxonomic category, which may be very broad. For example, a relatively specific allometric equation was available for predicting food ingestion rates from body weight for rodents. Uncertainty is added because an individual species will exhibit values different from those predicted by an equation based on several species. In addition, physiological factors are affected by sex and age, and predictions from allometric equations do not capture these differences. Uncertainty associated with allometric equations for food ingestion rates is reduced by very high regression coefficients for most of these equations (>0.9), which indicate a very good prediction level.

7.3.3.2 Exposure Pathways

Exposure pathways identify the paths by which contaminants move from the environmental media to the receptor of concern. Identifying inappropriate pathways leads to overestimating contaminant uptake and risk; incompletely identifying exposure pathways results in underestimating contaminant uptake and risk. For this ERA, the uncertainty associated with identifying exposure pathways is considered low. The ecological requirements of each receptor species are reasonably well known, as are the nature and extent of contamination and environmental fate and transport of contaminants. Thus, uncertainties associated with the identification of exposure pathways are not expected to affect the risk characterization.

7.3.3.3 Uptake Assumptions

The principal uncertainties associated with uptake model assumptions are related to (1) estimating contaminant transfer between and assimilation within trophic levels, (2) using a uniform foraging activity over the entire home range of a species, and (3) using exposure factor data from geographically different populations, allometric equations, or closely related species. The first two uncertainties are discussed in Section 5.2.3.7, and Section 7.3.3.1 addresses uncertainties associated with exposure factors.

7.3.4 Ecotoxicity Information

The availability of information regarding the effects of PCOECs on ecological resources varies, depending on both the contaminant and the receptor species of concern. For some contaminants, ecotoxicity data were available only for certain biota, were derived from laboratory biota, or provided information only for certain ecological responses. In other cases, little information was found regarding contaminant effects on wildlife species and populations.

7.3.5 Risk Estimation

7.3.5.1 Benchmark Values

Benchmark values were unavailable for some species and PCOECs, and benchmark values had to be derived following the approach discussed in Section 7.1.1. Developing these values required the use of data from other species. Thus, the uncertainty associated with deriving benchmark values is similar to that for the use of interspecific data in the uptake models. Although standardized uncertainty factors are commonly used in human health risk assessment when extrapolating the results of animal studies to humans, no standardized uncertainty factors are available for ecological risk assessments, and none were used in this ERA. In addition, some of the benchmark values were derived from a single NOAEL value. While this value is protective, it is possible that no adverse effects may be incurred by the same test organism at a higher contaminant level. Thus, some of the benchmark values may be overly conservative and result in an overestimation of potential risk.

7.3.5.2 Hazard Quotient

Use of the HQ for estimating risks to ecological receptors is subject to several inherent uncertainties: (1) it does not differentiate between long- and short-term effects on biota; (2) it does

not consider synergistic or antagonistic interactions among contaminants, which increase or decrease contaminant effects; and (3) the risk estimate is only as good as the estimated ADD, the benchmark values, and their associated uncertainties. The overall risk estimate would be subject to a high degree of uncertainty if the HQ were the only measure of risk. This uncertainty was reduced through the evaluation of the results of field studies and media toxicity investigations in a weight-of-evidence approach to estimate the overall risk. The field investigations and biotic surveys provided information on the long-term ecological effects of site contamination, and toxicity testing measured the toxicity of the actual contaminant mixtures to which site biota are exposed.

8 SUMMARY AND CONCLUSIONS

The ERA for the J-Field site was designed to (1) determine whether past site activities and current levels of contamination have adversely affected the ecological resources at the site, (2) determine whether current or future conditions at the site pose a potential adverse risk to ecological resources, and (3) identify areas of J-Field where remediation may be warranted from an ecological standpoint. The ERA addressed the following ecological questions about contamination at the site:

- Are current levels of contaminants in environmental media producing demonstrable ecological effects on the population, community, or ecosystem? If so, what are the extent and magnitude of the effects?
- Are contaminated environmental media directly toxic to biota?
- What is the potential risk to biota of receiving contaminant doses through direct and indirect uptake from contaminated environmental media? What are the extent and magnitude of any such risks?

The following sections discuss the results of the ERA in the context of these objectives and questions.

8.1 EVIDENCE OF ADVERSE ECOLOGICAL EFFECTS

To determine whether past activities and current conditions have adversely affected ecological resources at the J-Field site, the ERA used effects assessments (field investigations) to identify effects. These assessments targeted aquatic and terrestrial components at the AOCs and measured numerous ecological variables. On the basis of the results of these assessments, adverse effects at the individual, population, and community levels were identified at each AOC. The identified effects were primarily associated with soil biota and vegetation, whereas few adverse effects were evident for aquatic biota. At most AOCs, the observed effects were generally minor or very limited in extent (i.e., restricted to the AOC boundaries or specific areas, such as pits or trenches), and the ecological significance of the effects is considered minor. The AOCs for which relatively minor effects were identified include the PB, SBT, and SBDG (onshore detonation crater only).

In contrast, more significant effects resulting from past activities and/or current levels of contamination were evident at the TBP, WPP, RCP, RPTS, and RPDG AOCs. With the exception of the RPTS AOC, each of these AOCs showed evidence of physical disturbance in the form of

detonation craters, burn pits, and trenches. In addition, many ecological characteristics evaluated at these locations differed significantly from those at reference locations. Affected ecological variables included the abundance and diversity of plant and invertebrate biota, the activity of nutrient-acquiring microbial enzymes, rates of biologically mediated soil nutrient-cycling processes, and biomass of both soil biota and vegetation.

The effects identified at the RCP, WPP, RPTS, and RPDG AOCs were mostly limited to specific locations and do not appear to be widespread within the AOCs. In contrast, the effects at the TBP AOC appear throughout much of the AOC proper and are particularly evident in the contaminated Pushout Area and main pits. The data collected during the ERA and the characterization data obtained during the RI strongly suggest that past and current transport of contaminants via surface runoff from the Pushout Area has begun to affect the large marsh-pond ecosystem next to the TBP AOC.

8.2 MEDIA TOXICITY

The ERA used various toxicity tests to determine whether environmental media at J-Field were toxic to biota. Soil, sediment, and surface water were tested for toxicity at each AOC and PAOC, as appropriate. Testing of surface water evaluated toxicity (both acute and chronic) to bacteria, algae, aquatic vascular plants, zooplankton, fish, and amphibians, while sediment toxicity was evaluated by using bacteria and amphipods. These tests evaluated survival, growth, and reproduction of the test organisms. Toxicity testing of soils evaluated survival and growth of invertebrates (earthworms) and seed emergence and growth in plants (lettuce).

Table 8.1 summarizes the results of the media toxicity evaluations. Soil toxicity was found at each AOC in which testing was conducted. However, the magnitude of the toxicity varied widely among the AOCs. Soil toxicity was most evident at the TBP AOC, particularly the Pushout Area and main pits. Toxic effects included 100% mortality in earthworms and lettuce seedlings, 75-100% reductions in seedling emergence, and significant reductions in earthworm growth. Although soil toxicity was also indicated at multiple locations in the RPTS and PB AOCs, the magnitude of the toxicity was much lower than that observed for soils from the TBP AOC. Toxicity at the other AOCs was less widespread and often limited to pits or trenches.

Surface water toxicity was apparent at most of the AOCs, except for the SBDG AOC; however, at many locations, toxicity was observed only in the response of a single test organism, the green alga *Selenastrum*. This species exhibited reduced growth in nearly all waters tested, including waters for which no toxicity to other test organisms was indicated. This alga may be an oversensitive receptor; consequently, the toxicity results obtained by using this indicator should be viewed with caution. No toxicity was observed in the other organisms tested. Excluding the results

TABLE 8.1 Summary of Media Toxicity Testing for J-Field

AOC/PAOC	Media Toxicity ^a		
	Soil	Surface Water	Sediment
TBP	+	+	+
WPP	+	+ ^b	-
RCP	+	+ ^b	-
SBT	+	+ ^b	-
SBDG	NA	-	+
RPDG	+	+	+
RPTS	+	NA	NA
PB	+	NA	NA
Ruins Site PAOC	NA	+	-

^a + = toxicity indicated to one or more test organisms or in more than one test with the same test organism; - = no indication of media toxicity; NA = not applicable, media not evaluated.

^b Toxicity indicated only to green algae (*Selenastrum*).

of the *Selenastrum* tests, no surface water toxicity was indicated for the WPP, RCP, and SBT AOCs. Toxicity at other AOCs was typically limited to one or two additional receptors. Surface water toxicity at the TBP AOC was limited to the nearshore areas along the marsh-Pushout Area boundary; no toxicity was evident for surface waters from the pond or other marsh locations.

No sediment toxicity was evident at the WPP, RCP, and SBT AOCs or the Ruins Site PAOC (Table 8.1). Sediment toxicity was indicated for the TBP AOC, but it appears to be restricted to nearshore areas along the marsh-Pushout Area boundary, as was the surface water toxicity. Sediment toxicity was also indicated for the SBDG and RPDG AOCs. Although toxicity was indicated for the SBDG AOC, the crater pond evaluated supports a variety of invertebrates and appears to be used extensively by amphibians.

8.3 RISKS FROM CONTAMINANT EXPOSURE

The potential risks to biota from direct and indirect exposure and uptake of contaminants from environmental media were evaluated by using HQ risk estimation. In this approach, ADDs

from direct uptake from media (absorption or ingestion) and ingestion of contaminated foods (food chain transfer) were estimated for aquatic and terrestrial wildlife receptors and compared with reported no-effects doses. To derive HQ risk estimates for aquatic biota and terrestrial vegetation, media concentrations measured at J-Field were compared with benchmark media concentrations protective of aquatic biota or reported to result in no effects to terrestrial vegetation. Potential risks were inferred on the basis of the ratio of the benchmark to the ADD or media concentrations. Ratios exceeding 1.0 indicated potential risks.

Risk estimates based on HQ values indicated a potential for extreme risks for terrestrial vegetation (from antimony, arsenic, chromium, lead, and zinc) and moderate to high risks for aquatic receptors (from aluminum, copper, lead, iron, and zinc) at the TBP AOC. On the basis of the HQ evaluation for avian and mammalian receptors, the TBP AOC presents the greatest risk to biota at J-Field, primarily to receptors that have limited home ranges and live entirely at the AOC (e.g., American robin, white-footed mouse, and eastern cottontail). Among the wide-ranging receptors that may visit multiple AOCs, a high risk was indicated for the white-tailed deer from aluminum, while low to moderate risks were indicated for antimony, arsenic, lead, mercury, selenium, and zinc to the deer and other receptors.

At the TBP AOC, heavy metals pose the greatest potential risk to terrestrial wildlife; a potential for extreme risks ($HQ > 100$) was inferred for six of these contaminants. Lead contamination posed an extreme risk to the largest number of wildlife receptors (three), while arsenic and aluminum each posed potentially extreme risks to two wildlife receptors. Of the organic compounds evaluated, risks were identified only for trichloroethene; the inferred risk levels were low.

At the other AOCs, high risks were identified for terrestrial vegetation from chromium and zinc and moderate risks from copper, chromium, lead, and zinc. The only contaminant found to pose an extreme risk to aquatic receptors at other AOCs was iron at the RPDG AOC. High risks were indicated from aluminum, and moderate risks to aquatic biota were indicated from iron and lead. Extreme risks were identified for terrestrial wildlife only from aluminum at the other AOCs, although moderate to high risks from other heavy metals (particularly lead and zinc) were identified for a number of receptors at several AOCs. Although aluminum is the most widely implicated contaminant responsible for the adverse risks identified for J-Field, the risk estimates are based on 100% bioavailability of this metal. However, actual aluminum bioavailability is unknown for the J-Field site and is likely to be considerably lower, which would result in lower risk estimates for this contaminant. In addition, aluminum concentrations at many of the AOCs are lower than reported background levels.

In aquatic habitats outside the TBP AOC, HQ estimates identified potential risks from aluminum, iron, lead, and zinc. In terrestrial habitats, HQ-estimated risks are due to aluminum,

chromium, copper, iron, lead, and zinc. Excluding the TBP AOC, no risks were identified from the organic PCOECs for which HQs were estimated.

8.4 CONCLUSIONS

The following conclusions may be drawn from the results of this ERA:

- Some adverse ecological effects on the individual, population, and community are evident at all AOCs at J-Field. These effects are limited primarily to soil biota and vegetation, which are in direct contact with contaminated soils. However, the effects vary in magnitude among the AOCs. They are relatively minor at the PB, RPTS, SBT, and SBDG AOCs. The adverse effects in these areas are also limited to small areas within the AOC boundaries or specific areas such as pits and trenches.
- More extensive adverse ecological effects are evident at the TBP, WPP, RCP, and RPDG AOCs. These effects occur to soil biota and vegetation and also to aquatic components. Effects at the WPP, RCP, and RPDG AOCs are restricted to specific portions of each site and do not appear to be widespread.
- Adverse ecological effects are evident throughout the TBP AOC, particularly at the Pushout Area and main pits. The effects are generally limited to terrestrial biota; adverse effects on aquatic biota are limited to the boundary between the Pushout Area and the marsh.
- Soil toxicity is evident at all AOCs, but is generally low and limited to small areas (pits or trenches) within the AOCs. Soil toxicity is widespread and high at the TBP AOC. Soil toxicity is also suggested at multiple locations in the RPTS and PB AOCs; the magnitude of the toxic effects, however, is low.
- Limited surface water toxicity is evident at the WPP, RCP, and SBT AOCs, where surface waters were toxic only to one test organism, the green alga *Selenastrum*. Surface water toxicity was also indicated at the TBP AOC, but was limited to waters collected from along the marsh-Pushout Area boundary.
- No sediment toxicity is evident at the WPP, RCP, and SBT AOCs or at the Craters PAOC. Sediment toxicity was found at the TBP, SBDG, and RPDG AOCs and the Ruins Site PAOC. At the TBP, toxicity was detected only in sediments collected along the marsh-Pushout Area boundary; sediments from the pond and other portions of the marsh exhibited no toxicity. Sediment

toxicity at the other AOCs and the Ruins Site was not widespread and was generally limited in magnitude.

- Risk estimates to terrestrial receptors based on modeling identified the potential for extreme risks from exposure to contaminated media at the TBP, WPP, RCP, RPTS, and PB AOCs. Heavy metals (particularly aluminum, lead, and zinc) may pose the greatest risk to biota. Among the organic PCOECs modeled, risks from exposure to contaminants in soil were inferred only for trichloroethene. The inferred risk was low and was identified only for the TBP AOC. No organic PCOECs were predicted to pose risks at the other AOCs.
- At most AOCs, the ecological significance of the observed effects and the predicted risks is low; the potential risks are limited to small areas within the AOC boundaries. In contrast, the extent and magnitude of contamination at the TBP AOC may produce adverse effects that are ecologically significant on a local scale (J-Field) and may pose adverse risks to wide-ranging biota, including top-level avian predators.

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APPENDIX A:
ECOLOGICAL RISK ASSESSMENT METHODS

APPENDIX A:

ECOLOGICAL RISK ASSESSMENT METHODS

A variety of field and laboratory investigations were conducted to gather data for the J-Field ecological risk assessment (ERA). The methods followed the general approach developed for all of Aberdeen Proving Ground (ICF Kaiser Engineers 1993). Activities conducted as part of the J-Field ERA included (1) vegetation and wetland surveys, (2) soil invertebrate surveys, (3) aquatic invertebrate and fish surveys, (4) biological soil process evaluations, (5) soil toxicity investigations, and (6) aquatic toxicity investigations. The methods used for conducting these investigations are described below.

A.1 WETLANDS AND VEGETATION SURVEYS

Past activities at J-Field have resulted in environmental contamination that may adversely affect terrestrial and wetland vegetation. For the ERA, vegetation surveys were initiated in both wetland and terrestrial locations throughout J-Field. The purpose of these surveys was twofold. First, evaluations of species composition, abundance, and distribution among the areas of concern (AOCs) and reference areas helped identify areas of J-Field that may have been adversely affected by past or current site contamination. Specifically, vegetation was surveyed at several locations at J-Field to determine whether floristic composition, biomass, species diversity, or other ecological measures were related to levels of soil contaminants.

Second, remediation activities at J-Field, if necessary, may include excavation and construction activities that could directly or indirectly affect wetlands. Wetlands in the State of Maryland are regulated by the U.S. Army Corps of Engineers and the Maryland Department of Natural Resources. Disturbance of wetlands at J-Field during remediation may require permits from these agencies. Surveys to delineate wetlands near the J-Field AOCs identified wetland boundaries and will help avoid wetlands during remediation or, if avoidance is not possible, provide necessary information to meet permit requirements.

A.1.1 Sampling Locations

A.1.1.1 Wetlands

Sampling locations were selected on the basis of readily observed wetland characteristics such as inundation and hydrophytic vegetation. The jurisdictional wetland boundary was assumed

to be located along a gradient between these areas and areas observed to have upland characteristics (lack of soil saturation or inundation and dominance of upland plant species). At each location, transects extended from wetland to upland areas and were oriented perpendicular to the apparent wetland boundary. Transects were established in April 1994 in association with four AOCs: the Toxic Burning Pits (TBP), Riot Control Pit (RCP), Prototype Building (PB), and White Phosphorus Burning Pits (WPP) (Figure A.1).

Four transects were located near the TBP AOC (transects A4, A5, A6, and A9 in Figure A.1). The transects were located to include as many plant communities as possible and avoid the highly disturbed soils of the Pushout Area. Transect A4 was located at the marsh/old-field boundary north of the TBP AOC; transect A5 was located along the marsh/old-field boundary south of the TBP AOC; transect A6 was located at the marsh boundary within a forested area north of the TBP AOC; and transect A9 was situated at the marsh boundary within the forested area south of the TBP.

FIGURE A.1 Locations of Wetland Delineation and Vegetation Sampling Transects (Transects A1 through A11 were used for wetland delineation only; transects B1 through B5 were used for wetland delineation and vegetation sampling; transect B6 was used for vegetation sampling only.)

Two transects (A10 and A11) were located near the RCP AOC in areas where surface water had been observed early in the growing season. These areas included a large depressional area approximately 50 ft west of South Beach Road (south of the RCP AOC) and the tidal marsh along the shoreline of the Gunpowder River and Chesapeake Bay. The large amount of metal debris in the soil, as determined by magnetometer, precluded the placement of more transects in the RCP AOC.

Additional transects were located north of the PB AOC (transect A1), south and north of the WPP AOC (transects A2 and A3), and in the forested area northeast of the TBP AOC (transects A7 and A8). Five transects were established in June 1995 — the Robins Point Demolition Ground (RPDG) AOC (transects B1 and B2) and the Robins Point Tower site (RPTS) AOC (transects B3, B4, and B5).

A.1.1.2 Vegetation

Vegetation was inventoried at the WPP and TBP AOCs, including control sites near the AOCs. Particular emphasis was placed on the TBP AOC because of the accelerated need for data to support a focused feasibility study there. Six vegetation sampling grids were established at the TBP AOC in July 1993 (Figure A.2). A reference site sampling grid was also established at Gunpowder Falls State Park approximately 5 mi from J-Field. This uncontaminated area supports an open, grassy vegetation cover similar to that found at the TBP AOC.

Data from transects B1 through B5 (Figure A.1) were used for vegetation surveys, in addition to wetland delineation (see Section A.1.1.1 Wetlands).

A.1.2 Field Methods

A.1.2.1 Wetland Delineation

Wetlands were delineated by using the methodology of the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987). The Routine Determination Method was used to collect data for delineating the wetland boundaries near the TBP and RCP. Because of the presence of hazardous materials, and in accordance with the Health and Safety Plan (ANL 1995), no soil characterization was performed within the disposal trenches of the AOCs. Because of safety considerations, soil characterization was also eliminated for transects B1-B5.

In August 1993, a walkover survey was conducted at the TBP AOC to map vegetation communities and characterize each according to dominant species. In April 1994, transects were established and surveyed for unexploded ordnance; cleared areas were used for obtaining soil data,

FIGURE A.2 Locations of Vegetation Sampling Grids TBTB through TBTG (diagonal hatching) near the Toxic Burning Pits Area

dominant plant species data, and hydrologic data. The transects extended from areas of suspected wetlands (because of readily observable vegetation and hydrologic characteristics) to areas of suspected upland. Because of the extensive soil disturbance in the Pushout Area of the TBP AOC, transects were established lateral to the Pushout Area rather than within it. In May 1994, transects were sampled for soil and hydrologic characteristics. Little or no information was obtained from transect 5 at the TBP AOC (Figure A.1) because of the presence of large amounts of debris in the soil.

Data collection points on the transects were labeled alphabetically; the first point, A, was located in an area of standing water and dominated by hydrophytic species. Soil data were collected at each point by digging a soil pit and extracting a 40-cm-deep soil sample for examination. Soil data included color of the soil horizons, including mottles (determined with a Munsell Soil Color Chart [Kollmorgen Corporation 1990]), and texture of the soil. Hydrologic data collected at each point included standing water depth and depth to saturation. In July 1995, the dominant plant species was recorded for each data collection point. The hydrophytic indicator status of each species was determined from Reed (1988).

A.1.2.2 Vegetation Sampling

At each vegetation sampling location, a grid of 1- × 1-m plots was established. Total grid size ranged from 25 to 100 m², depending on the size of the study location. Vegetation was sampled in July and November 1993 and in November 1994. In November 1993 and November 1994, aboveground vegetation was also collected for biomass determinations. A subset of plots within each grid was randomly selected by using a random number generator. On each sampling date, the percent cover of each species was estimated. Relative cover was calculated for each species. Relative cover values indicate the proportion of each species to the total cover of all species in a sample. Voucher specimens were also collected for later confirmation of taxonomic identification.

Vegetation was also surveyed in two forested areas next to the TBP AOC. A 10- × 20-m plot was established southeast of the TBP AOC, and a 20- × 20-m plot was established south of the pits. All woody stems in each plot were counted, and diameters at breast height (approximately 1.5 m) were measured. Herbaceous species were inventoried for percent cover and density in 1-m² quadrats in each corner of each plot.

Samples collected for biomass determination were dried at 70°C for 72 hours, and the dried plant material was subsequently weighed to the nearest 0.01 g.

A.2 SOIL BIOTA SURVEYS

Assessment of the ecological conditions of contaminated soils included characterization of the soil biota present at the J-Field AOCs. Characterization activities included (1) surveys of the soil invertebrate communities at each AOC, (2) quantification of epigeic (surface-inhabiting) invertebrate activity, and (3) surveys to determine microbial abundance and activity in soils. The assessment and measurement endpoints for each of these characterization studies are shown in Table A.1. The following discussions summarize the methods used for the characterization studies. Detailed protocols for these methods can be found in Kuperman (1995) and Hlohowskyj et al. (1995).

TABLE A.1 Summary of Assessment and Measurement Endpoints for Soil Biota and Soil Process Investigations

Assessment Endpoint	Measurement Endpoint	Ecological Component
Community and population parameters	Taxonomic richness	Soil invertebrate community, including macroinvertebrates (Lumbricidae, Gastropoda, Myriapoda, Aranea, Insecta), microinvertebrates (Acari, Collembola and Nematoda), and soil protozoa
	Abundance/activity	Plant community composition, aboveground plant biomass
	Abundance of functional groups (trophic structure)	Decomposers, omnivore-predators bacterivores, fungivores, and herbivores
	Fungal and bacterial abundance and activity	Soil microorganisms, biomass nitrogen; carbon dioxide evolution (SIR ^a)
Effects on critical biological processes	Rates of organic matter decomposition; rates of nutrient release	Plant litter
	Nitrogen mineralization	Field incubations
	Enzyme activity	Carbon-, nitrogen-, phosphorus-acquiring enzymes

^a SIR = substrate-induced respiration.

A.2.1 Sampling Locations

Soil invertebrate surveys using 100-m² survey grids were conducted in 1993 (fall) and 1994 at three AOCs (TBP, WPP, and RCP). Surveys included a local background and a contaminated survey grid, and sampling was conducted in randomly selected quadrats (1 m²) in each grid. Off-site reference grids were also established at Gunpowder Falls State Park. Survey grids were used to determine the spatial distribution of the soil biota measurements in potentially toxic areas in all AOCs except the WPP AOC. The locations of the grids are shown in Figures A.3 through A.9.

In the TBP AOC, survey grids were located in the Pushout Area near the pits (TBTF) and in the local background area upslope and approximately 30 m from the main pits (TBTC)

FIGURE A.3 Locations of the Soil Biota Sampling Grids in the Pushout and Local Background Areas of the Toxic Burning Pits Area

FIGURE A.4 Locations of the Soil Biota Sampling Grids, Vegetation Sampling Grids, and Soil Toxicity Sampling Points in the Local Background and Adjacent Pit Areas of the White Phosphorus Burning Pits Area

FIGURE A.5 Locations of the Soil Biota Survey Grids and Soil Toxicity Sampling Points in the Local Background and Main Pit Areas of the Riot Control Pit Area

FIGURE A.6 Locations of the Soil Biota Survey Grids and Soil Toxicity Sampling Points in the Robins Point Demolition Ground Area

FIGURE A.7 Locations of the Soil Biota Survey Grid and Soil Toxicity Sampling Points in the Robins Point Tower Site Area

FIGURE A.8 Locations of the Soil Biota Survey Grid and Soil Toxicity Sampling Points in the South Beach Trench Area

FIGURE A.9 Locations of the Soil Biota Survey Grid and Soil Toxicity Sampling Points for the Prototype Building Area

(Figure A.3). Two terrestrial survey grids were located at the WPP AOC: a local background grid (WPE) located east-northeast of the main pits and a grid (WPS) immediately south of the southern pit (Figure A.4). At the RCP AOC, one grid (RCP) was centered on the main pit; the local background grid (RCB) was located about 400 ft east of the main pit (Figure A.5).

In addition to the local background grids established at the TBP, WPP, and RCP AOCs, off-site reference site survey grids with soil and vegetation parameters similar to those at the J-Field AOCs were selected in Gunpowder Falls State Park (Figure A.10). One grid (RSA) was established as the reference for grassland ecosystems, and another grid (RSB) was established as the reference for forest ecosystems.

A.2.2 Methods for Assessing the Abundance of Soil Macroinvertebrates

Determining the abundance of soil macroinvertebrates involves enumerating the macroinvertebrates in a unit area and depth of soil. Macroinvertebrate surveys were conducted in fall 1993 at the survey grids at the TBP AOC, in spring 1994 at the TBP and WPP AOCs, and in fall 1994 at the TBP AOC and the RSA reference grid at Gunpowder Falls State Park.

In fall 1993, the abundance of soil macroinvertebrates was estimated from 0.1-m² soil samples collected to a depth of 10 cm. Nine soil samples were taken in each of the survey grids in the TBP AOC, and 10 soil samples were taken in each of the survey grids in the WPP AOC. During the 1994 sampling period, this procedure was modified to increase the accuracy of soil extraction and decrease variability. Three soil cores (9.5-cm diameter and 10-cm depth) were collected in each of 10 quadrats within each grid of the TBP AOC and the RSA reference grid. All cores were collected with a stainless-steel soil sampler. Each intact soil core was hand sorted, and macroinvertebrates were preserved in ethyl alcohol for further identification. In summer 1995, the abundance of soil macroinvertebrates in the RSA and RSB reference sites and the RPDG, South Beach Trench (SBT), and PB AOCs was determined by using the same sitewide grids and sampling procedures used in 1994.

Macroinvertebrates were sorted into the following taxonomic categories: Isopoda (woodlice), Lumbricidae (earthworms), Gastropoda (snails and slugs), Diplopoda (millipedes), Lithobiomorpha (centipedes), Aranea (spiders), Gryllidae (field crickets), Formicidae (ants), Hemiptera (bugs), Cicindelidae (tiger beetles), Carabidae (ground beetles), Staphylinidae (rove beetles), Scarabaeidae (scarab beetles), Elateridae (click beetles), Curculionidae (snout beetles), other Coleoptera (beetles), Lepidoptera (butterflies and moths), and Diptera (flies). The abundance of soil macroinvertebrates was expressed as the number of individuals in each taxonomic category per square meter to a depth of 10 cm.

FIGURE A.10 Locations of the Soil Biota Survey Reference Grids at Gunpowder Falls State Park for Grassland and Forest Ecosystems

A.2.3 Methods for Assessing the Relative Abundance of Epigeic Macroarthropods

The abundance and activity of surface-dwelling invertebrates were evaluated by using pitfall traps that capture surface-dwelling macroarthropods as they travel over the soil surface. At each survey grid, pitfall traps containing about 50 mL of an ethylene glycol solution for field preservation were placed in the ground flush with the soil surface. The traps were left in situ for 1 to 2 days. The organisms were removed, taken to the laboratory, hand sorted, and preserved in 96% ethanol for later taxonomic identification. The epigeic macroinvertebrates were identified according to order, family, and genus, and where possible, species. The relative abundance of epigeic animals was expressed as the number per trap per day.

A.2.4 Methods for Assessing the Abundance of Soil Nematodes

The Baerman funnel technique (Edwards 1991) was used to extract nematodes from the soil. This method involves placing a soil sample on a fine-mesh sieve at the wide part of the funnel. The funnel is attached to a rubber tube closed by a clip and filled with water. The nematodes move out of the soil sample and collect in the neck of the tube, where they can easily be removed for identification.

The soil cores (5-cm diameter) were collected to a depth of 10 cm by using a stainless-steel soil sampler, placed in polyethylene bags, and taken to the laboratory. Twenty-gram soil subsamples were placed in a Baerman funnel extractor for 48 hours at room temperature. Extracted nematodes were counted live at 140× magnification and sorted into fungivore, bacterivore, herbivore, and omnivore-predator trophic groups. Classification was based primarily on reported feeding habits for recognized genera (Parmelee and Alston 1986). Esophageal morphology was used to determine trophic status for taxonomically unrecognized genera and for those taxa for which inadequate feeding data were available.

A.2.5 Methods for Assessing Abundance and Biomass of Soil Microorganisms

Soil microbial abundance and biomass were estimated because of the importance of soil microorganisms (bacteria and fungi) in nutrient cycling and their role as a source and sink of plant nutrients at J-Field. Microbial biomass is an important influence on most soil biogeochemical processes; it interacts with the primary productivity of ecosystems by regulating nutrient availability and degradation pathways of soil contaminants. Thus, any adverse impact of contaminants on a microbial community can adversely affect higher levels of the local ecosystem such as terrestrial vegetation and herbivorous species.

A.2.5.1 Methods for Estimating Active and Total Fungi and Active Bacteria

Soil samples were collected to a depth of 10 cm with a 5-cm-diameter stainless-steel soil sampler. The samples were placed in polyethylene bags and taken to the laboratory for analysis. A 1-g subsample of soil was placed in a dilution tube containing a solution of sterile water and phosphate buffer and gently shaken for 5 minutes. Gentle shaking is required to avoid disrupting the cell walls of the microorganisms. A 0.5- to 1-mL aliquot of this solution was then transferred to a test tube along with 1 mL of fluorescein diacetate (FDA) stain solution (Ingham and Klein 1984). This solution stains only active fungal hyphae and bacteria.

The length of FDA-stained hyphae was measured by epifluorescent microscopy at 250× total magnification. Three separate measurements were taken from each slide. Total fungal biomass was measured by using differential interference or phase contrast microscopy at 250× total magnification. Direct estimates of active bacteria were determined with epifluorescent microscopy at 40× magnification by counting the number of FDA-stained bacteria in each of five individual fields on each slide.

A.2.5.2 Methods for Indirect Estimation of Soil Microbial Biomass Nitrogen

The soil microbial biomass nitrogen was quantified by a fumigation-extraction method (Brookes et al. 1985). This method is based on chloroform (CHCl_3) fumigation, followed by immediate extraction with 0.5 M potassium sulfate and measuring the total nitrogen released by CHCl_3 in the soil extracts. The amount of total nitrogen released by CHCl_3 fumigation provides a measure of the microbial biomass nitrogen (Brookes et al. 1985).

Soil samples were collected to a depth of 10 cm with a 5-cm-diameter stainless-steel soil sampler, placed in polyethylene bags, stored on ice, and taken to the laboratory for processing and analysis. A detailed description of the extraction and fumigation process laboratory procedures can be found in Hlohowskyj et al. (1995) and Kuperman (1995).

A.3 AQUATIC INVERTEBRATE AND FISH SURVEYS

A.3.1 Aquatic Invertebrates

Benthic invertebrates were first collected in May 1993 from marsh locations surrounding the TBP AOC, one location in the RCP AOC drainage, four areas receiving drainage from the WPP

AOC, and an excavated pit located at the intersection of Rickett's Point Road and Robins Point Road (Figure A.11). These samples were collected with an Ekman grab sampler (0.02-m² sampling area), washed through a No. 30 (600- μ m-diameter mesh) sieve to remove fine sediment, placed in polyethylene containers, preserved with 95% ethanol, and transported to the laboratory for analysis. In the laboratory, organisms were separated from sediment and detritus with the aid of a dissecting microscope and identified to the lowest practical taxon, typically family or genus. The large amount of emergent vegetation in many of the sample locations occasionally prevented closure of the Ekman grab and thus made quantitative estimates of species abundance unreliable. Qualitative information, however, was obtained about the types of organisms present.

On May 12, 1994, benthic invertebrates were collected from the pond located in the marsh southeast of the TBP AOC (Figure A.7). Duplicate samples were collected from three locations in the pond by using a petite Ponar grab (0.02-m² sampling area). These samples were washed through a No. 30 sieve to remove fine sediment, placed in polyethylene jars, and preserved with a 10% formalin solution. In the laboratory, the organisms were separated from sediment and detritus with the aid of a dissecting microscope and placed in 75% ethanol solution for later taxonomic identification. Oligochaetes and chironomid larvae from these samples were mounted on microscope slides for taxonomic identification. All organisms were then identified to the lowest practical taxon and counted.

On June 9, 1995, three Hester-Dendy artificial substrate samplers were placed at three sample locations in the pond (SWQ-95, TPD-1, and TPD-2); they were retrieved on August 16, 1995. Each sampler was slowly lifted until it was near the surface of the water, and a No. 30 sieve was placed under the sampler to lift it from the water. The sampler was then placed in a sealable plastic bag and immersed in a 10% formalin solution. Any organisms observed on the sieve were captured with forceps and placed in the bag with the rest of the sample. In the laboratory, the organisms from each sample were identified, separated by taxa, and counted with the aid of a dissecting microscope.

A.3.2 Fish

The fish community inhabiting the pond in the marsh southeast of the TBP AOC (Figure A.11) was evaluated by using minnow traps, dip nets, and electrofishing techniques. Two baited wire mesh minnow traps were placed in the pond on the morning of August 19, 1993, and retrieved the following morning. The captured fish were identified by species, counted, and released. Five baited minnow traps were placed in the pond on March 13, 1995, and retrieved on March 14, 1995. The captured fish were identified by species, measured for standard length, weighed, examined for external abnormalities, and released. After the captured fish were removed, the traps were rebaited, returned to the pond, and retrieved on the morning of March 15, 1995.

FIGURE A.11 Approximate Locations of Benthic Invertebrate Collection Sites at J-Field: 1993 and 1994

An electrofishing survey of the pond was conducted on May 12, 1994. The survey was conducted from a small boat by using a Coffelt BP-1C electroshocker. Several passes were made of portions of the shoreline. The depth of the sampled areas ranged from approximately 4 in. to 3 ft. Electroshocked fish were collected in an electrically insulated dip net and placed in a holding container in the boat until they could be identified, counted, measured, and inspected for any visible signs of disease or external abnormalities. During the electrofishing survey, a small dip net was used to collect a sample of larval fish from schools observed in shallow areas of the pond. The larvae were preserved in 10% formalin and transported to the laboratory for identification and measurement.

A.4 SOIL PROCESS EVALUATIONS

Litter decomposition and nutrient mineralization affect the soil fertility and primary productivity of ecosystems at J-Field. Distribution and turnover of organic matter form organic matter pools in the soil and nutrient exchange sites for root uptake. An awareness of how increased concentrations of soil contaminants can alter rates of litter decomposition, rates and timing of nutrient retention, and nutrient release is critical to understanding the impacts of soil pollution on the overall structure and function of the J-Field terrestrial ecosystems. Evaluations of soil processes at J-Field included investigations of litter decomposition, nitrogen mineralization, microbial enzyme activity, and soil respiration.

A.4.1 Methods for Assessing Litter Decomposition and Nutrient Dynamics in Decomposing Litter

Decay and nutrient mineralization rates of plant residues were determined by a litterbag method (Hlohowskyj et al. 1995; Kuperman 1995). Preweighed plant residues were confined in mesh litterbags and placed in the field. Subsets of litterbags were periodically harvested to determine mass loss and change in nutrient content over time.

A.4.1.1 Sample Locations

Filled litterbags were incubated in the terrestrial survey grids at the TBP, RCP, and WPP AOCs. At the RCP AOC, the litterbags were placed on the soil surface in wooded areas. At the WPP and TBP AOCs, the litterbags were buried in the soil in grassland areas. Additional filled litterbags were taken to the field and handled in the same way as other litterbags, but immediately returned to the laboratory to determine any litter loss from handling.

A.4.1.2 Sample Collection and Analyses

The litterbags were constructed of fiberglass screen material with a 1.5-mm mesh size and had an inside area of 100 cm². Aboveground vegetation was collected in October 1993, at the time of natural plant senescence. *Phragmites australis* was used to represent grassland vegetation, and *Liquidambar styraciflua* was the surrogate species for forest vegetation. Aboveground plant material from each species was oven-dried at 80°C for a minimum of 48 hours. Each litterbag was filled with 4 to 5 grams of dried plant material, and the exact weight was recorded. The filled litterbags were sealed, and an aluminum identification tag was wired to each bag. Subsamples of dried litter were stored for later analysis of initial litter nutrient quality.

Ten litterbags were collected every 6 months from each terrestrial grid. The litterbags were placed in polyethylene bags, sealed, and stored in a cooler until returned to the laboratory, where they were stored at 4°C until further processing. The litter was processed according to the procedures in Hlohowskyj et al. (1995) and analyzed for total nitrogen and carbon content with a Carlo/Erba NA1500 automated carbon/nitrogen analyzer.

Because of the unavoidable contamination (mixing) of plant residues with soil, litter residue masses were corrected for soil infiltration with the following soil correction equation:

$$FLiC = (SaC - SiC)/(LiC - SiC) ,$$

where

$FLiC$ = fraction of the litterbag content that is actually litter-based carbon,

SaC = total carbon content of the litterbag sample after the incubation period,

SiC = carbon content of the soil from the field site, and

LiC = litter carbon content in the initial litter sample before incubation.

Decay rate constants of litter residues were calculated with a single negative exponential decay model:

$$m_t/m_0 = e^{-kt} ,$$

where

m_t/m_0 = proportion of litter carbon remaining at time t ,

t = time elapsed in days, and

k = the derived daily decay constant.

Patterns of net nutrient accumulation or release were calculated as the product of the percent of litter carbon remaining and the nutrient concentration in the residual material at time t , divided by the initial nutrient concentration. Statistical analyses were conducted on untransformed data; an $\alpha = 0.05$ was used to determine statistical significance.

A.4.2 Methods for Assessing Soil Nitrogen Mineralization

Nitrogen utilization requires distinct enzymatic steps for extracellular hydrolysis, uptake, deamination, and intracellular catabolism, each of which could be affected differently by pollutants. The effects of soil contamination on the overall nitrogen mineralization in J-Field ecosystems provide information regarding changes in the availability of this critical nutrient in the ecosystem.

A.4.2.1 Sample Locations

Nitrogen mineralization studies were conducted at seven soil sampling locations: the TBTC and TBTF grids at the TBP AOC, the WPE and WPS grids at the WPP AOC, the RCP and RCB grids at the RCP AOC, and the RSA survey grid at the reference site (see Section A.2.1).

A.4.2.2 Sample Collection and Analyses

Net nitrogen mineralization was quantified by the incubation tube method (Hlohowskyj et al. 1995). Ten polyvinyl chloride incubation tubes (20 cm total length) were installed to a depth of 15 cm at each of the seven soil sampling locations. At the same time, preincubation soil samples were collected from each sampling location to determine the initial levels of potassium chloride (KCl)-extractable inorganic nitrogen (ammonium-nitrogen [$\text{NH}_4\text{-N}$] and nitrate-nitrogen [$\text{NO}_3/\text{NO}_2\text{-N}$]). Each tube was sealed and incubated in situ for 4 to 6 weeks. The tubes were then removed from the soil, individually sealed in polyethylene bags, and transported in a cooler to the laboratory. The incubated soils were prepared and analyzed for KCl-extractable inorganic nitrogen ($\text{NH}_4\text{-N}$ and $\text{NO}_3/\text{NO}_2\text{-N}$) following the procedures described in Hlohowskyj et al. (1995). Net nitrogen mineralization was calculated as the sum of $\text{NH}_4\text{-N}$ and $\text{NO}_3/\text{NO}_2\text{-N}$ in the incubation tube after incubation, minus the amount of $\text{NH}_4\text{-N}$ and $\text{NO}_3/\text{NO}_2\text{-N}$ present in each preincubation soil sample. The concentrations of extractable $\text{NH}_4\text{-N}$ and $\text{NO}_3/\text{NO}_2\text{-N}$ were expressed as grams of nitrogen per gram of dry soil. Statistical analyses were conducted on natural log-transformed data; statistical significance was determined at $\alpha = 0.05$.

A.4.3 Methods for Assessing Soil Enzyme Activities

Soil enzyme activities were measured in the TBP AOC to determine whether the soil concentration of contaminants may have adversely affected microbial activity, rates of organic matter degradation, and subsequent release of nutrients to aboveground communities in the area.

Soil cores were collected with a 5-cm-diameter soil corer to a depth of 10 cm. Soil samples were placed in polyethylene bags, sealed, transported in a cooler at 2 to 4°C to the laboratory, and stored for no longer than 3 months at -20°C until analysis. Assays for enzyme activity were conducted according to the procedures in Hlohowskyj et al. (1995). The potential activities of the following soil extracellular enzymes were quantified: beta-1,4,-glucosidase, beta-1,4, endoglucanase (endo-cellulase), n-acetylglucosaminidase, acid phosphatase, alkaline phosphatase, and dehydrogenase.

Assays were conducted at 25°C with soil slurries (10 g fresh weight, 8.5 g dry weight soil) suspended in 150 mL of acetate buffer (50 mmol, pH 5), except for assays for alkaline phosphatase activity. Those slurries were suspended in 100 mmol tris buffer at pH 9.5. The activities of the extracellular enzymes (except endocellulase and dehydrogenase) were measured by the spectrophotometric method described in Sinsabaugh and Linkins (1990), which used substrates bound to the chromogen, p-nitrophenol (pNP): pNP-beta-D-glucopyranoside, pNP-n-acetylglucosaminide, and pNP-phosphate. Total phosphatase activity was obtained by summing the mean activities for acid phosphatase and alkaline phosphatase for each soil sample.

The endocellulase assay was performed with a viscometric method that uses carboxymethyl-cellulose as a substrate (Almin and Eriksson 1967). Enzyme activity for the endocellulase assay was expressed as viscometric units per gram dry mass per hour and per gram ash-free dry mass per hour.

The activity of soil dehydrogenase was measured by the 2,3,5-triphenyl tetrazolium chloride (TTC) method (Casida 1977). One gram of soil was incubated at 40°C for 6 hours in a 20-mL glass scintillation vial containing 1 mL 0.5% TTC in 0.5 M tris buffer (pH 7.6). The amount of 2,3,5-triphenyl formazan formed by the reduction of TTC was determined in methanol extracts by using a Lachat flow-injection autoanalyzer with a 480-nm filter. Enzyme activity for the pNP and TTC assays was expressed as micromoles of substrate converted per gram of dry mass soil per hour and per gram of ash-free dry mass per hour.

These assays permit the comparison of potential enzyme abundance and activity among sites in this study and should not be interpreted as actual in situ activities at the time of collection. Statistical analyses included an analysis of variance test (ANOVA) on the log-transformed data; statistical significance was determined at $\alpha = 0.05$.

A.4.4 Methods for Assessing Soil Microbial Activity

The soil respiration studies conducted at J-Field were designed to measure the carbon dioxide (CO₂) evolution in microcosms as an integrator of the effects of soil contamination on microorganisms within the soil ecosystem. Two methods were used: soil basal respiration and substrate-induced respiration (SIR).

A.4.4.1 Soil Basal Respiration

Basal respiration was determined for soil samples collected from the TBP AOC and WPP AOC survey grids following the general procedures described in Zibilske (1994). Basal respiration was estimated by measuring CO₂ evolution in laboratory microcosms during 27 days of incubation at 22°C. Soil was collected with a stainless-steel sampler, placed in polyethylene bags, and taken to the laboratory for further processing and analysis. In the laboratory, the soil was screened through a 4-mm sieve to remove any large invertebrates, roots, leaves, and other coarse materials. Thirty-gram subsamples of soil were placed in 80-mL glass beakers. The beakers were then placed in 1-L glass microcosm chambers. Deionized water was added to each beaker to adjust the soil moisture content to 60% of water-holding capacity, and 20 g of deionized water was added to each microcosm to control the humidity level. Five replicates were incubated for each soil sample location. Blank microcosms (no soil added) were used to account for the ambient CO₂ concentrations. Carbon dioxide was measured at 2- to 3-day intervals with an Illinois Instruments IR 3600 CO₂/oxygen analyzer. The analyzer was calibrated before each set of measurements. The cumulative amount of CO₂ produced was expressed as milligrams of CO₂ generated per gram of dry soil.

A.4.4.2 Substrate-Induced Respiration

Evaluating SIR involves adding glucose substrate to a soil sample to induce a maximal respiratory response from the microbiota present in the soil. Substrate-induced respiration, measured as CO₂ evolution, was evaluated by using a soil respiration measuring system with continuous gas flow (Cheng and Coleman 1989; Cheng and Virginia 1993). The soil respiration measuring system consisted of an incubation chamber, an airflow controlling unit, an airflow measuring unit, and a CO₂ analyzer.

Soil cores were collected with a 5-cm-diameter stainless-steel soil sampler to a depth of 10 cm. In the laboratory, each soil sample was screened with a No. 10 sieve to remove coarse organic matter, metal fragments, stones, rocks, and other large materials. A 15-g subsample of each sample was placed in a 125-mL Erlenmeyer flask. Glucose solution was added to the flask by syringe until the soil water content of the sample was near its water-holding capacity and with a final glucose amendment of 8 mg of glucose per gram of soil (dry weight). The soil was then incubated at 22°C

and 1 atm until the rate of CO₂ evolution from the sample became constant (approximately 40 min). The CO₂ evolution rate was recorded as the SIR of that soil sample. Statistical analyses were conducted on natural log-transformed data; statistical significance was accepted at $P \leq 0.05$.

A.5 SOIL TOXICITY

The toxicity of soils at the J-Field AOCs was evaluated with earthworm toxicity and phytotoxicity procedures that compared earthworm survival, seed germination, and seedling growth among site and control soils. A detailed description of the evaluation methods is presented in Phillips et al. (1995).

A.5.1 Sampling Locations

Soil samples were collected from seven locations at J-Field: (1) TBP and adjacent areas (19 samples; Figure A.12); (2) WPP (4 samples; Figure A.4); (3) RCP (12 samples; Figure A.5); (4) RPDG (4 samples; Figure A.6); (5) RPTS (10 samples; Figure A.7); (6) SBT (6 samples; Figure A.8); and (7) PB (8 samples; Figure A.9). Positive and negative controls used soil obtained from an area along Winters Run at APG. This soil was used as the reference soil (for both the plant and earthworm tests) because no appropriate soil could be found at J-Field.

A.5.2 Preparation of Soil Samples

Soil samples were screened through a wire sieve (5-mm² mesh) to remove rocks, stones, twigs, leaves, and other large debris. The dry fraction and water-holding capacity of each soil sample were determined according to the procedures described in Phillips et al. (1995). The dry fraction and water-holding capacity determined the quantity of water required to bring the soil of each sample up to nominal field moisture levels before conducting phytotoxicity and earthworm toxicity testing.

A.5.3 Earthworm Toxicity Tests

The earthworm toxicity tests used the earthworm *Eisenia foetida* in the screening and definitive tests. The screening tests exposed earthworms to unaltered, undiluted sample soil, and the definitive tests exposed earthworms to serial dilutions of sample soils. Survival rates and differences between initial and final weights (sublethal endpoints) were used as indices of toxicity. The test methods used for earthworm toxicity studies were adapted from Karnak and Hamelink (1982) and Neuhauser et al. (1985), as described in Phillips et al. (1995).

In the earthworm toxicity tests, five earthworms were placed in a 600-mL glass beaker containing 200 g of unaltered dry soil and enough distilled water to bring the soil moisture level up to nominal field capacity. Three replicates were established for each sampling location. Positive and negative controls were also established. A spike of pNP was added to the positive control at a target concentration of 50 g of pNP per gram of soil. The negative control was Winters Run soil, without a pNP spike.

After five earthworms were added to each beaker, the beakers were covered and placed in an incubator set at $21.0 \pm 0.2^\circ\text{C}$. Water was added to the trays to prevent the soil in the beakers from drying out. The incubator lights were set for continuous operation; because earthworms are photophobic, the light encouraged them to burrow into the test soil.

The earthworms were housed in the incubator for 14 days. They were then removed from the beakers and weighed. The physical condition of the earthworms was also examined, and any changes (e.g., color, texture, motility) were noted.

In each definitive test, sample soil was mixed with a quantity of reference soil to produce sample soil concentration percentages of 100, 75, 50, 25, and 0. The definitive tests were performed three times with appropriate positive and negative controls. An analysis of covariance to test the weight differences and a *t*-test pairwise comparison of least-square means were used to evaluate the test data.

A.5.4 Phytotoxicity Tests

The screening procedures for determining phytotoxicity of soils were adapted from the U.S. Environmental Protection Agency's (EPA's) Early Seedling Growth Toxicity Test (EPA 1982) and from EPA protocols for short-term toxicity screening of hazardous waste sites (Greene et al. 1989). The plant species used in the screening test was lettuce (*Lactuca sativa*). Data on seed emergence rates, plant heights, survival rate, and plant dry weights were produced for the following locations: (1) TBP (JBPMB, JHDP, JBPPC, JBPMA, JBPPA, JBP2C, JBP1C, and JBPPB); (2) WPP (JWP1E, JWP2C, JWPPA, and JWPPB); (3) RCP (JBTMA and JBT1W); and areas near the TBP (JBPGF and JBPCP104). Only the seed germination assay was used for the remaining samples. Statistical evaluations of plant data included ANOVA and Newman-Keuls pairwise comparison of means. A detailed description of phytotoxicity screening procedures is given in Phillips et al. (1995) and EnviroSystems (1995).

Each screening phytotoxicity test used 800 g of sample soil with enough distilled water to bring the soil moisture level up to nominal field capacity. Positive and negative controls were also established with soil from Winters Run. The positive control used a spike of copper sulfate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) at a target concentration of 1,000 g of copper per gram of soil, while the negative

control was Winters Run soil without a spike. In each definitive test, sample soil was mixed with reference soil to produce sample soil concentration percentages of 100, 75, 50, 25, and 0. The definitive tests were performed three times with appropriate positive and negative controls.

For each soil sample, 20 seeds were planted in a clay pot. After emergence, the seedlings were thinned to the 10 most uniform per pot. Day 1 of treatment was determined when 50% of the total number of control seeds had emerged. The seed emergence rate was recorded over a 14-day study period as a direct measure of effective seed germination. Plant height measurements were taken four times during the study period. Any plant abnormalities (e.g., chlorosis, necrosis) were noted. A final measurement was made when the plants were harvested (day 14). After harvest, fresh and dry weight measurements were made as additional measures of plant growth. Statistical evaluations included ANOVA and Student-Newman-Keuls multiple range tests; statistical significance was determined using $\alpha = 0.05$.

A.6 AQUATIC TOXICITY

A.6.1 Sampling Locations

Following reconnaissance of the J-Field site in April 1994, 24 locations containing surface water were selected for collection of media for toxicity testing (Figure A.13). Media were collected from the TBP AOC (SW-10, SW-11, SW-12, TBP-A, and TBP-B), the WPP AOC (WPP-A, WPP-B, and WPP-C), the RPDG AOC (DGD-1 and DGD-2), and the RCP AOC (RCP-1). These sampling locations included permanent and seasonal surface waters that were likely to receive runoff from areas of potential contamination. Many of these locations have been previously sampled and chemically characterized as part of the remedial investigation/feasibility study activities under way at the J-Field site.

Media for toxicity testing were also collected from the following locations:

- Two detonation craters located near the ruins site (DG-1 and DG-2),
- Two detonation craters in the woods south of the TBP AOC (TBC-A and TBC-B),
- The SBT (SBT-1),

FIGURE A.13 Sample Locations for Surface Water, Groundwater, and Sediment for Aquatic Toxicity Testing

- Three locations in the pond located southeast of the TBP AOC (TPd-1, Tpd-2, and SWQ-95), and
- One excavated area that may have been used for decontaminating vehicles, near the intersection of Rickett's Point Road and Robins Point Road (DG-3) (Figure A.11).

Three shallow wells (JF5-3, JF7-3, and JF8-3) that draw water from a surficial aquifer at the TBP AOC were also used as sources of media (groundwater only) for toxicity tests (Figure A.11). These wells were selected because they exhibited elevated levels of volatile organic compounds during previous chemical testing (U.S. Geological Survey 1991).

A.6.2 Water Quality Measurements

Water quality parameters were measured at locations of surface water collections with a Horiba U-10 water quality meter (at most sites) or a Hydrolab water meter (at sites Tpd-1 and Tpd-2), which were calibrated at the beginning of each day of sampling. Measured water quality parameters included pH, conductivity, turbidity, dissolved oxygen, temperature, and salinity.

A.6.3 Media Collection

Surface water for Microtox analyses was collected in laboratory-cleaned 125-mL glass jars with Teflon-lined lids. Surface water for other toxicity tests was collected by using clean and triple-rinsed polyethylene containers to fill 3.8-L low-density polyethylene containers (Cubitainers). Details on the surface water collection procedures are described in Hayse (1995).

Wet surficial sediments were collected from sample locations for Microtox analyses and for 10-day acute screening tests with the amphipod *Hyaella*. Sediments to a depth of 8 cm were collected with a stainless-steel coring device or shovel. Surficial sediments for Microtox analyses were placed in 125-mL glass containers with Teflon-lined lids, while sediments for *Hyaella* screening tests were placed in 6.8-L polypropylene buckets with locking polypropylene lids. Sample jars and buckets had been acid-washed and solvent-rinsed in the laboratory and were rinsed with surface water from the sample location before being filled with sediment.

On June 3, 1994, groundwater was collected from three wells (JF5-3, JF7-3, and JF8-3) that draw water from a surficial aquifer at the TBP AOC. Groundwater for Microtox analyses was collected in 125-mL glass sample jars; groundwater for other toxicity tests was placed in 3.8-L low-density polyethylene containers (Cubitainers).

A.6.4 Toxicity Testing

Biota used during the toxicity tests of aquatic media included primary producers, primary consumers, and secondary consumers. These test organisms were representative of biological receptors identified from J-Field (Hlohowskyj et al. 1995). Test organisms included bacteria (*Photobacterium phosphoreum*), green algae (*Selenastrum capricornutum*), vascular plants (*Lemna minor*), zooplankton (*Daphnia magna* and *Ceriodaphnia dubia*), amphipods (*Hyalella azteca*), fish (*Pimephales promelas*), and amphibians (*Rana sphenoccephala*). A summary of the methods for toxicity testing with these organisms and the measurement endpoints are presented in Table A.2; the types of tests performed at each media collection location are presented in Table A.3. Details on testing procedures are provided in Hayse (1995).

TABLE A.2 Summary of Toxicity Test Methods for Media Collected from Aquatic Habitats at J-Field

Test Medium	Test Organism (Age or Size)	Test Duration and Type	Endpoint
Acute Toxicity Tests			
Surface water	<i>Daphnia magna</i> (<24 hours old)	48-hour static nonrenewal	Survival
Sediment	<i>Hyalella azteca</i> (2–4 mm)	10-day static nonrenewal	Survival, growth
Surface water	<i>Pimephales promelas</i> (≤ 14 days old)	48-hour static nonrenewal	Survival
Surface water	<i>Rana sphenoccephala</i> (≤ 14 days old)	48-hour static nonrenewal or 96-hour static nonrenewal	Survival
Chronic Toxicity Tests			
Surface water	<i>Selenastrum capricornutum</i> (4–10 days old)	96-hour static nonrenewal	Production, growth
Surface water	<i>Ceriodaphnia dubia</i>	7-day static renewal	Survival, reproduction
Sediment	<i>Hyalella azteca</i>	28-day static nonrenewal	Survival, growth
Surface water	<i>Lemna minor</i>	96-hour static renewal	Production, growth
Surface water	<i>Pimephales promelas</i> (≤ 14 days old)	7-day static renewal	Survival, growth

TABLE A.3 Toxicity Tests Performed at J-Field: Spring 1994

Sample Locations												
Toxicity Test	TBP				Pond Southeast of TBP				RCP		RPDG	
	SW-7	SW-10	SW-11	SW-12	TBP-A	TBP-B	SWQ-95	TPd-1	TPd-2	RCP-1	DGD-1	DGD-2
Microtox screening (water)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Microtox screening (sediment)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<i>Selenastrum capricornutum</i> (96-hour chronic)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<i>Lemna minor</i> (96-hour chronic)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<i>Daphnia magna</i> (48-hour acute)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<i>Hyalella azteca</i> (10-day acute)	✓	✓	✓	✓	✓	✓	✓	✓	✓			
<i>Hyalella azteca</i> (28-day chronic)	✓	✓	✓	✓	✓	✓				✓		
<i>Pimephales promelas</i> (48-hour acute)	✓	✓	✓	✓	✓	✓	✓	✓	✓			
<i>Pimephales promelas</i> (7-day chronic)	✓	✓	✓	✓	✓	✓	✓	✓				
<i>Rana sphenoccephala</i> (48-hour acute)	✓	✓	✓	✓	✓		✓					
<i>Rana sphenoccephala</i> (96-hour acute)										✓		✓
<i>Ceriodaphnia dubia</i> (7-day chronic)	✓	✓	✓	✓		✓	✓	✓		✓		✓

TABLE A.3 (Cont.)

Toxicity Test	Sample Locations												
	SBT	WPP			SBDG	Craters					Groundwater		
	SBT-1	WPP-A	WPP-B	WPP-C	SBDG SW1	DG-1	DG-2	DG-3	TBC-A	TBC-B	JF5-3	JF7-3	JF8-3
Microtox screening (water)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Microtox screening (sediment)	✓	✓	✓	✓		✓	✓	✓	✓	✓			
<i>Selenastrum capricornutum</i> (96-hour chronic)	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓
<i>Lemna minor</i> (96-hour chronic)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<i>Daphnia magna</i> (48-hour acute)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
<i>Hyalella azteca</i> (10-day acute)	✓	✓	✓	✓									
<i>Hyalella azteca</i> (28-day chronic)	✓				✓								
<i>Pimephales promelas</i> (48-hour acute)		✓	✓	✓							✓	✓	✓
<i>Pimephales promelas</i> (7-day chronic)													
<i>Rana sphenocephala</i> (48-hour acute)		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
<i>Rana sphenocephala</i> (96-hour acute)	✓				✓								
<i>Ceriodaphnia dubia</i> (48-hour acute)					✓								

A.7 TISSUE RESIDUE ANALYSIS

Samples of the common reed (*Phragmites australis*) for analysis of chemical residues in tissues were collected from marsh areas at J-Field on July 21–22, 1994. Aboveground tissues of common reed were collected from 9 sample locations (Figure A.14) by clipping 7 to 13 stems at each sampling location and placing them into laboratory-cleaned 1-L glass jars with Teflon-lined lids. The tissues were analyzed for total metals, polychlorinated biphenyls, chlorinated pesticides, and semivolatile organic compounds according to Contract Laboratory Program methods. Details on laboratory procedures for tissue residue analyses are provided in EA Laboratories (1994).

FIGURE A.14 Tissue Residue Sample Locations for the Common Reed (*Phragmites australis*)

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APPENDIX B:
ECOLOGICAL SCREENING AND RISK
ESTIMATION BENCHMARKS

TABLE B.1 Surface Water Regulatory and Benchmark Concentrations Used in the Screening Process for Identifying Contaminants of Ecological Concern

Contaminant	Contaminant Concentration (µg/L)	Benchmark Criterion	Source
1,1,2,2-Tetrachloroethane	2,400	Chronic toxicity value	EPA (1996a)
1,1,2-Trichloroethane	9,400	Chronic toxicity value	EPA (1996a)
1,2-Dichloroethene (total)	11,600	Acute toxicity value	EPA (1996a)
2-Hexanone	428,000	Acute toxicity value	EPA (1996a)
Acetone	9,000,000	Acute toxicity value	EPA (1996a)
Aluminum	87	Freshwater chronic AWQC ^a	Suter and Tsao (1996)
Antimony	30	Freshwater chronic AWQC (proposed)	EPA (1996a)
Arsenic	190	Freshwater Chronic AWQC	EPA (1986)
Barium	10,000	Chronic toxicity value	EPA (1996a)
Beryllium	5.3	Freshwater chronic AWQC	EPA (1996a)
Cadmium	1.1 ^b	Freshwater chronic AWQC	EPA (1986)
Calcium	116,000	Lowest chronic value for daphnids	Suter and Tsao (1996)
Chromium	11	Freshwater chronic AWQC	EPA (1986)
cis-1,2-Dichloroethene	11,600	Chronic toxicity value	EPA (1996a)
Cobalt	35,000	Chronic toxicity value	EPA (1996a)
Copper	12 ^b	Freshwater chronic AWQC	EPA (1986)
Iron	1,000	Freshwater chronic AWQC	EPA (1986)
Lead	3.2 ^b	Freshwater chronic AWQC	EPA (1986)
Magnesium	82,000	Lowest chronic value for daphnids	Suter and Tsao (1996)
Manganese	14,500	Region III BTAG screening value	EPA (1996a)
Mercury	0.012	Freshwater chronic AWQC	EPA (1986)
Nickel	160 ^b	Freshwater chronic AWQC	EPA (1986)
Potassium	53,000	Lowest chronic value for daphnids	Suter and Tsao (1996)

TABLE B.1 (Cont.)

Contaminant	Contaminant Concentration (µg/L)	Benchmark Criterion	Source
RDX	190	Chronic screening value	Talmadge and Opresko (1996)
Selenium	5	Freshwater chronic AWQC	Suter and Tsao (1996)
Silver	4.1 ^b	Freshwater acute AWQC	EPA (1986)
Sodium	680,000	Lowest chronic value for daphnids	Suter and Tsao (1996)
trans-1,2-Dichloroethene, total	11,600	EPA Region III BTAG acute screening value	Suter and Tsao (1996)
Trichloroethene	21,900	EPA Region III BTAG screening value	EPA (1996a)
Vanadium	10,000	EPA Region III BTAG screening value	EPA (1996a)
Vinyl chloride	11,600	EPA Region III BTAG acute screening value	EPA (1996a)
Zinc	110 ^b	Freshwater chronic AWQC	EPA (1986)

^a AWQC = ambient water quality criterion (EPA 1986).

^b The benchmark value is hardness dependent. The value provided is for a hardness of 100 mg/L as CaCO₃.

TABLE B.2 Sediment Benchmark Concentrations Used in the Screening Process for Identifying Contaminants of Ecological Concern

Contaminant	Contaminant Concentration (µg/kg)	Benchmark Criterion	Source
1,1,2,2-Tetrachloroethane	940	Sediment quality benchmark ^a	EPA (1996b)
1,1,2-Trichloroethane	1,200	Secondary chronic value ^b	Jones et al. (1997)
1,2-Dichloroethane	250	Secondary chronic value	Jones et al. (1997)
1,2-Dichloroethene (total)	400	Secondary chronic value	Jones et al. (1997)
1,4-Dichlorobenzene	350	Sediment quality benchmark	EPA (1996b)
2-Butanone	270	Secondary chronic value	Jones et al. (1997)
2-Hexanone	22	Secondary chronic value	Jones et al. (1997)
4,4'-DDD	16	TEL ^c	EPA (1996a)
4,4'-DDE	2.2	TEL	EPA (1996a)
4-Methyl-2-pentanone	33	Secondary chronic value	Jones et al. (1997)
Acetone	8.7	Secondary chronic value	Jones et al. (1997)
Antimony	150,000	TEL	EPA (1996a)
Arsenic	8,200	ER-L ^d	EPA (1996b)
bis(2-Ethylhexyl)phthalate	890,000	Secondary chronic value	Jones et al. (1997)
Cadmium	1,200	ER-L	EPA (1996b)
Chromium	81,000	ER-L	EPA (1996b)
Copper	34,000	ER-L	EPA (1996a)
di-n-Butylphthalate	11,000	Sediment quality benchmark	EPA (1996b)
Ethylbenzene	3,600	Sediment quality benchmark	EPA (1996b)
Fluoranthene	600	ER-L	EPA (1996a)
Hexachlorobenzene	22	TEL	EPA (1996a)
Lead	46,700	ER-L	EPA (1996a)
Manganese	460,000	Lowest effect level	Jones et al. (1997)
Mercury	150	ER-L	EPA (1996a)
Methylene chloride	370	Secondary chronic value	Jones et al. (1997)
Nickel	20,900	ER-L	EPA (1996a)
Pyrene	665	ER-L	EPA (1996a)
Silver	1,000	ER-L	EPA (1996a)
Toluene	670	Sediment quality benchmark	EPA (1996b)
Trichloroethene	1,600	Sediment quality benchmark	EPA (1996b)
Zinc	150,000	ER-L	EPA (1996a)

See next page for footnotes.

Footnotes for TABLE B.2

- ^a Sediment quality benchmarks (SQB) were developed according to the procedure described in Hull and Suter (1994) with the following formula: $SQB = K_p \times WQB$, where K_p is a partition coefficient between sediment and water, and WQB is a water-quality benchmark (Suter and Mabrey 1994).
- ^b Secondary chronic value developed following the procedure described in Jones et al. (1997). The value is based on toxicity in water expressed as a secondary chronic water quality criterion and considering partitioning of the contaminant between organic matter (1% of sediment) and pore water. The secondary chronic water quality criterion is a conservative estimate of the water quality criterion for which available data are insufficient to derive a natural ambient water quality criterion value. See Suter and Tsao (1996) for additional details on derivation of secondary chronic water quality criteria.
- ^c TEL = threshold effect level (the geometric mean of the fiftieth percentile of reported concentrations that were associated with some level of effects and the fiftieth percentile of reported concentrations that were associated with no adverse effects).
- ^d ER-L = effects range-low (the tenth percentile of estuarine sediment concentrations reported to be associated with some level of toxic effects).

TABLE B.3 Soil Benchmark Concentrations Used in the Screening Process for Identifying Contaminants of Ecological Concern

Contaminant	Contaminant Concentration (µg/kg)	Benchmark Criterion	Source
1,1,2,2-Tetrachloroethane	300	Region III BTAG soil screening value	EPA (1996a)
1,2-Dichloroethene (total)	300	Region III BTAG soil screening value	EPA (1996a)
2-Methylphenol	100	Region III BTAG soil screening value	EPA (1996a)
4,4'-DDD	100	Region III BTAG soil screening value	EPA (1996a)
4,4'-DDE	100	Region III BTAG soil screening value	EPA (1996a)
4,4'-DDT	100	Region III BTAG soil screening value	EPA (1996a)
4-Methylphenol	100	Region III BTAG soil screening value	EPA (1996a)
Aldrin	100	Region III BTAG soil screening value	EPA (1996a)
Aluminum	1,000	Phytotoxicity value	EPA (1996a)
Antimony	480	Phytotoxicity value	EPA (1996a)
Aroclor 1248	100	Region III BTAG soil screening value	EPA (1996a)
Arsenic	10,000	Phytotoxicity value	Will and Suter (1995a)
Barium	440,000	Region III BTAG soil screening value	EPA (1996a)
Benzene	100	Region III BTAG soil screening value	EPA (1996a)
Benz(a)anthracene	100	Region III BTAG soil screening value	EPA (1996a)
Benzo(a)pyrene	100	Region III BTAG soil screening value	EPA (1996a)
Benzo(b)fluoranthene	100	Region III BTAG soil screening value	EPA (1996a)
Benzo(k)fluoranthene	100	Region III BTAG soil screening value	EPA (1996a)
Beryllium	10,000	Phytotoxicity value	Will and Suter (1995a)
Cadmium	2,500	Region III BTAG soil screening value	EPA (1996a)
Carbon disulfide	100	Region III BTAG soil screening value	EPA (1996a)
Chlorobenzene	100	Region III BTAG soil screening value	EPA (1996a)
Chloroform	300	Region III BTAG soil screening value	EPA (1996a)
Chromium	33,000	USGS ^a value	Shacklette and Boerngen (1984)
Chrysene	100	Region III BTAG soil screening value	EPA (1996a)
Cobalt	100,000	Phytotoxicity value	EPA (1996a)
Copper	15,000	Phytotoxicity value	EPA (1996a)
Cyanide	5	Region III BTAG soil screening value	EPA (1996a)
di-n-Butylphthalate	200,000	Phytotoxicity value	Will and Suter (1995a)
Fluoranthene	100	Region III BTAG soil screening value	EPA (1996a)
Fluorine	100	Region III BTAG soil screening value	EPA (1996a)
Hexachlorobenzene	1,000,000	Toxic to soil processes	Will and Suter (1995b)
Indeno(1,2,3-cd)pyrene	100	Region III BTAG soil screening value	EPA (1996a)
Iron	12,000	Region III BTAG soil screening value	EPA (1996a)

TABLE B.3 (Cont.)

Contaminant	Contaminant Concentration (µg/kg)	Benchmark Criterion	Source
Lead	10,000	Region III BTAG soil screening value	EPA (1996a)
m&p-Xylene	100	Region III BTAG soil screening value	EPA (1996a)
Manganese	330,000	Region III BTAG soil screening value	EPA (1996a)
Mercury	58	Region III BTAG soil screening value	EPA (1996a)
Methylene chloride	300	Region III BTAG soil screening value	EPA (1996a)
Nickel	2,000	Phytotoxicity value	EPA (1996a)
Phenol	100	Region III BTAG soil screening value	EPA (1996a)
Pyrene	100	Region III BTAG soil screening value	EPA (1996a)
Selenium	1,800	Region III BTAG soil screening value	EPA (1996a)
Silver	2,000	Phytotoxicity value	Will and Suter (1995a)
Tetrachloroethene	300	Region III BTAG soil screening value	EPA (1996a)
Thallium	1	Phytotoxicity value	EPA (1996a)
Toluene	100	Region III BTAG soil screening value	EPA (1996a)
Trichloroethene	300	Region III BTAG soil screening value	EPA (1996a)
Vanadium	58,000	Region III BTAG soil screening value	EPA (1996a)
Zinc	10,000	Phytotoxicity value	EPA (1996a)

^a USGS = U.S. Geological Survey.

TABLE B.4 Benchmark Values^a for No-Observed-Adverse-Effects-Level Applied Daily Doses (mg/kg-d) Used to Estimate Risk for Wildlife Receptors

Contaminant	Mallard	Great Blue Heron	American Robin	Tree Swallow	American Kestrel	Red- Tailed Hawk	Muskrat ^b	White- Footed Mouse	Eastern Cottontail	White- Tailed Deer	Red Fox
1,1-Dichloroethene	- ^c	-	-	-	-	-	20.8	59.9	22	8.4	3.1
Acetone	-	-	-	-	-	-	6.9	20	7.3	2.8	5.3
Aluminum	109.7 ^d	109.7 ^d	109.7 ^d	109.7 ^d	109.7 ^d	109.7 ^d	0.7 ^e	2.1 ^e	0.8 ^e	0.3 ^e	0.6 ^e
Antimony	-	-	-	-	-	-	0.047 ^f	0.135 ^f	0.050 ^f	0.019 ^f	0.036 ^f
Aroclor 1248	0.18 ^g	0.18 ^g	0.18 ^g	0.18 ^g	0.18 ^g	0.18 ^g	0.06	0.18	0.07	0.01	0.01
Arsenic	5.1 ^h	5.1 ^h	5.1 ^h	5.1 ^h	5.1 ^h	5.1 ^h	0.05 ⁱ	0.14 ⁱ	0.05 ⁱ	0.02 ⁱ	0.04 ⁱ
Barium	20.8 ^j	20.8 ^j	20.8 ^j	20.8 ^j	20.8 ^j	20.8 ^j	3.8 ^k	13.6 ^k	4.0 ^k	1.5 ^k	2.8 ^k
Benzo(a)pyrene	-	-	-	-	-	-	0.38	1.08	0.4	0.15	0.29
bis(2-Ethylhexyl)phthalate	1.1	1.1	1.1	1.1	1.1	1.1	6.9	19.8	7.3	2.8	5.2
Cadmium	1.45 ^l	1.45 ^l	1.45 ^l	1.45 ^l	1.45 ^l	1.45 ^l	0.67 ^l	1.93 ^l	0.71 ^l	0.27 ^l	0.51 ^l
Chloroform	-	-	-	-	-	-	10.4	30	11	4.2	7.9
Chromium	1.00 ^m	1.00 ^m	1.00 ^m	1.00 ^m	1.00 ^m	1.00 ^m	2.27 ⁿ	6.55 ⁿ	2.41 ⁿ	0.92 ⁿ	1.73 ⁿ
Copper	47.0 ^o	47.0 ^o	47.0 ^o	47.0 ^o	47.0 ^o	47.0 ^o	10.6 ^p	30.4 ^p	11.2 ^p	4.3 ^p	8.0 ^p
Cyanide	-	-	-	-	-	-	44.7 ^q	128.9 ^q	47.4 ^q	18.1 ^q	34.1 ^q
Diethyl phthalate	-	-	-	-	-	-	1,719	4,953	1,822	696	1,310
Lead	3.85 ^r	3.85 ^r	3.85 ^r	3.85 ^r	3.85 ^r	3.85 ^r	5.55 ^s	15.98 ^s	5.88 ^s	2.24 ^s	4.22 ^s
Manganese	997 ^t	997 ^t	997 ^t	997 ^t	997 ^t	997 ^t	61 ^t	176 ^t	65 ^t	25 ^t	46 ^t
Mercury	0.006 ^u	0.006 ^u	0.006 ^u	0.006 ^u	0.006 ^u	0.006 ^u	0.023 ^v	0.064 ^v	0.024 ^v	0.009 ^v	0.010 ^v
Nickel	77.40 ^w	77.40 ^w	77.40 ^w	77.40 ^w	77.40 ^w	77.40 ^w	27.74 ^x	79.89 ^x	29.40 ^x	11.22 ^x	21.12 ^x
Selenium	0.500 ^y	0.500 ^y	0.500 ^y	0.500 ^y	0.500 ^y	0.500 ^y	0.139 ^z	0.399 ^z	0.147 ^z	0.056 ^z	0.106 ^z
Trichloroethene	-	-	-	-	-	-	0.262	0.756	0.278	0.106	0.2
Vinyl chloride	-	-	-	-	-	-	0.118	0.34	0.125	0.05	0.09
Zinc	14.5 [*]	14.5 [*]	14.5 [*]	14.5 [*]	14.5 [*]	14.5 [*]	111.0 [†]	319.5 [†]	117.6 [†]	44.9 [†]	84.5 [†]

See next page for footnotes.

Footnotes for TABLE B.4

- ^a Source: Sample et al. (1996).
- ^b Muskrat values were calculated by using the value for the eastern cottontail scaled by body weight as described in Section 7.1.1.
- ^c - = NOAEL value unavailable.
- ^d Aluminum as $\text{Al}_2(\text{SO}_4)_3$.
- ^e Aluminum as AlCl_3 .
- ^f Antimony as antimony potassium tartrate.
- ^g Value for Aroclor 1254.
- ^h Arsenic as sodium arsenite.
- ⁱ Arsenic as arsenite.
- ^j Barium as barium hydroxide.
- ^k Barium as barium chloride.
- ^l Cadmium as cadmium chloride.
- ^m Chromium in form of Cr^{+3} as $\text{CrK}(\text{SO}_4)_2$.
- ⁿ Chromium in form of Cr^{+6} .
- ^o Copper as copper oxide.
- ^p Copper as copper sulfate.
- ^q Cyanide as potassium cyanide.
- ^r Lead in metallic form.
- ^s Lead as lead acetate.
- ^t Manganese as Mn_3O_4 .
- ^u Mercury as methyl mercury dicyandiamide.
- ^v Mercury as methyl mercury chloride.
- ^w Nickel as nickel sulfate.
- ^x Nickel as nickel sulfate hexahydrate.
- ^y Selenium as sodium selenite.
- ^z Selenium as selenate (SeO_4).
- * Zinc as zinc sulfate.
- † Zinc as zinc oxide.

TABLE B.5 Soil Concentration Benchmark Values for Estimating Risks to Terrestrial Vegetation^a

Contaminant	Benchmark Concentration (mg/kg)	Contaminant	Benchmark Concentration (mg/kg)
Aluminum	— ^b	Lead	100 ^j
Antimony	5	Manganese	500 ^k
Aroclor 1248	10 ^c	Mercury	0.3 ^h
Arsenic	10 ^d	Nickel	20 ^l
Barium	1,000 ^e	Phenol	79 ^m
Cadmium	5 ^f	Selenium	2 ⁿ
Chromium	3.5 ^g	Silver	2 ^h
Cobalt	25 ^h	Thallium	1 ^h
Copper	100 ⁱ	Zinc	10 ^o
Fluorene	200 ^h		

^a Source: Will and Suter (1995a) and references contained therein unless otherwise indicated.

^b Above a pH of 4.5, aluminum is not expected to be phytotoxic (Kelly et al. 1990).

^c No observable effect concentration (NOEC) for PCBs on shoot weight of soybeans.

^d Reported NOEC for effects on grain yield of barley and ryegrass; arsenic as NaAsO₂ and NaHASO₄.

^e Reported NOEC for effects on plant weight of bush beans; barium as Ba(NO₃)₂.

^f NOEC for effects on shoot weight of soybeans; cadmium as CdCl₂.

^g NOEC for effects on shoot weight of oats; chromium as K₂Cr₂O₇.

^h Lowest observed effect concentration (LOEC) for phytotoxicity.

ⁱ NOEC for effects on leaf weight of bush beans; copper as CuSO₄.

^j NOEC for effects on root weight in oats; lead as PbCl₂.

^k LOEC for effects on stem weight of bush beans; manganese as MnSO₄.

^l NOEC for effects on plant weight of red oak; nickel as NiCl₂.

^m LOEC for effects on shoot weight of lettuce.

ⁿ NOEC for effects on shoot weight of alfalfa; selenium as Na₂SeO₄.

^o NOEC for effects on seed production by soybeans; zinc as ZnSO₄.

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APPENDIX C:
WETLAND DELINEATIONS

APPENDIX C:

WETLAND DELINEATIONS

Wetlands are scattered throughout the J-Field site and vicinity and include shallow ponds, tidal and nontidal marshes, scrub-shrub wetlands, and forested wetlands. Delineations of wetland boundaries near the areas of concern (AOCs) were performed to assist in avoidance of wetlands during remediation activities or provide information for regulatory agencies. Wetland delineations were conducted at the Toxic Burning Pits (TBP), White Phosphorus Burning Pits (WPP), Riot Control Burning Pit (RCP), South Beach Trench (SBT), South Beach Demolition Ground (SBDG), Robins Point Demolition Ground (RPDG), Robins Point Tower Site (RPTS), and Prototype Building (PB) AOCs. Sampling locations and field methods used to conduct the delineations are presented in Appendix A.

C.1 WETLAND DELINEATIONS AT THE TBP AOC

Four transects for wetland delineation were located near the TBP AOC (Figure A.1 in Appendix A). The wetland boundary was determined along each transect and then extrapolated between transects on the basis of vegetation, elevation, or other natural features. Transects were established throughout the vicinity of the TBP AOC: (1) the marsh boundary in the forested area to the north of the pits; (2) the marsh/old-field boundary north of the pits; (3) the marsh/old-field boundary south of the pits; and (4) the marsh boundary in the forested area south of the pits. The purpose of these transects was to establish data collection points for obtaining soil characterization, dominant plant species, and hydrologic data. The transects extended from areas of suspected wetland (based on readily observable vegetation and hydrologic characteristics) to areas of suspected upland. Along each transect, the wetland boundary was determined between two adjacent data points, one having wetland characteristics and one having upland characteristics (i.e., not meeting the wetland criteria). Because of the extensive soil disturbance in the Pushout Area, transects were established adjacent to the Pushout Area rather than within it.

The transect immediately southwest of the pits was not used in the analysis. Because of the presence of large amounts of metal debris in the soil along this transect, indicating the potential presence of unexploded ordnance, a soil sample of adequate depth was not possible. Table C.1 presents the data used in determining the wetland boundaries.

Figure C.1 shows the wetland boundaries near the TBP AOC. Within the forested areas to the north and south of the pits, the transition from marsh to forest is abrupt. The marsh is dominated by common reed (*Phragmites australis*) and has a clear and distinct edge. The forest/wetland boundary in these areas is approximately 25 ft slightly upgradient from the marsh edge. The

TABLE C.1 Wetland Delineation Data Points Used for Boundary Determination at the Toxic Burning Pits Area

Data Point ^a	Delineation Parameters ^b		
	Vegetation Parameter	Soil Parameter	Hydrology Parameter
Transect A4			
Wetland	60% of dominant species hydrophytic	Hydric soil based on 10YR3/1.5 matrix with mottles	Saturation at 2 in. below soil surface
Upland	33% of dominant species hydrophytic ^c	Nonhydric soil based on 10YR3/3 matrix ^c	Saturation at 2.5 in. below soil surface
Transect A6			
Wetland	100% of dominant species hydrophytic	Hydric soil based on 10YR4/1.5 matrix with mottles	Saturation at the soil surface
Upland	67% of dominant species hydrophytic	Nonhydric soil based on 10YR4/2.5 matrix ^c	Saturation at 4 in. below soil surface
Transect A9			
Wetland	83% of dominant species hydrophytic	Hydric soil based on 10YR4.5/2 matrix with mottles	Saturation at 4 in. below soil surface
Upland	75% of dominant species hydrophytic	Hydric soil based on 10YR3/2 matrix with mottles	Saturation at 15 in. below soil surface ^c

^a See Figure A.1 for transect locations.

^b Parameters required for wetland delineation according to the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

^c Wetland characteristics for the given parameter are not present.

old-field/marsh boundary is much less distinct. The marsh in this area is also dominated by common reed, which intergrades gradually into the upland community of the old field. Slightly downgradient of the marsh edge, near the Pushout Area, a clear elevation change occurs, with deeper surface water to the east. A line of trees (black gum [*Nyssa sylvatica*], sycamore [*Platanus occidentalis*], sweetgum [*Liquidambar styraciflua*]) and shrubs (wax myrtle [*Myrica cerifera*], groundsel bush [*Baccharis halimifolia*]), along with common reed, follows the upper edge of the slope. The wetland boundary is approximately 50 ft upgradient from this tree line (Figure C.1).

The marsh is vegetated with persistent emergent vegetation except for a large area of open water and several small scattered open areas near the center. The marsh is inundated throughout the first half of the growing season. Surface water levels drop during the second half of the growing

FIGURE C.1 Wetland Boundaries of the Toxic Burning Pits Area

season, leaving much of the substrate exposed for extended periods. Although the vegetated areas of the marsh are infrequently inundated by extremely high tides, the primary source of water is groundwater discharge with limited surface water flow. The open water areas are unvegetated and remain shallowly inundated throughout the growing season. Because of the tidal influence, the marsh is classified as an intertidal estuarine wetland, irregularly flooded by tides (less often than daily) (Smith 1992). The open water areas are classified as intertidal estuarine, organic unconsolidated bottom, subtidal (permanently flooded) wetlands (Smith 1992). The area of the marsh, as mapped by the National Wetland Inventory (NWI) is 48.6 acres (Smith 1992).

The forested areas along much of the perimeter of the marsh are vegetated by broad-leaved deciduous trees and are inundated only early in the growing season. These wetlands are predominantly influenced by surface water flow and groundwater discharge. However, because they are next to the marsh, a slight tidal influence is present early in the growing season. This wetland area is classified as palustrine forested, broad-leaved deciduous, seasonally flooded-tidal wetland (Smith 1992). Shrubs, rather than trees, are the dominant stratum along the marsh near the Pushout Area. This portion is classified as palustrine scrub/shrub, broad-leaved deciduous, seasonally flooded-tidal wetland (Smith 1992). The NWI maps the forested and scrub/shrub wetland zone as extending 100-200 ft beyond the marsh boundary; however, the present delineation indicates a 25- to 50-ft-wide zone. The forested zone east and south of the AOC, as mapped by the NWI, is 5.8 acres, and the scrub/shrub zone is 1.2 acres (Smith 1992).

C.2 WETLAND DELINEATIONS AT THE WPP AOC

In August 1993, vegetation communities in and around the WPP AOC were characterized by dominant species during a general walkover of the site (Van Lonkhuyzen 1995). In April 1994, two transects (A2 and A3 in Figure A.1 in Appendix A) were established near the WPP AOC: (1) at the marsh boundary within the forested area between the PB and the WPP AOCs and (2) at the marsh boundary within the forested area north of the WPP AOC. The same methods used in the TBP AOC (Section C.1) were used for these transects. In May 1994, the transects were sampled for soil and hydrologic characteristics.

Figure C.2 shows the wetland boundaries near the WPP AOC, and Table C.2 lists the data points used in determining the wetland boundaries. In the forested area south of the AOC, the transition from marsh to forest is abrupt. The marsh has a clear and distinct edge. It is dominated by common reed in the interior and common reed, groundsel bush, and false nettle (*Boehmeria cylindrica*) toward the margins. The dominant trees within the forested area are sweetgum and red maple. Wetland indicators show the wetland boundary to be approximately 40 ft upgradient from the marsh edge. The NWI classifies a larger portion (1.1 acres) of the forested area along the northern side of the marsh as a seasonally flooded, palustrine forested wetland with broad-leaved

FIGURE C.2 Wetland Boundaries of the White Phosphorus Burning Pits Area

TABLE C.2 Wetland Delineation Data Points Used for Boundary Determination at the White Phosphorus Burning Pits Area

Data Point ^a	Delineation Parameters ^b		
	Vegetation Parameter	Soil Parameter	Hydrology Parameter
<i>Transect A2</i>			
Wetland	100% of dominant species hydrophytic	Hydric soil based on 10YR4/2 matrix with mottles	Saturation at 5 in. below soil surface
Upland	100% of dominant species hydrophytic	Nonhydric soil based on 10YR4/4 matrix ^c	Saturation at 10 in. below soil surface
<i>Transect A3</i>			
Wetland	80% of dominant species hydrophytic	Hydric soil based on 10YR4/1.5 matrix with mottles	Saturation at 2 in. below soil surface
Upland	50% of dominant species hydrophytic ^c	Nonhydric soil based on 10YR3/2 matrix ^c	Saturation at 5 in. below soil surface

^a See Figure A.1 for transect locations.

^b Parameters required for jurisdictional wetland delineation according to the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

^c Wetland characteristics for the given parameter are not present.

deciduous trees that experiences irregular tidal influence (Smith 1992). The NWI classifies the marsh as an intertidal estuarine wetland with persistent emergent vegetation that is irregularly flooded by tides and has an oligohaline water chemistry (Smith 1992). The marsh, as mapped by the NWI, encompasses 1.3 acres.

The marsh north of the AOC is dominated by common reed, groundsel bush, and false nettle. The southern portion of the marsh is bordered by the open, mowed grasses that make up most of the vegetation of the AOC. The remainder of the marsh is bordered by forest dominated by willow oak (*Quercus phellos*), sweetgum, and high-bush blueberry (*Vaccinium corymbosum*), which form an abrupt edge. The boundary between this forested wetland area and the adjacent upland forest is approximately 25 ft upgradient from the marsh. The NWI classifies this marsh as a 0.5-acre intertidal estuarine wetland with persistent emergent vegetation that is irregularly flooded by tides (less than daily) (Smith 1992). In the Cowardin (1979) classification system, the forested area next to the marsh is classified as a seasonally flooded, palustrine forested wetland with broad-leaf deciduous trees. Surface water appears in this area early in the growing season but is gone by the end of May.

Another wetland occurs between the pits and the northern marsh. This wetland is approximately rectangular and 0.03 acre in size, and it appears to have been excavated to receive

excess surface water runoff from the pits. Surface water is present throughout the growing season. It supports an emergent vegetation community around the margin dominated by narrow-leaf cattail (*Typha angustifolia*) and a community in the interior dominated by duckweed (*Lemna* sp.) and cattail. In the Cowardin (1979) system, this wetland is classified as a semipermanently flooded, palustrine wetland with persistent emergent vegetation.

A narrow band of marsh dominated by common reed lines the Gunpowder River shoreline west and south of the pits.

C.3 WETLAND DELINEATIONS AT THE RCP AOC

In August 1993, vegetation communities in and around the RCP AOC were characterized by dominant species. In April 1994, two transects were established near the RCP AOC (A10 and A11 in Figure A.1 in Appendix A). They were located in areas where surface water had been observed early in the growing season, including a large depression approximately 50 ft west of South Beach Road (between the RCP and SBT AOCs) and the tidal marsh along the Gunpowder River/Chesapeake Bay shoreline. The wetland boundary was determined along each transect and then extrapolated for the remainder of each wetland on the basis of vegetation, elevation, or other natural features. The large amount of metal debris in the soil, as determined by magnetometer, precluded the placement of more transects in the RCP AOC. In May 1994, the transects near the RCP AOC were sampled for soil and hydrologic characteristics.

Figure C.3 shows the wetland boundaries near the RCP AOC; and Table C.3 shows the vegetation, soil, and hydrologic characteristics at the data points used in determining the wetland boundaries along the transects. The marsh on the western side of the RCP AOC is dominated by common reed but does not form a distinct edge with the forested area. The common reed intergrades a short distance with the vegetation associated with the forest. The wetland boundary along transect A11 is located at the point where common reed is no longer a dominant species. Shallow surface water occurs temporarily within this marsh in spring and is gone by the beginning of summer. Because of the erosion barrier constructed around the perimeter of the marsh near the AOC, the marsh is no longer inundated by Chesapeake Bay tides. The present delineation indicates that the marsh is a palustrine wetland with persistent emergent vegetation, seasonally flooded. The NWI identifies this area as a 3.1-acre intertidal estuarine wetland with persistent emergent vegetation, irregularly flooded by tides (Smith 1992). The forested area next to the marsh is identified as palustrine forested, broad-leaved deciduous, seasonally flooded-tidal (Smith 1992); however, the present delineation indicates that wetland hydrology is absent.

The large depression southeast of the RCP contains surface water early in the growing season, but it is dry by the beginning of summer. As the surface water recedes, the soil becomes

FIGURE C.3 Wetland Boundaries of the Riot Control Pit Area

TABLE C.3 Wetland Delineation Data Points Used for Boundary Determination at the Riot Control Pit Area

Data Point ^a	Delineation Parameters ^b		
	Vegetation Parameter	Soil Parameter	Hydrology Parameter
Transect A10			
Wetland	100% of dominant species hydrophytic	Hydric soil based on 10YR4/1.5 matrix with mottles	Saturation at the soil surface
Upland	75% of dominant species hydrophytic	Nonhydric soil based on 10YR3/2.5 matrix ^c	No soil saturation observed ^c
Transect A11			
Wetland	67% of dominant species hydrophytic	Hydric soil based on 10YR3.5/1.5 matrix with mottles	Saturation at the soil surface
Upland	75% of dominant species hydrophytic	Hydric soil based on 10YR3/2 matrix with mottles	No soil saturation observed ^c

^a See Figure A.1 for transect locations.

^b Parameters required for jurisdictional wetland delineation according to the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

^c Wetland characteristics for the given parameter are not present.

vegetated with herbaceous hydrophytic species. The overstory canopy of sweetgum in this forested wetland is relatively open; false nettle and Nepal grass (*Microstegium vimineum*) dominate the herbaceous layer. The wetland boundary along transect A10 is located at the point where false nettle is no longer a dominant species. This wetland is a 0.6-acre seasonally flooded, palustrine forested wetland, with broad-leaved deciduous trees according to the Cowardin (1979) system. The NWI agrees with this classification, but gives the size as 2.8 acres (Smith 1992).

C.4 WETLAND DELINEATIONS AT THE SBT AOC

The trench at the SBT AOC contains surface water during the first half of the growing season, but surface water is gone by mid to late summer. The trench does not, however, support vegetation at any time of the year. Therefore, it is not considered a jurisdictional wetland. Under the Cowardin (1979) system, the trench is a seasonally flooded palustrine wetland with an unconsolidated bottom. Other wetlands at J-Field with similar physical characteristics (hydrology, soil type, canopy cover) typically support communities of emergent vegetation, usually dominated by common reed or soft rush. The absence of such a community within the SBT indicates a potential impact due to contamination at the site.

Other wetlands near the SBT AOC are the palustrine forested, seasonally flooded wetland in the forested area between the SBT and the RCP AOCs and the palustrine emergent, seasonally flooded marsh bordering Chesapeake Bay and the Gunpowder River. These wetlands were delineated as part of the RCP AOC wetland delineation and are discussed in Section C.3.

C.5 WETLAND DELINEATIONS AT THE SBDG AOC

One small jurisdictional wetland occurs within the SBDG AOC, within a crater designated as CRTR-1 (Figure A.1 in Appendix A). This crater supports a community of emergent vegetation dominated by common reed, similar to the marsh to the northeast. The crater is inundated throughout the growing season. This wetland is a semipermanently flooded palustrine wetland with persistent emergent vegetation. The NWI classifies the Chesapeake Bay shoreline along the SBDG AOC as an intertidal estuarine unconsolidated shore (sand) with an oligohaline water chemistry. The shoreline is approximately 3 ft below the elevation of the adjacent land surface.

C.6 WETLAND DELINEATIONS AT THE RPDG AOC

In June 1995, two transects for wetland delineation were established near the RPDG AOC (B1 and B2 in Figure A.1 in Appendix A). In contrast to the sampling conducted at other AOCs, here data were collected from 0.5-m² (5.4-ft²) plots at 2-m (6.6-ft) intervals along each transect at the RPDG AOC. Hydric soil indicators were not examined because of the potential for unexploded ordnance in the subsurface soils. Therefore, emphasis was placed on the collection of vegetation and hydrology data. Data points used in determining the wetland boundaries are given in Table C.4. Data included plant species found within the plot, vegetation stratum (herbaceous, sapling/shrub, vine, tree) of each species, estimated percent areal cover of each species within the plot, diameter at breast height of each woody stem in the plot, and hydrological indicator (such as inundation, saturation, or evidence of previous flooding, to a depth of 18 cm [7 in.]) observed within each plot.

The transects extended from areas of suspected wetland (based on the presence of hydrologic indicators) to areas of suspected upland (based on lack of hydrologic indicators). Transect B1 was located approximately 200 ft north of the western end of the RPDG AOC, near crater 9. This transect extends 30 m (98 ft), beginning in a forested wetland dominated by willow oak and high-bush blueberry to the northwest of the RPDG and ending in an upland forest north of the RPDG.

Figure C.4 shows the wetland boundaries. Although there is no abrupt change in the vegetation community at the wetland boundaries, sassafras becomes a dominant species of the tree stratum in the transition from wetland to upland. This wetland is a palustrine forested, broad-leaved deciduous, seasonally flooded wetland, according to the Cowardin (1979) system. Surface water is

TABLE C.4 Wetland Delineation Data Points Used for Boundary Determination at the Robins Point Demolition Ground Area

Data Point ^a	Delineation Parameters ^b		
	Vegetation Parameter	Soil Parameter	Hydrology Parameter
<i>Transect B1</i>			
Wetland	100% of dominant species hydrophytic	Unknown	Saturation at 3.9 in. below soil surface
Upland	50% of dominant species hydrophytic ^c	Unknown	Saturation at 5.9 in. below soil surface
<i>Transect B2</i>			
Wetland	67% of dominant species hydrophytic	Unknown	Sediment deposits, previous flooding
Upland	50% of dominant species hydrophytic ^c	Unknown	Sediment deposits, previous flooding

^a See Figure A.1 for transect locations.

^b Parameters required for jurisdictional wetland according to the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

^c Wetland characteristics for the given parameter are not present.

present in the wetland early in the growing season but is gone by midsummer. The NWI identifies the water regime of this wetland as seasonally flooded/saturated, and its size as 6.2 acres (Smith 1992).

Several large craters are scattered to the east of the forested wetland. These craters are unvegetated except for occasional emergent plants near their rims. They are inundated for much of the growing season, have low pH (4.5-6), and contain large amounts of leaf litter and other organic debris. According to the Cowardin (1979) classification system, the craters are seasonally flooded palustrine wetlands with an unconsolidated organic bottom.

Transect B2 was located immediately east of the RPDG, extending 30 m from the large tidal marsh to the berm bordering the east side of the demolition ground (Figure A.1 in Appendix A). The tidal marsh is dominated by common reed, which decreases between the marsh and berm and is no longer present near the wetland boundary. The wetland boundary is near the point where broom sedge (*Andropogon virginicus*) becomes a dominant species, approximately 46 ft downgradient from the crest of the berm (Figure C.4). Although the marsh is irregularly flooded by tides, the wetland

FIGURE C.4 Wetland Boundaries of the Robins Point Demolition Ground Area

area near the berm is flooded only temporarily, early in the growing season. This wetland is a temporarily flooded palustrine wetland with persistent emergent vegetation (Cowardin 1979). The NWI identifies the marsh, including the perimeter near the RPDG AOC, as a 34.1-acre irregularly flooded, intertidal estuarine wetland with persistent emergent vegetation (Smith 1992). The margin of the marsh to the northeast of the berm is classified as having broad-leaved evergreen scrub/shrub vegetation and encompassing 2.7 acres. Two craters and several shallow depressions are located in the upland area between the berm and the marsh. These craters and depressions are inundated during the early part of the growing season and are vegetated with emergent vegetation. They are seasonally flooded palustrine wetlands with persistent emergent vegetation (Cowardin 1979).

The NWI identifies the active portion of the RPDG AOC immediately to the west of the berm as a 0.9-acre seasonally flooded/saturated, diked/impounded palustrine wetland with persistent emergent vegetation (Smith 1992). This area is inundated early in the growing season, but surface water is absent by summer. Because of the ongoing demolition activities at the RPDG, no areas within the active portion of the site were surveyed.

C.7 WETLAND DELINEATIONS AT THE RPTS AOC

Three transects were established near the RPTS AOC (B3, B4, and B5 in Figure A.1 in Appendix A), and data along these transects were collected by methods similar to those used for the RPDG AOC wetland transects. Vegetation was sampled in 0.5-m² (5.4-ft²) plots at 3-m (9.8-ft) intervals along the transects. The data points used in determining the wetland boundaries along the transects are presented in Table C.5, and the wetland boundaries are shown in Figure C.5.

Transect B3 was located at the marsh boundary in the forested area southwest of the tower. The transect extended 30 m (98 ft) from within the marsh into the forested area. The transition from marsh to forest is abrupt. The marsh is dominated by common reed, individuals of which extend a short distance into the forested area. Black locust (*Robinia pseudoacacia*) trees line the edge of the marsh and continue a short distance into the forest. The wetland boundary is near the marsh edge, where black locust and common reed are dominant species. Because of the tidal influence, the marsh is classified as a 48.6-acre intertidal estuarine wetland that is irregularly flooded by tides (less often than daily) (Smith 1992). The NWI classifies much of the forested area near the marsh as a 1.0-acre palustrine forested wetland with broad-leaved deciduous trees, which is seasonally flooded by tides (Smith 1992).

Transect B4 was located south of RPTS. This transect was 21 m (69 ft) long, originating in a large depressional wetland area and extending into an upland forest. The wetland area is vegetated with emergent vegetation, such as common reed, cinnamon fern (*Osmunda cinnamomea*), and soft rush (*Juncus effusus*). It is ringed by a narrow band of hydrophytic shrubs (groundsel bush and wax myrtle). This wetland is inundated for extensive periods early in the growing season; the deeper portions are inundated throughout the first half of the growing season. This wetland is classified as seasonally flooded palustrine wetland with persistent emergent vegetation, according to the Cowardin (1979) system.

Transect B5 was located approximately 66 ft south of Robins Point Road. This transect was 27 m (89 ft) long, originating in the marsh northwest of the RPTS and extending into the forested area to the west, which is dominated by mature sweetgum trees and Nepal grass. The dominant species in the marsh is common reed, which intergrades into a community dominated by cinnamon fern and sweetgum. The marsh is inundated throughout the first half of the growing season. The wetland community next to the marsh is inundated early in the growing season and saturated close

TABLE C.5 Wetland Delineation Data Points Used for Boundary Determination at the Robins Point Tower Site

Data Point ^a	Delineation Parameters ^b		
	Vegetation Parameter	Soil Parameter	Hydrology Parameter
<i>Transect B3</i>			
Wetland	100% of dominant species hydrophytic	Unknown	Saturation at 3.2 in. below the soil surface
Upland	50% of dominant species hydrophytic ^c	Unknown	No indicator present ^c
<i>Transect B4</i>			
Wetland	100% of dominant species hydrophytic	Unknown	Saturation at the soil surface
Upland	100% of dominant species hydrophytic	Unknown	No indicator present ^c
<i>Transect B5</i>			
Wetland	100% of dominant species hydrophytic	Unknown	Saturation at the soil surface
Upland	100% of dominant species hydrophytic	Unknown	No indicator present ^c

^a See Figure A.1 for transect locations.

^b Parameters required for jurisdictional wetland delineation according to the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

^c Wetland characteristics for the given parameter are not present.

to the surface for extended periods during the first half of the growing season. This marsh is a seasonally flooded palustrine wetland with persistent emergent vegetation. The adjacent wetland community is classified as a seasonally saturated forested palustrine wetland with broad-leaved deciduous trees. The total combined wetland area is approximately 0.9 acre. The NWI identifies the marsh as a 0.5-acre intertidal estuarine wetland with persistent emergent vegetation that is irregularly flooded by tides and has an oligohaline water chemistry (Smith 1992). The adjacent wetland area is classified as a 0.3-acre seasonally flooded palustrine forested wetland with broad-leaved deciduous trees (Smith 1992). The shoreline area near the tower is classified as a 0.7-acre intertidal estuarine wetland with an unconsolidated shore that is irregularly flooded by tides and possesses an oligohaline water chemistry (Smith 1992).

FIGURE C.5 Wetland Boundaries of the Robins Point Tower Site

C.8 WETLAND DELINEATIONS AT THE PB AOC

Walkover surveys conducted in April 1994 indicated no wetlands in the immediate vicinity of the PB. However, a marsh, dominated by common reed and surrounded by deciduous forest, is located approximately 600 ft north of the PB (Figure C.6). A single transect was established at the marsh boundary within the forested area (A1 in Figure A.1 in Appendix A), and data were collected by the procedures used for the TBP AOC wetland evaluation. The transition from marsh to forest is abrupt; the marsh is completely dominated by common reed and has a clear and distinct edge. The dominant trees within the forested area are sweetgum and persimmon in the lower areas and black locust at the upper elevations. Soil horizon data from the transect, as well as the results of magnetometer testing (Yuen et al. 1999), indicate a high degree of soil disturbance and do not identify a clearly defined wetland boundary. Wetland indicators, however, show the wetland boundary to be close to the marsh, slightly upgradient from the marsh edge. The NWI classifies the marsh as a 1.3-acre intertidal estuarine wetland with persistent emergent vegetation that is irregularly flooded by tides and has an oligohaline water chemistry (Smith 1992). A large portion (0.6 acre) of the forested area along the southern side of the marsh is classified as a semipermanently flooded palustrine forested wetland with broad-leaved deciduous trees that experiences irregular tidal influence (Smith 1992).

The NWI identifies a second wetland area within a forested area approximately 200 ft southwest of the PB. This wetland area is within a depression approximately 4 ft below the elevation of the surrounding area at its lowest point. Surface water occurs within the depression early in the growing season but is absent by the end of spring. A small community of emergent vegetation, dominated by common reed, exists at the northeastern side of the wetland. This wetland is classified as a 0.4-acre seasonally flooded palustrine forested wetland with broad-leaved deciduous trees (Smith 1992).

FIGURE C.6 Wetland Boundaries of the Prototype Building Area

C.9 REFERENCES FOR APPENDIX C

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APPENDIX D:
TERRESTRIAL VEGETATION SURVEY DATA

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TERRESTRIAL VEGETATION SURVEY DATA

Field investigations conducted in support of the J-Field ERA included terrestrial vegetation surveys. Surveys were conducted at each of the areas of concern (AOCs) except the South Beach Demolition Ground AOC (because of the lack of vegetation). Field methods used to conduct the surveys are described in Appendix A. Data collected during the terrestrial vegetation surveys are presented in this appendix.

TABLE D.1 Vegetation Sampling Results at the Toxic Burning Pits Area, July and November 1993

Sampling Location ^a /Species	Percent Cover ^b	Biomass (g/0.1 m ²)
Grid TBTD		
Plot 2		
<i>Aristida oligantha</i>	30	2.69
<i>Andropogon virginicus</i>	5	1.23
	<i>H</i> = 0.59	3.92 Total
Plot 6		
<i>Andropogon virginicus</i>	25	10.51
<i>Phragmites australis</i>	15	1.14
<i>Aristida oligantha</i>	10	0.63
	<i>H</i> = 1.49	12.28 Total
Plot 14		
<i>Andropogon virginicus</i>	10	2.62
<i>Aristida oligantha</i>	30	1.19
<i>Phragmites australis</i>	5	0.83
	<i>H</i> = 1.22	4.64 Total
Plot 18		
<i>Aristida oligantha</i>	30	1.54
<i>Digitaria ischaemum</i>	5	0.82
<i>Phragmites australis</i>	5	0.82
	<i>H</i> = 1.06	3.18 Total
Plot 21		
<i>Aristida oligantha</i>	60	1.71
<i>Andropogon virginicus</i>	20	1.43
Unidentified herb	2.5	0.09
	<i>H</i> = 0.98	3.23 Total
Grid TBTC		
Plot 1		
<i>Agrostis stolonifera</i>	10	- ^c
Unidentified grass 1	70	-
<i>Dianthus armeria</i>	2.5	-
	<i>H</i> = 0.72	

TABLE D.1 (Cont.)

Sampling Location ^a /Species	Percent Cover ^b	Biomass (g/0.1 m ²)
<i>Grid TBTC (Cont.)</i>		
Plot 14		
<i>Agrostis stolonifera</i>	10	-
<i>Plantago major</i>	2.5	-
Unidentified grass 1	80	-
Unidentified grass 4	2.5	-
	$H = 0.83$	
Plot 38		
<i>Agrostis stolonifera</i>	30	-
<i>Plantago major</i>	2.5	-
Unidentified grass 1	60	-
Unidentified grass 4	2.5	-
	$H = 1.22$	
Plot 76		
<i>Agrostis stolonifera</i>	70	-
<i>Liquidambar styraciflua</i> (seedling)	2.5	-
Unidentified grass 1	60	-
Unidentified grass 4	5	-
	$H = 1.30$	
Plot 93		
<i>Agrostis stolonifera</i>	60	-
<i>Plantago major</i>	2.5	-
<i>Vitis</i> (seedling)	2.5	-
<i>Rosa</i> sp.	2.5	-
Unidentified grass 1	5	-
	$H = 0.99$	
Plot 3		
<i>Andropogon virginicus</i>	35	10.64
<i>Aristida oligantha</i>	30	3.32
<i>Arthraxon hispidus</i>	10	1.8
<i>Plantago</i> sp.	5	1.41
	$H = 1.68$	17.17 Total

TABLE D.1 (Cont.)

Sampling Location ^a /Species	Percent Cover ^b	Biomass (g/0.1 m ²)
<i>Grid TBTC (Cont.)</i>		
Plot 12		
<i>Andropogon virginicus</i>	40	5.58
<i>Plantago</i> sp.	5	1.93
<i>Verbascum</i> sp.	2.5	0.21
	<i>H</i> = 0.77	7.72 Total
Plot 21		
<i>Andropogon virginicus</i>	85	15.26
<i>Aristida oligantha</i>	2.5	1.12
<i>Plantago</i> sp.	2.5	0.13
	<i>H</i> = 0.37	16.51 Total
Plot 32		
<i>Andropogon virginicus</i>	50	14.25
<i>Plantago</i> sp.	5	1.78
<i>Aristida oligantha</i>	10	0.34
	<i>H</i> = 0.99	16.37 Total
Plot 48		
<i>Andropogon virginicus</i>	45	15.33
<i>Aristida oligantha</i>	50	1.86
<i>Plantago</i> sp.	2.5	1.77
<i>Digitaria ischaemum</i>	2.5	0.3
<i>Arthraxon hispidus</i>	2.5	0.11
	<i>H</i> = 1.42	19.37 Total
Plot 62		
<i>Andropogon virginicus</i>	60	6.61
<i>Aristida oligantha</i>	25	1.14
<i>Tridens flavus</i>	2.5	0.84
<i>Plantago</i> sp.	2.5	0.76
<i>Digitaria ischaemum</i>	2.5	0.19
<i>Allium</i> sp.	2.5	0.1
	<i>H</i> = 1.48	9.64 Total

TABLE D.1 (Cont.)

Sampling Location ^a /Species	Percent Cover ^b	Biomass (g/0.1 m ²)
<i>Grid TBTC (Cont.)</i>		
Plot 64		
<i>Andropogon virginicus</i>	40	7.31
<i>Digitaria ischaemum</i>	15	1.96
<i>Aristida oligantha</i>	20	1.49
<i>Phragmites australis</i>	2.5	1.34
<i>Plantago</i> sp.	10	1.34
<i>Arthraxon hispidus</i>	2.5	0.5
	<i>H</i> = 2.07	13.94 Total
Plot 71		
<i>Andropogon virginicus</i>	80	15.46
<i>Phragmites australis</i>	2.5	1.97
<i>Aristida oligantha</i>	2.5	0.7
<i>Plantago</i> sp.	2.5	0.58
	<i>H</i> = 0.56	18.71 Total
Plot 78		
<i>Andropogon virginicus</i>	70	10.84
<i>Phragmites australis</i>	5	4.41
<i>Plantago</i> sp.	5	1.67
<i>Aristida oligantha</i>	20	0.64
<i>Dianthus armeria</i>	2.5	0.38
<i>Digitaria ischaemum</i>	2.5	0.24
<i>Arthraxon hispidus</i>	2.5	0.23
	<i>H</i> = 1.64	18.41 Total
Plot 81		
<i>Andropogon virginicus</i>	40	7.54
<i>Aristida oligantha</i>	30	2.07
<i>Phragmites australis</i>	10	1.66
	<i>H</i> = 1.41	11.27 Total

TABLE D.1 (Cont.)

Sampling Location ^a /Species	Percent Cover ^b	Biomass (g/0.1 m ²)
Grid TBTB		
Plot 5		
<i>Phragmites australis</i>	5	4.84
<i>Arthraxon hispidus</i>	40	3.88
<i>Plantago</i> sp.	10	1.44
<i>Baccharis halimifolia</i>	2.5	0.51
<i>Melilotus</i> sp.	2.5	0.27
	<i>H</i> = 1.50	10.94 Total
Plot 7		
<i>Arthraxon hispidus</i>	40	9.99
<i>Phragmites australis</i>	5	4.57
<i>Baccharis halimifolia</i>	2.5	2.13
<i>Plantago</i> sp.	20	1.37
	<i>H</i> = 1.42	18.06 Total
Plot 12		
<i>Agrostis perennans</i>	15	9.47
<i>Phragmites australis</i>	50	8.91
<i>Arthraxon hispidus</i>	30	5.45
<i>Plantago</i> sp.	2.5	0.52
<i>Juniperus</i> sp. (seedling)	2.5	0.05
<i>Liquidambar styraciflua</i>	2.5	0.05
	<i>H</i> = 1.82	24.45 Total
Plot 22		
<i>Phragmites australis</i>	5	13.61
<i>Agrostis perennans</i>	30	5.04
<i>Arthraxon hispidus</i>	30	4.03
<i>Andropogon virginicus</i>	2.5	1.56
<i>Aristida oligantha</i>	10	0.73
<i>Plantago</i> sp.	2.5	0.59
<i>Myrica cerifera</i>	2.5	0.35
	<i>H</i> = 2.13	25.91 Total

TABLE D.1 (Cont.)

Sampling Location ^a /Species	Percent Cover ^b	Biomass (g/0.1 m ²)
Grid TBTB (Cont.)		
Plot 19		
<i>Arthraxon hispidus</i>	70	10.83
<i>Plantago</i> sp.	2.5	0.08
<i>Melilotus</i> sp.	2.5	0.18
<i>Agrostis perennans</i>	20	5.31
<i>Andropogon virginicus</i>	5	4.96
	<i>H</i> = 1.31	21.36 Total
Grid TBTE		
Herbaceous Plot A		
<i>Parthenocissus quinquefolia</i>	30	-
<i>Agrostis rotundifolia</i>	2.5	-
<i>Smilax</i> (seedling)	2.5	-
Unidentified fern	30	-
Unidentified woody sp.	2.5	-
	<i>H</i> = 1.57	
Herbaceous Plot B		
<i>Agrostis rotundifolia</i>	90	-
<i>Smilax rotundifolia</i>	2.5	-
Unidentified woody sp.	2.5	-
	<i>H</i> = 0.35	
Herbaceous Plot C		
<i>Agrostis rotundifolia</i>	2.5	-
<i>Smilax rotundifolia</i>	2.5	-
Unidentified woody sp.	2.5	-
Unidentified grass 2	5	-
Unidentified grass 3	2.5	-
Unidentified grass 4	2.5	-
<i>Viola</i> sp.	2.5	-
	<i>H</i> = 2.75	

TABLE D.1 (Cont.)

Sampling Location ^a /Species	Percent Cover ^b	Biomass (g/0.1 m ²)
Grid TBTE (Cont.)		
Herbaceous Plot D		
<i>Agrostis rotundifolia</i>	10	-
<i>Boehmeria cylindrica</i>	5	-
Unidentified woody sp.	2.5	-
<i>Elymus</i> sp.	2.5	-
Unidentified grass 2	2.5	-
Unidentified fern	5	-
	$H = 2.37$	
Grid TBTG		
Herbaceous Plot A		
<i>Liquidambar styraciflua</i> (seedling)	10	-
<i>Eupatorium altissimum</i>	2.5	-
<i>Poa</i> sp. 1	30	-
<i>Vitis</i> (seedling)	2.5	-
<i>Solidago graminifolia</i>	2.5	-
Unidentified grass 1	2.5	-
Unidentified grass 2	2.5	-
<i>Panicum</i> sp.	2.5	-
<i>Agrostis</i> sp.	50	-
Unidentified woody sp.	5	-
	$H = 2.29$	
Herbaceous Plot B		
<i>Liquidambar styraciflua</i> (seedling)	5	-
<i>Eupatorium altissimum</i>	2.5	-
<i>Poa</i> sp. 1	20	-
<i>Pycnanthemum</i> sp.	2.5	-
Unidentified grass 1	60	-
Unidentified grass 2	2.5	-
<i>Panicum</i> sp.	10	-
<i>Elymus</i> sp.	2.5	-
<i>Parthenocissus quinquefolia</i>	2.5	-
Unidentified woody sp.	2.5	-
	$H = 2.19$	

TABLE D.1 (Cont.)

Sampling Location ^a /Species	Percent Cover ^b	Biomass (g/0.1 m ²)
Grid TBTG (Cont.)		
Herbaceous Plot C		
<i>Agrostis</i> sp.	50	-
<i>Eupatorium altissimum</i>	5	-
<i>Poa</i> sp. 1	15	-
<i>Acer rubrum</i> (seedling)	2.5	-
<i>Vitis</i> sp.	2.5	-
<i>Carex</i> sp.	5	-
<i>Parthenocissus quinquefolia</i>	2.5	-
	$H = 1.83$	
Herbaceous Plot D		
<i>Agrostis</i> sp.	40	-
<i>Eupatorium altissimum</i>	60	-
<i>Panicum</i> sp.	2.5	-
<i>Liquidambar styraciflua</i>	2.5	-
<i>Poa</i> sp. 1	10	-
<i>Bromus</i> sp.	2.5	-
<i>Agrimonia</i> sp.	5	-
<i>Carex</i> sp.	5	-
	$H = 2.02$	
Grid TBTF		
Plot 1		
<i>Phragmites australis</i>	2.5	0.08
	$H = 0$	
Plot 2		
<i>Phragmites australis</i>	80	10.65
	$H = 0$	
Plot 3		
<i>Atriplex patula</i>	5	4.37
	$H = 0$	
Plot 4		
<i>Phragmites australis</i>	10	1.73
	$H = 0$	

TABLE D.1 (Cont.)

Sampling Location ^a /Species	Percent Cover ^b	Biomass (g/0.1 m ²)
<i>Grid TBTF (Cont.)</i>		
Plot 5		
<i>Atriplex patula</i>	15	6.4
<i>Phragmites australis</i>	5	0.86
	$H = 0.81$	7.26 Total
Plot 6		
<i>Phragmites australis</i>	30	1.66
	$H = 0$	
Plot 7		
<i>Atriplex patula</i>	5	1.23
	$H = 0$	
Plot 8		
<i>Phragmites australis</i>	2.5	0.12
	$H = 0$	
Plot 9		
<i>Phragmites australis</i>	2.5	0.3
	$H = 0$	
Plot 10		
<i>Phragmites australis</i>	20	0.78
	$H = 0$	

^a See Figure A.2 in Appendix A for sampling grid locations.

^b H = Shannon-Weiner diversity index. $H = -\sum_{i=1}^s (p_i)(\log_n p_i)$, where s = number of species and p_i = proportional abundance of the i th species.

^c - = biomass not collected.

TABLE D.2 Biomass Collected at 40 Plots in the Toxic Burning Pits Area, November 1994

Sampling Location ^a /Species	Biomass (g/0.1 m ²)	Relative Biomass ^b
Grid TBTC		
Plot 1		
<i>Andropogon virginicus</i>	9.00	41.90
<i>Aristida oligantha</i>	10.63	49.49
<i>Digitaria ischaemum</i>	0.47	2.19
<i>Plantago</i> sp.	0.15	0.70
Unidentified species 3	0.09	0.42
Unidentified species 4	1.14	5.31
	21.48 Total	$H = 1.46^c$
Plot 5		
<i>Andropogon virginicus</i>	3.33	31.27
<i>Aristida oligantha</i>	5.32	49.95
<i>Digitaria ischaemum</i>	0.03	0.28
<i>Plantago</i> sp.	0.41	3.85
Unidentified species 4	1.56	14.65
	10.65 Total	$H = 1.64$
Plot 14		
<i>Andropogon virginicus</i>	3.02	18.57
<i>Aristida oligantha</i>	8.1	49.82
<i>Arthraxon hispidus</i>	0.16	0.98
<i>Digitaria ischaemum</i>	1.89	11.62
Unidentified species 3	0.4	2.46
Unidentified species 4	2.69	16.54
	16.26 Total	$H = 1.94$
Plot 15		
<i>Andropogon virginicus</i>	5.52	29.39
<i>Aristida oligantha</i>	5.35	28.49
<i>Arthraxon hispidus</i>	0.11	0.59
<i>Dianthus armeria</i>	0.05	0.27
<i>Digitaria ischaemum</i>	0.15	0.80
<i>Plantago</i> sp.	0.25	1.33
Unidentified species 4	7.30	38.87
<i>Gnaphalium obtusifolium</i>	0.05	0.27
	18.78 Total	$H = 1.79$

TABLE D.2 (Cont.)

Sampling Location ^a /Species	Biomass (g/0.1 m ²)	Relative Biomass ^b
<i>Grid TBTC (Cont.)</i>		
Plot 16		
<i>Andropogon virginicus</i>	5.4	32.79
<i>Aristida oligantha</i>	8.26	50.15
<i>Digitaria ischaemum</i>	0.07	0.43
<i>Plantago</i> sp.	0.83	5.04
<i>Verbascum thapsus</i>	0.01	0.06
Unidentified species 4	1.9	11.54
	16.47 Total	<i>H</i> = 1.64
Plot 18		
<i>Andropogon virginicus</i>	6.47	59.36
<i>Aristida oligantha</i>	3.38	31.01
<i>Plantago</i> sp.	0.34	3.12
Unidentified species 4	0.71	6.51
	10.9 Total	<i>H</i> = 1.38
Plot 24		
<i>Andropogon virginicus</i>	5.07	30.88
<i>Aristida oligantha</i>	10.34	62.97
<i>Digitaria ischaemum</i>	0.74	4.51
Unidentified species 12	0.27	1.64
	16.42 Total	<i>H</i> = 1.24
Plot 33		
<i>Andropogon virginicus</i>	5.52	44.73
<i>Aristida oligantha</i>	1.14	9.24
<i>Digitaria ischaemum</i>	1.06	8.59
<i>Oxalis</i> sp.	0.01	0.08
<i>Plantago</i> sp.	0.81	6.56
Unidentified species 4	3.8	30.79
	12.34 Total	<i>H</i> = 1.93

TABLE D.2 (Cont.)

Sampling Location ^a /Species	Biomass (g/0.1 m ²)	Relative Biomass ^b
<i>Grid TBTC (Cont.)</i>		
Plot 43		
<i>Andropogon virginicus</i>	1.8	18.52
<i>Aristida oligantha</i>	4.06	41.77
<i>Digitaria ischaemum</i>	1.84	18.93
<i>Plantago</i> sp.	0.37	3.81
<i>Tridens flavus</i>	0.1	1.03
Unidentified species 4	1.55	15.95
	9.72 Total	H = 2.10
Plot 45		
<i>Andropogon virginicus</i>	4.19	24.04
<i>Aristida oligantha</i>	5.09	29.20
<i>Digitaria ischaemum</i>	0.01	0.06
<i>Plantago</i> sp.	1.27	7.29
Unidentified species 4	6.87	39.41
	17.43 Total	H = 1.82
Plot 53		
<i>Andropogon virginicus</i>	2.38	16.06
<i>Aristida oligantha</i>	7.38	49.80
<i>Arthraxon hispidus</i>	0.05	0.34
<i>Digitaria ischaemum</i>	1.81	12.21
<i>Oxalis</i> sp.	0.01	0.07
<i>Plantago</i> sp.	2.03	13.70
Unidentified species 4	1.01	6.82
Unidentified species 7	0.15	1.01
	14.82 Total	H = 2.05

TABLE D.2 (Cont.)

Sampling Location ^a /Species	Biomass (g/0.1 m ²)	Relative Biomass ^b
<i>Grid TBTC (Cont.)</i>		
Plot 55		
<i>Andropogon virginicus</i>	0.65	3.10
<i>Aristida oligantha</i>	5.99	28.59
<i>Digitaria ischaemum</i>	6.42	30.64
<i>Digitaria sanguinalis</i>	0.43	2.05
<i>Juncus secundus</i>	0.56	2.67
<i>Panicum</i> sp.	2.67	12.74
<i>Plantago</i> sp.	0.28	1.34
<i>Polygonum persicaria</i>	0.48	2.29
Unidentified species 4	2.74	13.08
<i>Gnaphalium obtusifolium</i>	0.73	3.48
	20.95 Total	<i>H</i> = 2.59
Plot 59		
<i>Andropogon virginicus</i>	7.84	47.80
<i>Aristida oligantha</i>	5.54	33.78
<i>Dianthus armeria</i>	0.25	1.52
<i>Digitaria ischaemum</i>	0.11	0.67
<i>Plantago</i> sp.	1.52	9.27
<i>Verbascum thapsus</i>	0.04	0.24
Unidentified species 4	0.63	3.84
<i>Gnaphalium obtusifolium</i>	0.47	2.87
	16.4 Total	<i>H</i> = 1.85
Plot 72		
<i>Andropogon virginicus</i>	3.88	30.03
<i>Aristida oligantha</i>	6.12	47.37
<i>Digitaria ischaemum</i>	2.18	16.87
<i>Digitaria sanguinalis</i>	0.39	3.02
<i>Plantago</i> sp.	0.01	0.08
Unidentified species 4	0.01	0.08
Unidentified species 11	0.33	2.55
	12.92 Total	<i>H</i> = 1.77

TABLE D.2 (Cont.)

Sampling Location ^a /Species	Biomass (g/0.1 m ²)	Relative Biomass ^b
<i>Grid TBTC (Cont.)</i>		
Plot 76		
<i>Andropogon virginicus</i>	12.65	73.04
<i>Aristida oligantha</i>	3.18	18.36
<i>Arthraxon hispidus</i>	0.08	0.46
<i>Plantago</i> sp.	1.24	7.16
Unidentified species 4	0.17	0.98
	17.32 Total	<i>H</i> = 1.15
Plot 83		
<i>Andropogon virginicus</i>	4.93	43.90
<i>Aristida oligantha</i>	4.26	37.93
<i>Dianthus armeria</i>	0.08	0.71
<i>Plantago</i> sp.	1.63	14.51
Unidentified species 4	0.33	2.94
	11.23 Total	<i>H</i> = 1.66
Plot 89		
<i>Andropogon virginicus</i>	8.17	47.42
<i>Aristida oligantha</i>	4.11	23.85
<i>Digitaria ischaemum</i>	2.52	14.63
<i>Oxalis</i> sp.	0.01	0.06
<i>Plantago</i> sp.	0.36	2.09
Unidentified species 4	2.05	11.90
Unidentified species 11	0.01	0.06
	17.23 Total	<i>H</i> = 1.90
Plot 92		
<i>Allium</i> sp.	0.02	0.08
<i>Andropogon virginicus</i>	6.95	28.26
<i>Aristida oligantha</i>	9.16	37.25
<i>Digitaria ischaemum</i>	1.75	7.12
<i>Oxalis</i> sp.	0.01	0.04
<i>Plantago</i> sp.	3.15	12.81
Unidentified species 4	1.67	6.79
Unidentified species 11	1.88	7.65
	24.58 Total	<i>H</i> = 2.26

TABLE D.2 (Cont.)

Sampling Location ^a /Species	Biomass (g/0.1 m ²)	Relative Biomass ^b
<i>Grid TBTC (Cont.)</i>		
Plot 97		
<i>Andropogon virginicus</i>	14.41	66.59
<i>Aristida oligantha</i>	1.49	6.89
<i>Digitaria ischaemum</i>	2.60	12.01
<i>Plantago</i> sp.	0.5	2.31
Unidentified species 4	2.64	12.20
	21.64 Total	<i>H</i> = 1.52
Plot 99		
<i>Allium</i> sp.	0.31	1.70
<i>Andropogon virginicus</i>	0.16	0.88
<i>Aristida oligantha</i>	7.73	42.45
<i>Dianthus armeria</i>	0.25	1.37
<i>Digitaria ischaemum</i>	7.15	39.26
<i>Plantago</i> sp.	2.06	11.31
<i>Verbascum thapsus</i>	0.03	0.16
Unidentified species 4	0.52	2.86
	18.21 Total	<i>H</i> = 1.82
<i>Grid TBTF</i>		
Plot 22	0 Total	
Plot 23	0 Total	
Plot 24	0 Total	
Plot 25		
<i>Phragmites australis</i>	5.12	100
	5.12 Total	<i>H</i> = 0
Plot 26		
<i>Phragmites australis</i>	8.74	100
	8.74 Total	<i>H</i> = 0

TABLE D.2 (Cont.)

Sampling Location ^a /Species	Biomass (g/0.1 m ²)	Relative Biomass ^b
<i>Grid TBTF (Cont.)</i>		
Plot 27		
<i>Atriplex</i> sp.	0.05	0.15
<i>Phragmites australis</i>	30.67	93.85
<i>Setaria geniculata</i>	1.42	4.35
Unidentified species A	0.54	1.65
	32.68 Total	<i>H</i> = 0.39
Plot 28		
<i>Atriplex</i> sp.	0.27	2.39
<i>Digitaria ischaemum</i>	0.75	6.63
<i>Phragmites australis</i>	5.3	46.86
<i>Plantago</i> sp.	0.13	1.15
<i>Setaria geniculata</i>	0.96	8.49
Unidentified species A	1.73	15.30
Unidentified species D	2.17	19.19
	11.31 Total	<i>H</i> = 2.15
Plot 29		
<i>Aristida oligantha</i>	0.08	0.47
<i>Phragmites australis</i>	11.59	68.02
<i>Setaria geniculata</i>	0.08	0.47
Unidentified species A	5.14	30.16
Unidentified species B	0.15	0.88
	17.04 Total	<i>H</i> = 1.03
Plot 30		
<i>Cynodon dactylon</i>	1.68	4.80
<i>Phragmites australis</i>	32.27	92.25
<i>Setaria geniculata</i>	1.03	2.94
	34.98 Total	<i>H</i> = 0.47
Plot 41		
<i>Atriplex</i> sp.	0.29	3.54
<i>Phragmites australis</i>	2.22	27.11
Unidentified species A	1.74	21.25
Unidentified species B	3.94	48.11
	8.19 Total	<i>H</i> = 1.66

TABLE D.2 (Cont.)

Sampling Location ^a /Species	Biomass (g/0.1 m ²)	Relative Biomass ^b
<i>Grid TBTF (Cont.)</i>		
Plot 42		
<i>Atriplex</i> sp.	0.09	0.98
<i>Phragmites australis</i>	3.94	42.87
Unidentified species A	4.15	45.16
Unidentified species B	1.01	10.99
	9.19 Total	<i>H</i> = 1.46
Plot 43		
<i>Phragmites australis</i>	1.83	100
	1.83 Total	<i>H</i> = 0
Plot 44		
<i>Phragmites australis</i>	9.47	100
	9.47 Total	<i>H</i> = 0
Plot 45		
<i>Phragmites australis</i>	21.04	76.31
<i>Setaria geniculata</i>	0.65	2.36
Unidentified species A	5.88	21.33
	27.57 Total	<i>H</i> = 0.90
Plot 46		
<i>Andropogon virginicus</i>	23.75	66.73
<i>Phragmites australis</i>	6.39	17.95
<i>Setaria geniculata</i>	0.31	0.87
<i>Trifolium</i> sp.	0.63	1.77
Unidentified species A	4.51	12.67
	35.59 Total	<i>H</i> = 1.37
Plot 47		
<i>Andropogon virginicus</i>	0.2	0.68
<i>Atriplex</i> sp.	0.06	0.20
<i>Phragmites australis</i>	27.72	94.38
<i>Plantago</i> sp.	0.02	0.07
<i>Setaria geniculata</i>	0.69	2.35
<i>Trifolium</i> sp.	0.68	2.32
	29.37 Total	<i>H</i> = 0.41

TABLE D.2 (Cont.)

Sampling Location ^a /Species	Biomass (g/0.1 m ²)	Relative Biomass ^b
<i>Grid TBTF (Cont.)</i>		
Plot 48		
<i>Phragmites australis</i>	5.24	100
	5.24 Total	$H = 0$
Plot 49	0 Total	$H = 0$
Plot 50	0 Total	$H = 0$
Plot x	0 Total	$H = 0$

^a See Figure A.2 in Appendix A for sampling grid locations.

^b Relative biomass is the percent of the total biomass of the plot.

^c H = Shannon-Weiner diversity index.

$H = -\sum_{i=1}^s (p_i)(\log_n p_i)$, where s = number of species and p_i = proportional abundance of the i th species.

TABLE D.3 Biomass and Soil Analysis Results for Vegetation Collected at 20 Plots in the Toxic Burning Pits Area, September 1995

Plot ^a	Biomass (g/0.1 m ²)	Total Metals (mmol/kg)	Phosphorus (mg/kg)	Potassium (mg/kg)	Calcium (mg/kg)	Magnesium (mg/kg)
SGTBP-6	12.20	35.04	- ^b	-	-	-
SGTBP-11	0.16	265.73	-	-	-	-
SGTBP-12	2.17	486.57	<2	59	320	150
SGTBP-13	49.54	32.32	44	39.5	1,270	826
SGTBP-18	28.32	4.10	5	45	520	74
SGTBP-20	0.0	21.78	57	15	2,260	140.5
SGTBP-21	32.85	3.96	5	42	610	98.5
SGTBP-24	42.11	16.64	47	36	870	307
SGTBP-28	0.45	267.62	-	-	-	-
SGTBP-30	32.84	31.33	37	54	1,220	205.5
SGTBP-31	69.46	14.04	81	37.5	655	118
SGTBP-32	24.47	5.20	18	59.5	400	106
SGTBP-32	49.00	5.20	-	-	-	-
SGTBP-35	8.52	3.43	-	-	-	-
SGTBP-36	4.55	34.98	8	50	595	93.5
SGTBP-37	5.90	20.55	-	-	-	-
SGTBP-38	2.39	38.24	-	-	-	-
SGTBP-39	0.0	495.98	-	-	-	-
SGTBP-41	27.28	77.57	-	-	-	-
SGTBP-44	21.84	122.23	36	85	1,170	78.5

^a See Figure A.3 in Appendix A for sampling grid locations.

^b - = indicates that soil analyses were not performed.

TABLE D.4 Ground Layer Vegetation Composition and Biomass (mean g/0.1 m²) at Toxic Burning Pits Sampling Grids, November 1993^{a,b}

Species	TBTC	TBTD	TBTB	TBTF
<i>Andropogon virginicus</i>	10.88	3.16	1.30	
<i>Aristida oligantha</i>	1.27	1.56	0.15	
<i>Plantago</i> sp.	1.14		0.80	
<i>Phragmites australis</i>	0.94	0.56	6.39	1.62
<i>Digitaria ischaemum</i>	0.27	0.16		
<i>Arthraxon hispidus</i>	0.26		6.84	
<i>Tridens flavus</i>	0.08			
<i>Dianthus armeria</i>	0.04			
<i>Verbascum</i> sp.	0.02			
<i>Allium</i> sp.	0.01			
<i>Baccharis halimifolia</i>		1.32		
<i>Melilotus</i> sp.			0.09	
<i>Agrostis perennans</i>			3.96	
<i>Myrica cerifera</i>			0.07	
<i>Juniperus</i> sp. (seedling)			0.01	
<i>Liquidambar styraciflua</i> (seedling)			0.01	
<i>Atriplex patula</i>				1.20

^a See Figure A.2 in Appendix A for sampling grid locations.

^b See Table D.1 for data from individual plots.

**TABLE D.5 Ground Layer Vegetation
Composition and Biomass (mean g/0.1 m²)
at Toxic Burning Pits Sampling Grids,
November 1994^{a,b}**

Species	TBTC	TBTF
<i>Andropogon virginicus</i>	5.01	1.20
<i>Aristida oligantha</i>	5.31	0.01
<i>Plantago</i> sp.	0.91	0.01
<i>Digitaria ischaemum</i>	1.50	0.04
<i>Arthraxon hispidus</i>	0.01	
<i>Tridens flavus</i>	T ^c	
<i>Dianthus armeria</i>	0.03	
<i>Verbascum</i> sp.	0.01	
<i>Allium</i> sp.	0.02	
<i>Panicum</i> sp.	0.13	
<i>Oxalis</i> sp.	T	
<i>Juncus secundus</i>	0.03	
<i>Polygonum persicaria</i>	0.02	
Species 3	0.02	
Species 4	1.96	
Species 7	0.01	
<i>Gnaphalium obtusifolium</i>	0.06	
Species 10	0.07	
Species 11	0.11	
<i>Phragmites australis</i>		8.58
<i>Atriplex patula</i>		0.04
<i>Setaria geniculata</i>		0.24
<i>Cynodon dactylon</i>		0.08
<i>Trifolium</i> sp.		0.08

^a See Figure A.2 in Appendix A for sampling grid locations.

^b See Table D.2 for data from individual plots.

^c T = trace ($\ll 0.01$ g/m²).

TABLE D.6 Species Composition and Biomass for Reference Site Plots

Sampling Location/Species	Biomass (g/0.1 m ²)	Relative Biomass
Plot 1		
<i>Dactylis glomerata</i>	57.72	77.0
<i>Paspalum laeve</i>	9.38	12.50
Unidentified species 4	6.92	9.2
<i>Agrostis</i> sp.	0.94	1.3
Plot 2		
<i>Plantago lanceolata</i>	0.81	0.9
<i>Oxalis</i> sp.	0.05	0.1
<i>Dactylis glomerata</i>	16.27	19.0
<i>Paspalum laeve</i>	25.93	30.2
Unidentified species 3	0.47	0.5
Unidentified species 4	27.38	31.9
<i>Agrostis</i> sp.	14.47	16.9
Unidentified species 7	0.12	0.1
Plot 3		
<i>Dactylis glomerata</i>	11.97	19.0
<i>Paspalum laeve</i>	3.11	4.9
Unidentified species 3	0.72	1.1
Unidentified species 4	28.77	45.6
<i>Agrostis</i> sp.	16.06	25.5
Unidentified species 7	0.23	0.4
<i>Rumex acetosella</i>	2.18	3.5
Plot 4		
<i>Dactylis glomerata</i>	23.90	41.7
<i>Paspalum laeve</i>	1.40	2.4
Unidentified species 3	1.04	1.8
Unidentified species 4	30.15	52.6
<i>Aster pilosus</i>	0.80	1.4

TABLE D.6 (Cont.)

Sampling Location/Species	Biomass (g/0.1 m ²)	Relative Biomass
Plot 5		
<i>Allium</i> sp.	0.05	0.1
<i>Dactylis glomerata</i>	14.00	19.0
<i>Paspalum laeve</i>	18.10	24.6
Unidentified species 3	0.09	0.1
Unidentified species 4	27.11	36.8
<i>Agrostis</i> sp.	14.31	19.4
Plot 6		
<i>Allium</i> sp.	0.24	0.4
<i>Dactylis glomerata</i>	13.10	20.2
<i>Paspalum laeve</i>	4.07	6.3
Unidentified species 4	30.78	47.4
<i>Agrostis</i> sp.	16.71	25.7
Plot 7		
<i>Plantago</i> sp.	7.89	9.9
<i>Dactylis glomerata</i>	15.79	19.8
<i>Paspalum laeve</i>	13.17	16.5
Unidentified species 3	1.59	2.0
Unidentified species 4	18.40	23.0
<i>Agrostis</i> sp.	23.01	28.8
Plot 8		
<i>Dactylis glomerata</i>	12.78	16.0
<i>Paspalum laeve</i>	26.57	33.2
Unidentified species 4	12.76	15.9
<i>Agrostis</i> sp.	15.16	18.9
Unidentified species 7	12.82	16.0

TABLE D.6 (Cont.)

Sampling Location/Species	Biomass (g/0.1 m ²)	Relative Biomass
Plot 9		
<i>Dactylis glomerata</i>	12.06	19.6
<i>Paspalum laeve</i>	12.05	19.6
Unidentified species 3	1.67	2.7
Unidentified species 4	23.24	37.7
<i>Agrostis</i> sp.	12.56	20.4
Plot 10		
<i>Dactylis glomerata</i>	11.34	11.7
<i>Paspalum laeve</i>	32.92	34.0
Unidentified species 4	2.39	2.5
<i>Agrostis</i> sp.	8.41	8.7
Unidentified species 7	41.74	43.1

**TABLE D.7 Species Composition and Biomass
for the Reference Site**

Species	Total Biomass (g/0.1 m ²)	Mean Biomass (g/0.1 m ²)	Relative Biomass
<i>Plantago lanceolata</i>	8.70	0.87	1.18
<i>Oxalis</i> sp.	0.05	0.01	0.01
<i>Allium</i> sp.	0.29	0.03	0.04
<i>Dactylis glomerata</i>	188.93	18.89	25.60
<i>Paspalum laeve</i>	146.70	14.67	19.88
Species 3	5.58	0.56	0.76
Species 4	207.90	20.79	28.17
<i>Agrostis</i> sp.	121.63	12.16	16.48
<i>Aster pilosus</i>	0.80	0.08	0.11
Species 7	54.91	5.49	7.44
<i>Rumex acetosella</i>	2.43	0.24	0.33
Total	737.92	73.79	99.99

**TABLE D.8 Terrestrial Vegetation Grids of the
White Phosphorus Burning Pits Area**

Sampling Location/Species	Percent Cover	Relative Cover
Grid WPE		
Unidentified grass 4	80	80
<i>Anthoxanthum odoratum</i>	10	10
<i>Cyperus echinatus</i>	5	5
<i>Dianthus armeria</i>	2.5	2.5
<i>Eupatorium</i> sp.	2.5	2.5
$H = 1.07^a$		
Grid WPS		
Unidentified grass 1	90	83.7
<i>Plantago</i> sp.	10	9.3
<i>Lespedeza</i> sp.	2.5	2.3
Unidentified grass 4	2.5	2.3
<i>Parthenocissus</i> sp.	2.5	2.3
$H = 0.91$		
Grid WPW		
<i>Juncus marginatus</i>	15	33.3
<i>Gnaphthaliun</i> sp.	5	11.1
<i>Tripsacum dactyloides</i>	5	11.1
<i>Plantago</i> sp.	5	11.1
<i>Trifolium</i> sp.	10	22.2
<i>Centaureum</i> sp.	2.5	5.6
<i>Cyperus echinatus</i>	2.5	5.6
$H = 2.53$		

^a H = Shannon-Weiner diversity index.

$$H = -\sum_{i=1}^s (p_i)(\log_n p_i), \text{ where } s = \text{number of species and}$$

p_i = proportional abundance of the i th species.

TABLE D.9 Terrestrial Vegetation Plots of the Riot Control Pit Area, Transect B6

Sampling Location/ Species	Stratum ^a	Percent Cover	Relative Cover
Plot 1			
<i>Microstegium vimineum</i>	h	90	47.49
<i>Leersia oryzoides</i>	h	12	6.33
<i>Lonicera japonica</i>	h	9	4.75
<i>Toxicodendron radicans</i>	h	2	1.06
<i>Parthenocissus quinquefolia</i>	h	1	0.53
Unknown forb 1	h	0.5	0.26
<i>Liquidambar styraciflua</i>	t	75	39.58
			$H = 1.63^b$
Plot 2			
<i>Microstegium vimineum</i>	h	70	26.27
<i>Leersia oryzoides</i>	h	60	22.51
<i>Panicum</i> sp.	h	5	1.88
<i>Carex</i> sp.	h	10	3.75
<i>Juncus effusus</i>	h	0.5	0.19
<i>Lonicera japonica</i>	h	10	3.75
Unknown forb 1	h	0.5	0.19
<i>Parthenocissus quinquefolia</i>	h	0.5	0.19
<i>Liquidambar styraciflua</i>	t	100	37.52
<i>Toxicodendron radicans</i>	v	10	3.75
			$H = 2.21$
Plot 3			
<i>Microstegium vimineum</i>	h	85	33.66
<i>Leersia oryzoides</i>	h	65	25.74
<i>Tripsacum dactyloides</i>	h	15	5.94
<i>Vaccinium corymbosum</i>	s	10	3.96
<i>Lonicera japonica</i>	h	2	0.79
Unknown forb 1	h	0.5	0.20
<i>Liquidambar styraciflua</i>	t	75	29.70
			$H = 2.05$
Plot 4			
<i>Vaccinium corymbosum</i>	s	100	52.08
<i>Microstegium vimineum</i>	h	6	3.13

TABLE D.9 (Cont.)

Sampling Location/ Species	Stratum ^a	Percent Cover	Relative Cover
Plot 4 (Cont.)			
<i>Leersia oryzoides</i>	h	3	1.56
<i>Lonicera japonica</i>	h	7	3.65
<i>Juncus effusus</i>	h	0.5	0.26
<i>Panicum</i> sp.	h	0.5	0.26
<i>Liquidambar styraciflua</i>	t	5	2.60
			$H = 1.10$
Plot 5			
<i>Microstegium vimineum</i>	h	85	42.08
<i>Leersia oryzoides</i>	h	40	19.80
<i>Lonicera japonica</i>	h	12	5.94
<i>Liquidambar styraciflua</i>	t	65	32.18
			$H = 1.76$
Plot 6			
<i>Microstegium vimineum</i>	h	75	25.77
<i>Leersia oryzoides</i>	h	17	5.84
Unidentified grass 1	h	1	0.34
<i>Toxicodendron radicans</i>	v	1	0.34
<i>Lonicera japonica</i>	h	12	4.12
<i>Liquidambar styraciflua</i>	t	100	34.36
<i>Diospyros virginiana</i>	t	5	1.72
<i>Vitis</i> sp.	v	80	27.49
			$H = 2.13$
Plot 7			
<i>Microstegium vimineum</i>	h	100	51.02
<i>Leersia oryzoides</i>	h	10	5.10
Unidentified grass 1	h	0.5	0.26
<i>Parthenocissus quinquefolia</i>	h	0.5	0.26
<i>Liquidambar styraciflua</i>	t	85	43.37
			$H = 1.28$

TABLE D.9 (Cont.)

Sampling Location/ Species	Stratum ^a	Percent Cover	Relative Cover
Plot 8			
<i>Microstegium vimineum</i>	h	90	27.36
<i>Tripsacum dactyloides</i>	h	12	3.65
<i>Panicum virgatum</i>	h	5	1.52
<i>Leersia oryzoides</i>	h	90	27.36
<i>Lonicera japonica</i>	h	30	9.12
<i>Toxicodendron radicans</i>	v	1	0.30
<i>Poa compressa</i>	h	0.5	0.15
Unidentified grass 1	h	0.5	0.15
<i>Liquidambar styraciflua</i>	t	100	30.40
			$H = 2.18$
Plot 9			
<i>Microstegium vimineum</i>	h	100	28.86
<i>Leersia oryzoides</i>	h	3	0.87
<i>Panicum</i> sp. 2	h	10	2.89
Unidentified grass 1	h	5	1.44
<i>Tripsacum dactyloides</i>	h	3	0.87
<i>Toxicodendron radicans</i>	v	0.5	0.14
<i>Lonicera japonica</i>	h	12	3.46
<i>Parthenocissus quinquefolia</i>	h	1	0.29
<i>Liquidambar styraciflua</i>	t	20	5.77
<i>Fraxinus pennsylvanica</i>	t	85	24.53
<i>Vitis</i> sp.	v	20	5.77
			$H = 2.05$

^a Stratum coding: h = herbaceous, t = tree, s = shrub, and v = vine.

^b H = Shannon-Weiner diversity index. $H = -\sum_{i=1}^s (p_i)(\log_n p_i)$, where
 s = number of species and p_i = proportional abundance of the i th species.

**TABLE D.10 Terrestrial Vegetation Plots of the Robins Point
Demolition Ground Area Transects**

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B1</i>			
Plot 1			
<i>Acer rubrum</i>	h	5	2.55
<i>Smilax rotundifolia</i>	h	5	2.55
Unidentified grass 1	h	1	0.51
<i>Sassafras albidum</i>	t	90	45.92
<i>Quercus phellos</i>	t	90	45.92
<i>Ilex opaca</i>	t	5	2.55
			$H = 1.48^c$
Plot 2			
<i>Acer rubrum</i>	h	2	1.14
Unidentified grass 1	h	1	0.57
<i>Carex</i> sp.	h	2	1.14
<i>Nyssa sylvatica</i>	t	10	5.71
<i>Sassafras albidum</i>	t	100	5.71
<i>Ilex opaca</i>	t	10	5.71
<i>Quercus phellos</i>	t	50	28.57
			$H = 1.64$
Plot 3			
Unidentified grass 1	h	15	6.82
<i>Acer rubrum</i>	h	10	4.55
<i>Nyssa sylvatica</i>	t	85	38.67
<i>Acer rubrum</i>	t	10	4.55
<i>Sassafras albidum</i>	t	10	4.55
<i>Quercus phellos</i>	t	90	40.91
			$H = 1.93$
Plot 4			
<i>Acer rubrum</i>	h	15	6.00
Unidentified grass 1	h	10	4.00
<i>Smilax rotundifolia</i>	h	5	2.00
<i>Acer rubrum</i>	t	100	40.00
<i>Liquidambar styraciflua</i>	t	50	20.00
<i>Quercus phellos</i>	t	70	28.00
			$H = 2.05$

TABLE D.10 (Cont.)

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B1 (Cont.)</i>			
Plot 5			
<i>Liquidambar styraciflua</i>	t	70	44.03
Unidentified grass 1	h	20	12.58
<i>Acer rubrum</i>	h	8	5.03
<i>Carex</i> sp.	h	5	3.14
Unidentified forb 1	h	3	1.89
<i>Ilex opaca</i>	h	3	1.89
<i>Acer rubrum</i>	t	50	31.45
			$H = 2.01$
Plot 6			
<i>Acer rubrum</i>	h	3	9.09
Unidentified grass 1	h	10	30.30
<i>Liquidambar styraciflua</i>	t	10	30.30
<i>Quercus michauxii</i>	t	10	30.30
			$H = 1.88$
Plot 7			
Unidentified grass 1	h	25	17.48
<i>Carex</i> sp.	h	10	6.99
<i>Ilex opaca</i>	h	15	10.49
<i>Smilax rotundifolia</i>	h	3	2.10
<i>Vaccinium corymbosum</i>	h	5	3.50
<i>Acer rubrum</i>	h	10	6.99
<i>Quercus michauxii</i>	t	75	52.45
			$H = 2.09$
Plot 8			
Unidentified grass 1	h	35	22.29
<i>Acer rubrum</i>	h	10	6.37
<i>Carex</i> sp.	h	10	6.37
<i>Smilax rotundifolia</i>	h	2	1.27
<i>Liquidambar styraciflua</i>	t	50	31.85
<i>Quercus michauxii</i>	t	50	31.85
			$H = 2.12$

TABLE D.10 (Cont.)

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B1 (Cont.)</i>			
Plot 9			
Unidentified grass 1	h	12	8.05
<i>Acer rubrum</i>	h	5	3.36
<i>Smilax rotundifolia</i>	h	2	1.34
<i>Liquidambar styraciflua</i>	t	95	63.76
<i>Quercus michauxii</i>	t	35	23.49
			$H = 1.45$
Plot 10			
Unidentified grass 1	h	5	7.69
<i>Acer rubrum</i>	h	10	15.38
<i>Liquidambar styraciflua</i>	t	50	76.92
			$H = 0.99$
<i>Transect B2</i>			
Plot A			
<i>Panicum virgatum</i>	h	10	12.20
<i>Andropogon virginicus</i>	h	15	18.29
<i>Eleocharis</i> sp.	h	40	48.78
<i>Juncus secundus</i>	h	3	3.66
<i>Acer rubrum</i>	h	3	3.66
Unidentified <i>Asteraceae</i> 1	h	2	2.44
<i>Panicum</i> sp.	h	3	3.66
Unidentified <i>Juncaceae</i> 1	h	3	3.66
Unidentified <i>Juncaceae</i> 2	h	3	3.66
			$H = 2.33$

TABLE D.10 (Cont.)

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B2 (Cont.)</i>			
Plot B			
<i>Liquidambar styraciflua</i>	h	7	17.5
<i>Andropogon virginicus</i>	h	10	25
<i>Solidago</i> sp.	h	3	7.5
<i>Carex</i> sp.	h	3	7.5
<i>Juncus</i> sp.	h	3	7.5
<i>Panicum</i> sp. 1	h	3	7.5
<i>Panicum virgatum</i>	h	2	5
Unidentified forb 1	h	3	7.5
Unidentified forb 2	h	4	10
<i>Eupatorium</i> sp.	h	1	2.5
Unidentified forb 3	h	1	2.5
			$H = 3.16$
Plot C			
<i>Andropogon virginicus</i>	h	30	65.22
Unidentified <i>Asteraceae</i> 1	h	3	6.52
<i>Panicum</i> A	h	3	6.52
Unidentified forb 2	h	1	2.17
<i>Liquidambar styraciflua</i>	h	1	2.17
<i>Acer rubrum</i>	h	1	2.17
<i>Juncus</i> sp.	h	1	2.17
<i>Eleocharis</i> sp.	h	5	10.87
Unidentified forb 1	h	1	2.17
			$H = 1.86$
Plot D			
<i>Andropogon virginicus</i>	h	25	65.79
<i>Juncus</i> sp.	h	2	5.26
<i>Eleocharis</i> sp.	h	5	13.16
Unidentified <i>Asteraceae</i> 1	h	3	7.89
<i>Carex</i> sp.	h	3	7.89
			$H = 1.58$

TABLE D.10 (Cont.)

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B2 (Cont.)</i>			
Plot E			
<i>Andropogon virginicus</i>	h	25	58.14
<i>Eleocharis</i> sp.	h	5	11.63
Unidentified <i>Asteraceae</i> 1	h	3	6.98
Unidentified grass 1	h	3	6.98
<i>Acer rubrum</i>	h	3	6.98
<i>Carex</i> sp.	h	3	6.98
<i>Juncus</i> sp.	h	0.5	1.16
Unidentified forb 1	h	0.5	1.16
			$H = 2.04$
Plot F			
Unidentified <i>Asteraceae</i> 1	h	35	15.77
Unidentified grass 1	h	25	11.26
<i>Eleocharis</i> sp.	h	3	1.35
Unidentified forb 4	h	25	11.26
Unidentified grass 2	h	12	5.41
Unidentified grass 3	h	10	4.50
<i>Echinochloa</i> sp.	h	3	1.35
<i>Acer rubrum</i>	h	2	0.90
Unidentified forb 2	h	3	1.35
<i>Carex</i> sp.	h	3	1.35
Unidentified forb 1	h	1	0.45
<i>Liquidambar styraciflua</i>	s	100	45.05
			$H = 2.51$
Plot G			
<i>Carex</i> sp.	h	20	19.14
Unidentified grass 3	h	50	47.85
<i>Solidago</i> sp.	h	4	3.83
Unidentified <i>Asteraceae</i> 1	h	7	6.70
Unidentified grass 1	h	10	9.57
Unidentified grass 2	h	5	4.78

TABLE D.10 (Cont.)

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B2 (Cont.)</i>			
Plot G (Cont.)			
<i>Andropogon virginicus</i>	h	4	3.83
<i>Acer rubrum</i>	h	1	0.96
Unidentified forb 2	h	1	0.96
Unidentified forb 1	h	2	1.91
Unidentified forb 5	h	0.5	0.48
			<i>H</i> = 2.40
Plot H			
<i>Juncus</i> sp.	h	12	19.67
<i>Panicum</i> sp. 1	h	10	16.39
Unidentified forb 4	h	15	24.59
Unidentified grass 2	h	10	16.39
<i>Asteraceae</i>	h	7	11.48
Unidentified forb 1	h	1	1.63
Unidentified grass 3	h	3	4.92
<i>Carex</i> sp.	h	2	3.28
<i>Eleocharis</i> sp.	h	1	1.64
			<i>H</i> = 2.74

^a See Figure A.1 in Appendix A for sampling transect locations.

^b Stratum coding: h = herbaceous, t = tree, s = shrub, and v = vine.

^c *H* = Shannon-Weiner diversity index. $H = -\sum_{i=1}^s (p_i)(\log_n p_i)$, where
s = number of species and *p_i* = proportional abundance of the *i*th species.

**TABLE D.11 Biomass
for Sampling Plots at the
Robins Point Demolition
Ground Area**

Plot ^a	Biomass (g/0.1 m ²)
SGRPDG-1	47.11
SGRPDG-2	115.61
SGRPDG-3	34.87
SGRPDG-5	27.74

^a See Figure A.6 in
Appendix A for plot
locations.

TABLE D.12 Terrestrial Vegetation Plots of the Robins Point Tower Site Transects

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B3</i>			
Plot 6			
<i>Phragmites australis</i>	h	90	36.73
<i>Arisaema triphyllum</i>	h	12	4.90
<i>Microstegium vimineum</i>	h	45	18.37
<i>Oxalis</i> sp.	h	3	1.22
<i>Robinia pseudoacacia</i>	t	95	38.78
			$H = 1.80^c$
Plot 9			
<i>Phragmites australis</i>	h	30	22.99
<i>Microstegium vimineum</i>	h	95	72.80
<i>Oxalis</i> sp.	h	0.5	0.38
<i>Robinia pseudoacacia</i>	t	5	3.83
			$H = 1.03$
Plot 12			
<i>Microstegium vimineum</i>	h	95	45.24
<i>Panicum virgatum</i>	h	10	4.76
<i>Phragmites australis</i>	h	5	2.38
<i>Arisaema triphyllum</i>	h	10	4.76
<i>Robinia pseudoacacia</i>	t	80	38.10
<i>Liquidambar styraciflua</i>	s	10	4.76
			$H = 1.80$
Plot 15			
<i>Microstegium vimineum</i>	h	100	76.92
<i>Robinia pseudoacacia</i>	t	30	23.08
			$H = 0.78$
Plot 18			
<i>Microstegium vimineum</i>	h	95	62.91
<i>Panicum</i> sp.	h	5	3.31
<i>Oxalis</i> sp.	h	1	0.66
<i>Robinia pseudoacacia</i>	t	50	33.11
			$H = 1.16$

TABLE D.12 (Cont.)

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B3 (Cont.)</i>			
Plot 21			
<i>Microstegium vimineum</i>	h	80	40.30
<i>Robinia pseudoacacia</i>	h	8	4.04
<i>Arisaema triphyllum</i>	h	20	10.08
<i>Robinia pseudoacacia</i>	t	90	45.34
<i>Oxalis</i> sp.	h	0.5	0.252
			$H = 1.59$
Plot 24			
<i>Microstegium vimineum</i>	h	100	50.13
<i>Arisaema triphyllum</i>	h	1	0.50
<i>Oxalis</i> sp.	h	4	2.01
<i>Liquidambar styraciflua</i>	h	5	2.51
<i>Lonicera japonica</i>	h	3	1.50
<i>Parthenocissus quinquefolia</i>	h	1	0.50
<i>Oxalis violacea</i>	h	0.5	0.25
<i>Robinia pseudoacacia</i>	t	60	30.08
<i>Liquidambar styraciflua</i>	t	25	12.53
			$H = 1.83$
Plot 27			
<i>Microstegium vimineum</i>	h	90	46.15
<i>Lonicera japonica</i>	h	5	2.56
<i>Arisaema triphyllum</i>	h	8	4.10
<i>Oxalis</i> sp.	h	1	0.51
<i>Carex</i> sp.	h	1	0.51
<i>Liquidambar styraciflua</i>	t	90	46.15
			$H = 1.43$
Plot 30			
<i>Microstegium vimineum</i>	h	35	22.88
Unidentified grass	h	20	13.07
<i>Arisaema triphyllum</i>	h	25	16.34
<i>Oxalis</i> sp.	h	2	1.31
<i>Carex</i> sp.	h	1	0.65
<i>Liquidambar styraciflua</i>	t	70	45.75
			$H = 1.94$

TABLE D.12 (Cont.)

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B4</i>			
Plot 12			
<i>Osmunda cinnamomea</i>	h	50	20.37
<i>Onoclea sensibilis</i>	h	5	2.04
<i>Microstegium vimineum</i>	h	95	38.70
Unidentified grass 1	h	25	10.18
<i>Parthenocissus quinquefolia</i>	h	1	0.41
Unidentified <i>Fabaceae</i> 1	h	1	0.41
<i>Oxalis</i> sp.	h	0.5	0.20
Unidentified <i>Asteraceae</i> 1	h	2	0.81
<i>Juncus</i> sp.	h	1	0.41
<i>Solanum carolinense</i>	h	1	0.41
<i>Festuca</i> sp.	h	1	0.41
<i>Anthoxanthum odoratum</i>	h	8	3.26
<i>Baccharis halimifolia</i>	v	20	8.15
<i>Liquidambar styraciflua</i>	s	35	14.26
			$H = 2.54$
Plot 15			
<i>Microstegium vimineum</i>	h	90	40.00
<i>Parthenocissus quinquefolia</i>	h	3	1.33
<i>Osmunda cinnamomea</i>	h	12	5.33
<i>Carex</i> sp.	h	0.5	0.22
Unidentified <i>Fabaceae</i> 1	h	0.5	0.22
Unidentified <i>Lamiaceae</i> 1	h	3	1.33
Unidentified <i>Asteraceae</i> 1	h	5	2.22
<i>Lonicera japonica</i>	h	7	3.11
<i>Trifolium</i> sp.	h	0.5	0.22
<i>Oxalis</i> sp.	h	1	0.44
<i>Festuca</i> sp.	h	1	0.44
<i>Anthoxanthum odoratum</i>	h	0.5	0.22
<i>Holcus lanatus</i>	h	0.5	0.22
<i>Panicum</i> sp.	h	0.5	0.22
<i>Liquidambar styraciflua</i>	s	100	44.44
			$H = 1.91$

TABLE D.12 (Cont.)

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
Transect B4 (Cont.)			
Plot 18			
<i>Microstegium vimineum</i>	h	80	30.36
<i>Osmunda cinnamomea</i>	h	75	28.46
<i>Onoclea sensibilis</i>	h	5	1.90
<i>Viola</i> sp.	h	2	0.76
<i>Juncus effusus</i>	h	0.5	0.19
<i>Allium</i> sp.	h	0.5	0.19
<i>Festuca</i> sp.	h	0.5	0.19
<i>Liquidambar styraciflua</i>	s	100	37.95
			$H = 1.78$
Plot 21			
<i>Osmunda cinnamomea</i>	h	60	26.03
<i>Onoclea sensibilis</i>	h	5	2.17
<i>Holcus lanatus</i>	h	10	4.34
<i>Anthoxanthum odoratum</i>	h	7	3.04
<i>Trifolium</i> sp.	h	2	0.87
Unidentified forb 2	v	4	1.74
<i>Oxalis</i> sp.	h	0.5	0.22
Unidentified Asteraceae 1	h	5	2.17
<i>Pilea pumila</i>	h	1	0.43
<i>Festuca</i> sp.	h	35	15.18
<i>Vitis</i> sp.	h	0.5	0.22
Unidentified forb 3	h	0.5	0.22
<i>Liquidambar styraciflua</i>	s	100	43.38
			$H = 2.28$
Transect B5			
Plot 15			
<i>Osmunda cinnamomea</i>	h	85	31.25
<i>Microstegium vimineum</i>	h	80	29.41
<i>Juncus effusus</i>	h	7	2.57
<i>Liquidambar styraciflua</i>	t	100	36.76
			$H = 1.71$

TABLE D.12 (Cont.)

Sampling Location ^a /Species	Stratum ^b	Percent Cover	Relative Cover
<i>Transect B5 (Cont.)</i>			
Plot 18			
<i>Osmunda cinnamomea</i>	h	90	34.09
<i>Microstegium vimineum</i>	h	85	32.20
<i>Onoclea sensibilis</i>	h	10	3.79
<i>Toxicodendron radicans</i>	h	8	3.03
Unidentified <i>Rosaceae</i> 1	h	0.5	0.18
<i>Acer rubrum</i>	h	0.5	0.18
<i>Liquidambar styraciflua</i>	t	70	26.52
			$H = 1.93$
Plot 21			
<i>Osmunda cinnamomea</i>	h	75	33.19
<i>Microstegium vimineum</i>	h	50	22.12
<i>Liquidambar styraciflua</i>	t	100	44.25
Unidentified grass 1	h	0.5	0.22
Unidentified forb 1	h	0.5	0.22
			$H = 1.57$
Plot 24			
<i>Osmunda cinnamomea</i>	h	100	45.35
<i>Microstegium vimineum</i>	h	40	18.14
Unidentified forb 1	h	0.5	0.23
<i>Liquidambar styraciflua</i>	t	80	36.28
			$H = 1.51$
Plot 27			
<i>Microstegium vimineum</i>	h	100	40.76
<i>Boehmeria cylindrica</i>	h	5	2.54
<i>Osmunda cinnamomea</i>	h	7	3.55
<i>Liquidambar styraciflua</i>	t	85	43.15
			$H = 1.33$

^a See Figure A.1 in Appendix A for sampling transect locations.

^b Stratum coding: h = herbaceous, t = tree, s = shrub, and v = vine.

^c H = Shannon-Weiner diversity index. $H = -\sum_{i=1}^s (p_i)(\log_n p_i)$, where s = number of species and p_i = proportional abundance of the i th species.

**TABLE D.13 Biomass for
Sampling Plots at Robins
Point Tower Site**

Plot ^a	Biomass (g/0.1 m ²)
SGRPT-2	23.076
SGRPT-4	19.874
RPTS-6	0.132
SGRPT-10	11.49
SGRPT-14	9.868
SGRPT-18	41.904
SGRPT-22	52.196
SGRPT-23	48.252
RPT-(A3SE)	13.30
RPT-(B3NW)	13.884

^a See Figure A.7 in
Appendix A for sampling
plot locations.

**TABLE D.14 Biomass
for Sampling Plots at the
Prototype Building Area**

Plot ^a	Biomass (g/0.1 m ²)
SGPB-1	32.548
SGPB-2	42.568
SGPB-6	26.00
SGPB-7	44.738
SGPB-10	38.222
SGPB-11	49.596
SGPB-16	55.74
SGPB-17	59.794
<hr/>	
Mean	43.65
Minimum	26.00
Maximum	59.79

^a See Figure A.9 in
Appendix A for
sampling plot locations.

APPENDIX E:
OUTPUT FROM CONTAMINANT UPTAKE AND
RISK ESTIMATION MODELING

APPENDIX E:**OUTPUT FROM CONTAMINANT UPTAKE AND
RISK ESTIMATION MODELING**

Media-based or dose-based benchmark values were used to model contaminant uptake and estimate risk to obtain hazard quotients (HQs) for the various ecological receptors for the areas of concern at J-Field. The intermediate calculations and results of the contaminant uptake modeling are presented in this appendix in the form of spreadsheet output tables. The title line at the top of each table identifies the area of concern, by acronym (see acronym list at beginning of the report), and the receptor that is the subject of the table. The following notations and abbreviations are used in the tables in this appendix:

-- = the contaminant was not considered a contaminant of concern in media that contributed to the specified uptake pathway or risk calculation

ADD = applied daily dose

BCF = bioconcentration factor

HQ = hazard quotient

NA = not available (refers to the lack of a suitable benchmark value for specific contaminant-receptor combinations and the resulting inability to calculate an HQ)

PB = Prototype Building

RCP = Riot Control Burning Pit

RPDG = Robins Point Demolition Ground

RPTS = Robins Point Tower Site

SBDG = South Beach Demolition Ground

SPTF = soil-to-plant transfer factor;

TBP = Toxic Burning Pits

WPP = White Phosphorus Burning Pits

TABLE E.1 TBP: Vegetation

Contaminant	SPTF	Grass Tissue Concentration (mg/kg)	Reed Tissue Concentration (mg/kg)	Benchmark (mg/kg)	HQ
1,1 Oxathiane	1.00E+00	--	--	NA	--
1,1,2,2-Tetrachloroethane	4.03E-01	1.008	0.009	NA	NA
1,1-Dichloroethene	8.36E-01	0.084	--	NA	NA
1,4-Dichlorobenzene	8.04E-03	--	0.003	NA	NA
1,4-Dithiane	1.00E+00	--	--	NA	NA
1,4-Oxathiane	1.00E+00	--	--	NA	NA
2,4,6-Trichloroaniline	1.00E+00	7.900	--	NA	NA
2,4-Dinitrotoluene	6.76E-01	--	1.426	NA	NA
2-Butanone	1.00E+00	0.037	0.200	NA	NA
2-Methylnaphthalene	5.69E-03	0.007	--	NA	NA
2-Methylphenol	7.04E-01	0.880	1.126	NA	NA
4,4'-DDE	8.71E-04	--	<0.001	NA	NA
4-Methylphenol	7.42E-01	0.928	--	NA	NA
Acetone	1.33E+01	0.266	2.660	NA	NA
Aluminum	1.80E-04	4.068	7.700	NA	NA
Antimony	1.10E-02	5.511	0.175	5.000	100.2
Aroclor 1248	4.54E-03	0.003	--	10.000	<0.1
Arsenic	1.00E-02	14.400	0.120	10.000	144.0
Barium	1.50E-02	23.700	4.700	1,000.000	1.6
Benzo(b)fluoranthene	3.04E-03	0.004	--	NA	NA
Benzo(k)fluoranthene	3.04E-03	0.004	--	NA	NA
Cadmium	5.50E-01	19.525	3.872	10.000	3.6
Calcium	1.00E+00	36,000.000	841.000	NA	NA
Carbon disulfide	6.76E-01	0.026	--	NA	NA
Chloroethane	1.44E+00	--	--	NA	NA
Chloroform	7.04E-01	0.035	--	NA	NA
Chromium	7.50E-03	6.585	0.910	3.500	250.9
Cobalt	9.40E-03	1.015	0.500	25.000	4.3
Copper	1.30E-01	561.600	3.100	100.000	43.2
Cyanide	1.35E+01	1,620.000	--	NA	NA
Diethyl phthalate	3.67E-01	0.734	--	NA	NA
DIMP	1.00E+00	--	--	NA	NA
Dithiane	1.00E+00	--	--	NA	NA
Fluorene	3.62E-02	0.045	--	200.000	<0.1
Hexachlorobenzene	9.18E-03	0.028	0.003	NA	NA
Hexachloroethane	2.12E-02	0.027	--	NA	NA
Iron	4.00E-03	616.000	22.000	NA	NA
Lead	6.80E-02	6,405.600	0.580	100.000	942.0
Magnesium	1.30E-01	504.400	509.000	NA	NA
Manganese	3.00E-02	18.990	39.500	330.000	1.9
Mercury	3.80E-01	1.368	0.650	0.300	12.0
N-Nitrosodiphenylamine	1.50E-01	0.188	--	NA	NA
Nickel	6.00E-02	5.070	1.000	NA	NA
Nitroglycerin	8.85E-01	13.541	--	NA	NA
Phenol	1.39E+00	1.738	--	NA	NA
Pyrene	8.15E-03	0.010	0.003	NA	NA
Selenium	1.30E+00	9.256	0.110	2.000	3.6
Silver	1.50E+00	62.850	5.610	2.000	21.0
Sodium	5.00E-02	26.050	668.000	NA	NA
Tetrachloroethene	3.04E-01	0.304	--	NA	NA
Thallium	2.50E-01	4.825	--	NA	NA
Trichloroethene	4.08E-01	1.142	0.012	NA	NA
Vinyl chloride	1.54E+00	--	0.083	NA	NA
Zinc	4.00E-01	7,120.000	26.900	10.000	1,780.0

TABLE E.2 TBP: Aquatic Invertebrates

Contaminant	Surface Water Concentration (µg/L)	BCF	Estimated Dry Weight Tissue Concentration (mg/kg)	Estimated Wet Weight Tissue Concentration (mg/kg)	Benchmark Surface Water Concentrations (µg/L)	HQ
1,1 Oxathiane	12.2	1.00E+00	0.012	0.004	NA	NA
1,1,2,2-Tetrachloroethane	4,348.0	3.32E-03	0.014	0.004	2,400.0	1.8
1,1-Dichloroethene	--	4.44E-01	--	--	NA	--
1,4-Dichlorobenzene	--	3.22E+02	--	--	NA	--
1,4-Dithiane	1.9	1.00E+00	0.002	<0.001	NA	NA
1,4-Oxathiane	9.7	1.00E+00	0.010	0.003	NA	NA
2,4,6-Trichloroaniline	--	1.00E+00	--	--	NA	--
2,4-Dinitrotoluene	--	1.95E+01	--	--	NA	--
2-Butanone	--	1.00E+00	--	--	NA	--
2-Methylnaphthalene	--	5.03E+02	--	--	NA	--
2-Methylphenol	--	1.85E+01	--	--	NA	--
4,4'-DDE	--	3.86E+04	--	--	NA	--
4-Methylphenol	--	1.72E+01	--	--	NA	--
Acetone	32.0	3.89E-01	0.012	0.004	NA	NA
Aluminum	18,000.0	2.31E+02	4,158.000	1205.916	460.0	39.1
Antimony	32.9	3.00E-03	<0.001	<0.001	NA	NA
Aroclor 1248	--	3.03E+04	--	--	2.0	--
Arsenic	36.3	1.70E+01	0.617	0.179	190.0	0.2
Barium	559.0	9.00E+02	503.100	145.911	5,800.0	<0.1
Benzo(b)fluoranthene	--	2.46E+04	--	--	NA	--
Benzo(k)fluoranthene	--	2.46E+04	--	--	NA	--
Cadmium	13.4	1.00E+04	134.000	38.863	NA	NA
Calcium	205,000.0	1.00E+00	205.000	59.455	116,000.0	1.8
Carbon disulfide	--	1.95E+01	--	--	NA	--
Chloroethane	125.0	7.21E+00	0.901	0.261	NA	NA
Chloroform	--	1.85E+01	--	--	NA	--
Chromium	64.8	1.92E+02	12.442	3.608	NA	NA
Cobalt	104.0	1.00E-03	<0.001	<0.001	NA	NA
Copper	525.0	1.00E+00	0.525	0.152	32.7	16.1
Cyanide	--	1.41E-08	--	--	NA	--
Diethyl phthalate	--	4.44E+01	--	--	NA	--
DIMP	0.4	1.00E+00	<0.001	<0.001	NA	NA
Dithiane	3.6	1.00E+00	0.004	0.001	NA	NA
Fluorene	--	3.97E-04	--	--	NA	--
Hexachlorobenzene	--	1.80E+03	--	--	NA	--
Hexachloroethane	--	1.84E+03	--	--	NA	--
Iron	181,100.0	1.00E+00	181.100	52.523	1,000.0	181.1
Lead	1,590.0	1.75E+01	27.825	8.070	14.4	110.4
Magnesium	228,000.0	1.00E+00	228.000	66.125	82,000.0	2.8
Manganese	3,700.0	1.00E+00	3.700	1.073	1,200,000.0	<0.1
Mercury	1.7	2.37E+04	40.224	11.666	0.2	7.4
N-Nitrosodiphenylamine	--	1.45E+02	--	--	NA	--
Nickel	116.0	1.06E+02	12.296	3.566	5.0	23.2
Nitroglycerin	--	1.00E+01	--	--	NA	--
Phenol	--	2.77E+02	--	--	2,005.0	--
Pyrene	--	6.53E+03	--	--	NA	--
Selenium	3.4	2.89E+04	98.158	28.468	NA	NA
Silver	7.6	1.70E-02	<0.001	<0.001	NA	NA
Sodium	958,000.0	1.00E+00	958.000	277.842	680,000.0	1.4
Tetrachloroethene	--	9.26E+00	--	--	NA	--
Thallium	--	1.50E+04	--	--	NA	--
Trichloroethene	3,615.0	4.07E+01	146.986	42.629	7,257.0	0.5
Vinyl chloride	125.0	6.36E+00	0.795	0.231	87.8	1.4
Zinc	4,040.0	1.00E+05	404,000.000	117169.374	290.2	13.9

TABLE E.3 TBP: Fish

Contaminant	Surface Water Concentration (µg/L)	BCF	Estimated Tissue Concentrations (mg/kg)	Method for Deriving Tissue Concentration
1,1 Oxathiane	12.20	1.00E+00	0.012	Calculated
1,1,2,2-Tetrachloroethane	4,348.00	1.00E+00	4.348	Calculated
1,1-Dichloroethene	--	1.07E+00	--	--
1,4-Dichlorobenzene	--	7.20E+02	--	--
1,4-Dithiane	1.89	1.00E+00	0.002	Calculated
1,4-Oxathiane	9.75	1.00E+00	0.010	Calculated
2,4,6-Trichloroaniline	--	1.00E+00	--	--
2,4-Dinitrotoluene	--	4.47E-01	--	--
2-Butanone	--	1.00E+00	--	--
2-Methylnaphthalene	--	2.12E-01	--	--
2-Methylphenol	--	4.53E-01	--	--
4,4'-DDE	--	8.45E+03	0.136	Measured
4-Methylphenol	--	4.60E-01	--	--
Acetone	32.00	6.90E-01	0.022	Calculated
Aluminum	18,000.00	2.31E+02	30.300	Measured
Antimony	32.90	3.00E-03	<0.001	Calculated
Aroclor 1248	--	9.83E-02	--	--
Arsenic	36.30	4.00E+00	0.440	Measured
Barium	559.00	8.00E+00	12.200	Measured
Benzo(b)fluoranthene	--	8.66E-02	--	--
Benzo(k)fluoranthene	--	8.66E-02	--	--
Cadmium	13.40	4.90E+03	1.160	Measured
Calcium	205,000.00	1.00E+00	90028.000	Measured
Carbon disulfide	--	4.47E-01	--	--
Chloroethane	125.00	5.62E-01	0.070	Calculated
Chloroform	--	1.40E+00	--	--
Chromium	64.80	3.40E+00	2.320	Measured
Cobalt	104.00	4.00E+01	3.250	Measured
Copper	525.00	0	5.580	Measured
Cyanide	--	1.41E-08	--	--
Diethyl phthalate	--	1.17E+02	--	--
DIMP	0.43	1.00E+00	<0.001	Calculated
Dithiane	3.56	1.00E+00	0.004	Calculated
Fluorene	--	3.97E-04	--	--
Hexachlorobenzene	--	1.20E+03	--	--
Hexachloroethane	--	1.84E+03	--	--
Iron	181,100.00	7.48E+00	151.000	Measured
Lead	1,590.00	7.26E+02	1.190	Measured
Magnesium	228,000.00	7.48E+00	2400.000	Measured
Manganese	3,700.00	2.30E+01	61.100	Measured
Mercury	1.70	1.58E+02	0.110	Measured
N-Nitrosodiphenylamine	--	2.82E-01	--	--
Nickel	116.00	1.00E+02	6.280	Measured
Nitroglycerin	--	5.21E-01	--	--
Phenol	--	1.90E+00	--	--
Pyrene	--	9.70E+02	--	--
Selenium	3.40	4.70E+02	1.960	Measured
Silver	7.60	1.50E+02	0.240	Measured
Sodium	958,000.00	7.48E+00	5280.000	Measured
Tetrachloroethene	--	5.57E+01	--	--
Thallium	--	1.00E+04	--	--
Trichloroethene	3,615.00	3.79E+01	137.009	Calculated
Vinyl chloride	125.00	6.59E+00	0.824	Calculated
Zinc	4,040.00	1.74E+03	273.000	Measured

TABLE E.4 TBP: Leopard Frog

Contaminant	Surface Water Concentration (µg/L)	BCF	Estimated Leopard Frog Tissue Concentration (mg/kg)
1,1 Oxathiane	12.20	1.00E+00	0.012
1,1,2,2-Tetrachloroethane	4348.00	1.00E+00	4.348
1,1-Dichloroethene	--	1.07E+00	--
1,4-Dichlorobenzene	--	7.20E+02	--
1,4-Dithiane	1.89	1.00E+00	0.002
1,4-Oxathiane	9.75	1.00E+00	0.010
2,4,6-Trichloroaniline	--	1.00E+00	--
2,4-Dinitrotoluene	--	4.47E-01	--
2-Butanone	--	1.00E+00	--
2-Methylnaphthalene	--	2.12E-01	--
2-Methylphenol	--	4.53E-01	--
4,4'-DDE	--	8.45E+03	--
4-Methylphenol	--	4.60E-01	--
Acetone	32.00	6.90E-01	0.022
Aluminum	18000.00	2.31E+02	4158.000
Antimony	32.90	3.00E-03	<0.001
Aroclor 1248	--	9.83E-02	--
Arsenic	36.30	4.00E+00	0.145
Barium	559.00	8.00E+00	4.472
Benzo(b)fluoranthene	--	8.66E-02	--
Benzo(k)fluoranthene	--	8.66E-02	--
Cadmium	13.40	4.90E+03	65.660
Calcium	205000.00	1.00E+00	205.000
Carbon disulfide	--	4.47E-01	--
Chloroethane	125.00	5.62E-01	0.070
Chloroform	--	1.40E+00	--
Chromium	64.80	3.40E+00	0.220
Cobalt	104.00	4.00E+01	4.160
Copper	525.00	5.00E+00	2.625
Cyanide	--	1.41E-08	--
Diethyl phthalate	--	1.17E+02	--
DIMP	0.43	1.00E+00	<0.001
Dithiane	3.56	1.00E+00	0.004
Fluorene	--	3.97E-04	--
Hexachlorobenzene	--	1.20E+03	--
Hexachloroethane	--	1.84E+03	--
Iron	181100.00	7.48E+00	1354.990
Lead	1590.00	1.00E+02	159.000
Magnesium	228000.00	7.48E+00	1705.896
Manganese	3700.00	2.30E+01	85.100
Mercury	1.70	1.58E+02	0.269
N-Nitrosodiphenylamine	--	2.82E-01	--
Nickel	116.00	8.50E+01	9.860
Nitroglycerin	--	5.21E-01	--
Phenol	--	1.90E+00	--
Pyrene	--	9.70E+02	--
Selenium	3.40	4.70E+02	1.598
Silver	7.60	1.50E+02	1.140
Sodium	958000.00	7.48E+00	7167.756
Tetrachloroethene	--	5.57E+01	--
Thallium	--	1.00E+04	--
Trichloroethene	3615.00	3.79E+01	137.009
Vinyl chloride	125.00	6.59E+00	0.824
Zinc	4040.00	2.28E+02	921.120

TABLE E.5 TBP: Great Blue Heron

Contaminant	ADD from	ADD from	ADD from	ADD from	Total ADD (mg/kg-d)	Benchmark	HQ
	Fish Ingestion (mg/kg-d)	Amphibian Ingestion (mg/kg-d)	Drinking Water (mg/kg-d)	Incidental Sediment Ingestion (mg/kg-d)		ADD (mg/kg-d)	
1,1 Oxathiane	<0.001	<0.001	<0.001	--	<0.001	NA	NA
1,1,2,2-Tetrachloroethane	0.014	<0.001	0.004	<0.001	0.018	NA	NA
1,1-Dichloroethene	--	--	--	--	--	NA	--
1,4-Dichlorobenzene	--	--	--	<0.001	<0.001	NA	NA
1,4-Dithiane	<0.001	<0.001	<0.001	--	<0.001	NA	NA
1,4-Oxathiane	<0.001	<0.001	<0.001	--	<0.001	NA	NA
2,4,6-Trichloroaniline	--	--	--	--	--	NA	--
2,4-Dinitrotoluene	--	--	--	<0.001	<0.001	NA	NA
2-Butanone	--	--	--	<0.001	<0.001	NA	NA
2-Methylnaphthalene	--	--	--	--	--	NA	--
2-Methylphenol	--	--	--	--	--	NA	--
4,4'-DDE	<0.001	--	--	<0.001	<0.001	0.003	0.1
4-Methylphenol	--	--	--	--	--	NA	--
Acetone	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Aluminum	0.097	0.272	0.015	1.762	2.147	109.700	<0.1
Antimony	<0.001	<0.001	<0.001	0.001	0.001	NA	NA
Aroclor 1248	--	--	--	--	--	0.180	--
Arsenic	0.001	<0.001	<0.001	<0.001	0.002	5.100	<0.1
Barium	0.039	<0.001	<0.001	0.061	0.101	20.800	<0.1
Benzo(b)fluoranthene	--	--	--	--	--	NA	--
Benzo(k)fluoranthene	--	--	--	--	--	NA	--
Cadmium	0.004	0.004	<0.001	<0.001	0.008	1.450	<0.1
Calcium	289.033	0.013	0.168	0.375	289.589	NA	NA
Carbon disulfide	--	--	--	--	--	NA	--
Chloroethane	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Chloroform	--	--	--	--	--	NA	--
Chromium	0.007	<0.001	<0.001	0.005	0.013	1.000	<0.1
Cobalt	0.010	<0.001	<0.001	<0.001	0.011	NA	NA
Copper	0.018	<0.001	<0.001	0.034	0.052	47.000	<0.1
Cyanide	--	--	--	--	--	NA	--
Diethyl phthalate	--	--	--	--	--	NA	--
DIMP	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Dithiane	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Fluorene	--	--	--	--	--	NA	--
Hexachlorobenzene	--	--	--	<0.001	<0.001	NA	NA
Hexachloroethane	--	--	--	--	--	NA	--
Iron	0.485	0.089	0.148	2.333	3.054	NA	NA
Lead	0.004	0.010	0.001	0.117	0.132	3.850	<0.1
Magnesium	7.705	0.112	0.187	0.335	8.338	NA	NA
Manganese	0.196	0.006	0.003	0.010	0.215	997.000	<0.1
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.1
N-Nitrosodiphenylamine	--	--	--	--	--	NA	--
Nickel	0.020	<0.001	<0.001	0.002	0.023	77.400	<0.1
Nitroglycerin	--	--	--	--	--	NA	--
Phenol	--	--	--	--	--	NA	--
Pyrene	--	--	--	<0.001	<0.001	NA	NA
Selenium	0.006	<0.001	<0.001	<0.001	0.007	0.500	<0.1
Silver	<0.001	<0.001	<0.001	<0.001	0.001	NA	NA
Sodium	16.951	0.470	0.785	0.117	18.322	NA	NA
Tetrachloroethene	--	--	--	--	--	NA	--
Thallium	--	--	--	--	--	NA	--
Trichloroethene	0.440	0.009	0.003	<0.001	0.452	NA	NA
Vinyl chloride	0.003	<0.001	<0.001	<0.001	0.003	NA	NA
Zinc	0.876	0.060	0.003	0.223	1.164	14.500	<0.1

TABLE E.6 TBP: American Kestrel

Contaminant	Insect Contaminant Concentration (mg/kg)	Snake Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Insect Ingestion (mg/kg-d)	ADD from Snake Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	Total ADD (mg/kg-d)	Benchmark ADD (mg/kg-d)	HQ
1,1 Oxathlane	--	<0.001	0.002	<0.001	0.002	0.002	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
1,1,2,2-Tetrachloroethane	1.008	0.304	1.111	0.091	2.171	2.292	0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.006	0.010	NA	NA
1,1-Dichloroethene	0.084	<0.001	0.039	0.004	0.128	0.133	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
1,4-Dichlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	--
1,4-Dithiane	--	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
1,4-Oxathlane	--	<0.001	0.001	<0.001	0.001	0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
2,4,6-Trichloroaniline	7.900	0.049	3.626	0.334	12.104	12.488	0.009	<0.001	0.004	<0.001	0.004	0.004	--	0.022	NA	NA
2,4-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	--
2-Butanone	0.037	<0.001	0.017	0.002	0.057	0.058	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
2-Methylnaphthalene	0.007	<0.001	0.014	<0.001	0.026	0.087	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
2-Methylphenol	0.880	0.006	0.407	0.037	1.353	1.414	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	0.002	NA	NA
4,4'-DDE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--
4-Methylphenol	0.928	0.006	0.429	0.039	1.425	1.486	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	0.003	NA	NA
Acetone	0.266	0.004	0.125	0.012	0.409	0.410	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Aluminum	4.068	24.526	207.859	0.371	283.519	1,382.783	0.005	0.005	0.229	<0.001	0.100	0.486	0.024	0.848	109.700	<0.1
Antimony	5.511	0.176	6.994	0.234	14.473	38.842	0.006	<0.001	0.008	<0.001	0.005	0.014	<0.001	0.033	NA	NA
Aroclor 1248	0.003	<0.001	0.050	<0.001	0.039	0.039	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	0.180	<0.1
Arsenic	0.500	0.364	1.548	0.022	39.403	100.994	<0.001	<0.001	0.002	<0.001	0.014	0.035	<0.001	0.052	5.100	<0.1
Barium	0.725	0.465	5.055	0.037	55.315	118.197	<0.001	<0.001	0.006	<0.001	0.019	0.042	<0.001	0.068	20.800	<0.1
Benzo(b)fluoranthene	0.004	<0.001	0.013	<0.001	0.021	0.082	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Benzo(k)fluoranthene	0.004	<0.001	0.013	<0.001	0.021	0.082	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Cadmium	4.569	0.298	0.410	0.194	30.112	22.745	0.005	<0.001	<0.001	<0.001	0.011	0.008	<0.001	0.024	1.450	<0.1
Calcium	1,850.004	61.466	7,640.781	80.587	55,186.460	36,174.302	2.098	0.012	8.426	0.028	19.389	12.710	0.271	42.934	NA	NA
Carbon disulfide	0.026	<0.001	0.012	0.001	0.040	0.041	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Chloroethane	--	0.008	0.018	0.001	0.018	0.018	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Chloroform	0.035	<0.001	0.016	0.001	0.054	0.057	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Chromium	2.698	0.242	2.667	0.115	20.695	61.037	0.003	<0.001	0.003	<0.001	0.007	0.021	<0.001	0.035	1.000	<0.1
Cobalt	1.015	0.060	1.444	0.044	2.871	8.124	0.001	<0.001	0.002	<0.001	0.001	0.003	<0.001	0.007	NA	NA
Copper	43.799	1.920	156.531	1.860	906.237	801.539	0.050	<0.001	0.173	<0.001	0.318	0.282	<0.001	0.824	47.000	<0.1
Cyanide	1,620.000	9.625	730.080	68.589	2,463.859	2,469.698	1.837	0.002	0.805	0.024	0.868	0.868	--	4.401	NA	NA
Diethyl phthalate	0.734	0.005	0.348	0.031	1.140	1.237	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	0.002	NA	NA
DIMP	--	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Dithiane	--	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Fluorene	0.045	<0.001	0.032	0.002	0.084	0.145	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Hoxachlorobenzene	0.028	0.001	0.041	0.001	0.081	0.232	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Hoxachloroethane	0.027	<0.001	0.023	0.001	0.055	0.116	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Iron	145.000	61.787	1,566.710	8.136	2,834.314	10,038.506	0.164	0.012	1.728	0.003	0.986	3.527	0.240	6.669	NA	NA
Lead	9.884	23.876	1.433	0.436	10,882.207	11,575.499	0.011	0.004	0.002	<0.001	3.823	4.067	0.002	7.910	3.850	2.1
Magnesium	1,109.998	28.822	453.249	49.510	845.789	1,402.715	1.259	0.005	0.500	0.017	0.297	0.493	0.302	2.873	NA	NA
Manganese	46.900	1.020	22.067	2.026	37.080	84.838	0.053	<0.001	0.024	<0.001	0.013	0.030	0.005	0.126	997.000	<0.1
Mercury	0.002	0.003	0.292	<0.001	2.123	1.468	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.006	0.2
N-Nitrosodiphenylamine	0.188	0.001	0.096	0.008	0.300	0.361	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Nickel	5.070	0.102	3.059	0.216	8.750	12.860	0.006	<0.001	0.003	<0.001	0.003	0.005	<0.001	0.017	77.400	<0.1
Nitroglycerin	13.541	0.084	6.231	0.573	20.768	21.512	0.015	<0.001	0.007	<0.001	0.007	0.008	--	0.037	NA	NA
Phenol	1.738	0.011	0.793	0.074	2.656	2.717	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	--	0.005	NA	NA
Pyrene	0.010	<0.001	0.016	<0.001	0.031	0.091	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Selenium	9.256	0.064	4.230	0.392	14.156	14.502	0.010	<0.001	0.005	<0.001	0.005	0.005	<0.001	0.025	0.500	<0.1
Silver	62.850	0.389	28.661	2.661	96.043	98.081	0.071	<0.001	0.032	<0.001	0.034	0.034	<0.001	0.172	NA	NA
Sodium	3,800.000	110.593	1,141.280	171.449	180.051	2,499.954	4.309	0.021	1.259	0.060	0.063	0.878	1.269	7.859	NA	NA
Tetrachloroethene	0.304	0.002	0.146	0.013	0.474	0.523	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Thallium	4.825	0.034	2.345	0.204	7.569	8.507	0.005	<0.001	0.003	<0.001	0.003	0.003	--	0.014	NA	NA
Trichloroethene	1.142	0.799	1.067	0.088	2.277	2.413	0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.005	0.009	NA	NA
Vinyl chloride	--	0.011	0.018	0.001	0.018	0.018	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Zinc	242.009	15.776	1,569.634	10.291	11,039.414	7,723.387	0.274	0.003	1.731	0.004	3.878	2.714	0.005	8.609	14.500	0.6

TABLE E.7 TBP: Red-Tailed Hawk

Contaminant	Insect Contaminant Concentration (mg/kg)	Snake Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Contaminant Concentration (mg/kg)	Herbivorous Contaminant Concentration (mg/kg)	Omnivorous Contaminant Concentration (mg/kg)	ADD from Snake Ingestion (mg/kg-d)	ADD from Small Mammals Ingestion (mg/kg-d)	ADD from Rabbits Ingestion (mg/kg-d)	ADD from Insectivorous Birds Ingestion (mg/kg-d)	ADD from Herbivorous Birds Ingestion (mg/kg-d)	ADD from Omnivorous Birds Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	Total ADD (mg/kg-d)	Benchmark ADD (mg/kg-d)	HQ
1,1 Oxathiane	--	<0.001	0.002	<0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
1,1,2,2-Tetrachloroethane	1.008	0.304	1.111	0.091	2.171	2.292	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
1,1-Dichloroethane	0.084	<0.001	0.039	0.004	0.128	0.133	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
1,4-Dichlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA
1,4-Difluorene	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
2,4,6-Trichloroaniline	--	<0.001	0.001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
2,4,6-Trichlorotoluene	7.900	0.049	3.626	0.334	12.104	12.488	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
2,4-Dinitrotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA
2-Butanone	0.037	<0.001	0.017	0.002	0.057	0.058	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
2-Methylnaphthalene	0.007	<0.001	0.014	<0.001	0.026	0.087	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
2-Methylphenol	0.080	0.006	0.407	0.037	1.353	1.414	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
4,4'-DDE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.003	--
4-Methylphenol	0.028	0.006	0.429	0.039	1.425	1.486	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Acetone	0.206	0.004	0.125	0.012	0.409	0.410	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Aluminum	4.068	24.526	207.859	0.371	283.519	1,392.783	<0.001	<0.001	0.006	<0.001	0.002	0.008	0.002	0.047	109,700	<0.1
Antimony	5.511	0.176	6.994	0.234	14.473	38.842	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Aroclor 1248	0.003	<0.001	0.050	<0.001	0.011	0.039	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	0.180	<0.1
Arsenic	0.500	0.364	1.548	0.022	39.403	100.994	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	5,100	<0.1
Barium	0.725	0.465	5.055	0.037	55.315	118.197	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	20,800	<0.1
Benzofluoranthene	0.004	<0.001	0.013	<0.001	0.021	0.082	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Benzofluorethene	0.004	<0.001	0.013	<0.001	0.021	0.082	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Cadmium	4.569	0.298	61.468	0.194	30.112	22.745	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1,450	<0.1
Calcium	1,850,004	61,468	7,640,781	80,587	55,186,460	36,174,302	0.002	0.002	0.161	<0.001	0.328	0.214	0.025	1,771	NA	NA
Carbon disulfide	0.026	<0.001	0.012	0.001	0.040	0.041	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Chloroethane	--	0.008	0.018	0.001	0.018	0.018	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Chloroform	0.035	<0.001	0.016	0.001	0.054	0.057	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Chromium	2.898	0.242	2.667	0.115	20.695	61.037	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	1,000	<0.1
Cobalt	1.015	0.060	1.444	0.044	2.871	8.124	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Copper	43,709	1,920	150,531	1,860	906,237	801,539	<0.001	0.021	0.004	<0.001	0.005	0.005	<0.001	0.035	47,000	<0.1
Cyanide	1,620,000	9,825	730,080	68,589	2,463,859	2,463,859	<0.001	0.100	0.007	<0.001	0.015	0.015	--	0.136	NA	NA
Diethyl phthalate	0.734	0.005	0.348	0.031	1.140	1.237	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
DMP	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Dihlone	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Fluorene	0.045	<0.001	0.032	0.002	0.084	0.145	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Hexachlorobenzene	0.028	0.001	0.041	0.001	0.081	0.232	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Hexachloroethane	0.027	<0.001	0.023	0.001	0.055	0.116	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Iron	145,000	61,787	1,566,710	8,136	2,834,314	10,038,506	0.002	0.214	0.044	<0.001	0.017	0.059	0.022	0.357	NA	NA
Lead	9.884	23,876	1,433	0.435	10,882,207	11,575,489	<0.001	<0.001	0.052	<0.001	0.064	0.068	<0.001	0.186	3,850	<0.1
Magnesium	1,109,998	28,822	453,240	45,510	845,769	1,402,715	<0.001	0.062	0.003	<0.001	0.005	0.008	0.027	0.107	NA	NA
Manganese	46,900	1,020	22,067	2,026	37,090	84,838	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	997,000	<0.1
Mercury	0.002	0.003	0.292	<0.001	2.123	1,468	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	<0.1
N-Nitrosodiphenylamine	0.188	0.001	0.095	0.008	0.300	0.361	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Nickel	5,070	0.102	3,059	0.216	8,750	12,860	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	77,400	<0.1
Nitroguaiacol	13,541	0.084	6.231	0.573	20,768	21,512	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	0.001	NA	NA
Phenol	1,738	0.011	0.793	0.074	2,658	2,717	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Pyrene	0.010	<0.001	0.016	<0.001	0.031	0.091	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Selenium	9,256	0.064	4,230	0.392	14,156	14,502	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.500	<0.1
Silver	62,850	0.389	28,661	2,661	96,043	98,081	<0.001	0.004	<0.001	0.001	0.001	0.015	0.115	0.292	NA	NA
Sodium	3,800,000	110,593	1,141,280	171,449	180,051	2,499,954	0.003	0.156	0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Tetrachloroethene	0.304	0.002	0.146	0.013	0.474	0.523	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Thallium	4,825	0.034	2,345	0.204	7,569	8,507	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	NA	NA
Trichloroethene	1,142	0.799	1,067	0.088	2,277	2,413	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Vinyl chloride	--	0.011	0.016	0.001	0.018	0.018	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Zinc	242,009	15,776	1,569,634	10,291	11,039,414	7,723,397	<0.001	0.214	0.035	<0.001	0.065	0.046	<0.001	0.381	14,500	<0.1

TABLE E.8 TBP: American Robin

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	Total ADD (mg/kg-d)	Benchmark ADD (mg/kg-d)	HQ
1,1 Oxathiane	--	--	--	--	0.002	--	0.002	NA	NA
1,1,2,2-Tetrachloroethane	1.008	1.008	0.613	0.919	0.609	0.152	2.292	NA	NA
1,1-Dichloroethene	0.084	0.084	0.051	0.076	--	0.006	0.133	NA	NA
1,4-Dichlorobenzene	--	--	--	--	--	--	--	NA	--
1,4-Dithiane	--	--	--	--	<0.001	--	<0.001	NA	NA
1,4-Oxathiane	--	--	--	--	0.001	--	0.001	NA	NA
2,4,6-Trichloroaniline	7.900	7.900	4.803	7.205	--	0.480	12.488	NA	NA
2,4-Dinitrotoluene	--	--	--	--	--	--	--	NA	--
2-Butanone	0.037	0.037	0.022	0.034	--	0.002	0.058	NA	NA
2-Methylnaphthalene	0.007	0.007	0.004	0.006	--	0.076	0.087	NA	NA
2-Methylphenol	0.880	0.880	0.535	0.803	--	0.076	1.414	NA	NA
4,4'-DDE	--	--	--	--	--	--	--	0.003	--
4-Methylphenol	0.928	0.928	0.564	0.846	--	0.076	1.486	NA	NA
Acetone	0.266	0.266	0.162	0.243	0.004	0.001	0.410	NA	NA
Aluminum	4.068	4.068	2.473	3.710	2.520	1,374.080	1,382.783	109.700	12.6
Antimony	5.511	5.511	3.351	5.026	0.005	30.461	38.842	NA	NA
Aroclor 1248	0.003	0.003	0.002	0.002	--	0.035	0.039	0.180	0.2
Arsenic	0.500	14.400	0.304	13.133	0.005	87.552	100.994	5.100	19.8
Barium	0.725	23.700	0.441	21.614	0.078	96.064	118.197	20.800	5.7
Benzo(b)fluoranthene	0.004	0.004	0.002	0.003	--	0.076	0.082	NA	NA
Benzo(k)fluoranthene	0.004	0.004	0.002	0.003	--	0.076	0.082	NA	NA
Cadmium	4.569	19.525	2.778	17.807	0.002	2.158	22.745	1.450	15.7
Calcium	1,850.004	36,000.000	1,124.802	32,832.000	28.700	2,188.800	36,174.302	NA	NA
Carbon disulfide	0.026	0.026	0.016	0.023	--	0.002	0.041	NA	NA
Chloroethane	--	--	--	--	0.018	--	0.018	NA	NA
Chloroform	0.035	0.035	0.021	0.032	--	0.003	0.057	NA	NA
Chromium	2.698	6.585	1.640	6.006	0.009	53.382	61.037	1.000	61.0
Cobalt	1.015	1.015	0.617	0.926	0.015	6.566	8.124	NA	NA
Copper	43.799	561.600	26.630	512.179	0.074	262.656	801.539	47.000	17.1
Cyanide	1,620.000	1,620.000	984.960	1,477.440	--	7.296	2,469.696	NA	NA
Diethyl phthalate	0.734	0.734	0.446	0.669	--	0.122	1.237	NA	NA
DIMP	--	--	--	--	<0.001	--	<0.001	NA	NA
Dithiane	--	--	--	--	<0.001	--	<0.001	NA	NA
Fluorene	0.045	0.045	0.028	0.041	--	0.076	0.145	NA	NA
Hexachlorobenzene	0.028	0.028	0.017	0.026	--	0.188	0.232	NA	NA
Hexachloroethane	0.027	0.027	0.016	0.024	--	0.076	0.116	NA	NA
Iron	145.000	616.000	88.160	561.792	25.354	9,363.200	10,038.506	NA	NA
Lead	9.884	6,405.600	6.009	5,841.907	0.223	5,727.360	11,575.499	3.850	3,006.6
Magnesium	1,109.998	504.400	674.879	460.013	31.920	235.904	1,402.715	NA	NA
Manganese	46.900	18.990	28.515	17.319	0.518	38.486	84.838	997.000	0.1
Mercury	0.002	1.368	0.002	1.248	<0.001	0.219	1.468	0.006	229.4
N-Nitrosodiphenylamine	0.188	0.188	0.114	0.171	--	0.076	0.361	NA	NA
Nickel	5.070	5.070	3.083	4.624	0.016	5.138	12.860	77.400	0.2
Nitroglycerin	13.541	13.541	8.233	12.349	--	0.930	21.512	NA	NA
Phenol	1.738	1.738	1.056	1.585	--	0.076	2.717	NA	NA
Pyrene	0.010	0.010	0.006	0.009	--	0.076	0.091	NA	NA
Selenium	9.256	9.256	5.628	8.441	<0.001	0.433	14.502	0.500	29.0
Silver	62.850	62.850	38.213	57.319	0.001	2.548	98.081	NA	NA
Sodium	3,800.000	26.050	2,310.400	23.758	134.120	31.677	2,499.954	NA	NA
Tetrachloroethene	0.304	0.304	0.185	0.277	--	0.061	0.523	NA	NA
Thallium	4.825	4.825	2.934	4.400	--	1.173	8.507	NA	NA
Trichloroethene	1.142	1.142	0.695	1.042	0.506	0.170	2.413	NA	NA
Vinyl chloride	--	--	--	--	0.018	--	0.018	NA	NA
Zinc	242.009	7,120.000	147.141	6,493.440	0.566	1,082.240	7,723.387	14.500	532.6

TABLE E.9 TBP: Tree Swallow

Contaminant	Insect Contaminant Concentration (mg/kg)	ADD from Insect Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Benchmark ADD (mg/kg-d)	HQ
1,1 Oxathiane	--	--	<0.001	--	<0.001	NA	NA
1,1,2,2-Tetrachloroethane	1.008	0.043	0.048	0.043	0.091	NA	NA
1,1-Dichloroethene	0.084	0.004	--	0.004	0.004	NA	NA
1,4-Dichlorobenzene	--	--	--	--	--	NA	--
1,4-Dithiane	--	--	<0.001	--	<0.001	NA	NA
1,4-Oxathiane	--	--	<0.001	--	<0.001	NA	NA
2,4,6-Trichloroaniline	7.900	0.334	--	0.334	0.334	NA	NA
2,4-Dinitrotoluene	--	--	--	--	--	NA	--
2-Butanone	0.037	0.002	--	0.002	0.002	NA	NA
2-Methylnaphthalene	0.007	<0.001	--	<0.001	<0.001	NA	NA
2-Methylphenol	0.880	0.037	--	0.037	0.037	NA	NA
4,4'-DDE	--	--	--	--	--	0.003	--
4-Methylphenol	0.928	0.039	--	0.039	0.039	NA	NA
Acetone	0.266	0.011	<0.001	0.011	0.012	NA	NA
Aluminum	4.068	0.172	0.198	0.172	0.371	109.700	<0.1
Antimony	5.511	0.233	<0.001	0.233	0.234	NA	NA
Aroclor 1248	0.003	<0.001	--	<0.001	<0.001	0.180	<0.1
Arsenic	0.500	0.021	<0.001	0.021	0.022	5.100	<0.1
Barium	0.725	0.031	0.006	0.031	0.037	20.800	<0.1
Benzo(b)fluoranthene	0.004	<0.001	--	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	0.004	<0.001	--	<0.001	<0.001	NA	NA
Cadmium	4.569	0.193	<0.001	0.193	0.194	1.450	0.1
Calcium	1,850.004	78.327	2.260	78.327	80.587	NA	NA
Carbon disulfide	0.026	0.001	--	0.001	0.001	NA	NA
Chloroethane	--	--	0.001	--	0.001	NA	NA
Chloroform	0.035	0.001	--	0.001	0.001	NA	NA
Chromium	2.698	0.114	<0.001	0.114	0.115	1.000	0.1
Cobalt	1.015	0.043	0.001	0.043	0.044	NA	NA
Copper	43.799	1.854	0.006	1.854	1.860	47.000	<0.1
Cyanide	1,620.000	68.589	--	68.589	68.589	NA	NA
Diethyl phthalate	0.734	0.031	--	0.031	0.031	NA	NA
DIMP	--	--	<0.001	--	<0.001	NA	NA
Dithiane	--	--	<0.001	--	<0.001	NA	NA
Fluorene	0.045	0.002	--	0.002	0.002	NA	NA
Hexachlorobenzene	0.028	0.001	--	0.001	0.001	NA	NA
Hexachloroethane	0.027	0.001	--	0.001	0.001	NA	NA
Iron	145.000	6.139	1.997	6.139	8.136	NA	NA
Lead	9.884	0.418	0.018	0.418	0.436	3.850	0.1
Magnesium	1,109.998	46.996	2.514	46.996	49.510	NA	NA
Manganese	46.900	1.986	0.041	1.986	2.026	997.000	<0.1
Mercury	0.002	<0.001	<0.001	<0.001	<0.001	0.006	<0.1
N-Nitrosodiphenylamine	0.188	0.008	--	0.008	0.008	NA	NA
Nickel	5.070	0.215	0.001	0.215	0.216	77.400	<0.1
Nitroglycerin	13.541	0.573	--	0.573	0.573	NA	NA
Phenol	1.738	0.074	--	0.074	0.074	NA	NA
Pyrene	0.010	<0.001	--	<0.001	<0.001	NA	NA
Selenium	9.256	0.392	<0.001	0.392	0.392	0.500	0.8
Silver	62.850	2.661	<0.001	2.661	2.661	NA	NA
Sodium	3,800.000	160.887	10.562	160.887	171.449	NA	NA
Tetrachloroethene	0.304	0.013	--	0.013	0.013	NA	NA
Thallium	4.825	0.204	--	0.204	0.204	NA	NA
Trichloroethene	1.142	0.048	0.040	0.048	0.088	NA	NA
Vinyl chloride	--	--	0.001	--	0.001	NA	NA
Zinc	242.009	10.246	0.045	10.246	10.291	14.500	0.7

TABLE E.10 TBP: Mallard

Contaminant	Water Invertebrate Contaminant Concentration (mg/kg)	Sediment Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Water Invertebrate Ingestion (mg/kg-d)	ADD from Sediment Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Sediment Ingestion (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	Total ADD (mg/kg-d)	Benchmark ADD (mg/kg-d)	HQ
1,1 Oxathlane	0.004	--	--	<0.001	--	--	<0.001	--	--	<0.001	NA	NA
1,1,2,2-Tetrachloroethane	0.004	0.023	1.008	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	0.003	NA	NA
1,1-Dichloroethene	--	--	0.084	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
1,4-Dichlorobenzene	--	0.332	--	--	<0.001	--	--	<0.001	--	<0.001	NA	NA
1,4-Dihlpane	<0.001	--	--	<0.001	--	--	<0.001	--	--	<0.001	NA	NA
1,4-Oxathlane	0.003	--	--	<0.001	--	--	<0.001	--	--	<0.001	NA	NA
2,4,6-Trichloroaniline	--	--	7.900	--	--	0.003	--	--	<0.001	0.004	NA	NA
2,4-Dinitrotoluene	--	2.110	--	--	0.001	--	--	<0.001	--	0.001	NA	NA
2-Butanone	--	0.200	0.037	--	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
2-Methylnaphthalene	--	--	0.007	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
2-Methylphenol	--	--	0.880	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
4,4'-DDE	--	0.009	--	--	<0.001	--	--	<0.001	--	<0.001	0.003	<0.1
4-Methylphenol	--	--	0.928	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Acetone	0.004	0.200	0.266	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Aluminum	1,205.916	26,900.000	4.068	0.752	16.780	0.002	0.009	0.895	0.752	19.190	109.700	0.2
Antimony	<0.001	15.900	5.511	<0.001	0.010	0.002	<0.001	<0.001	0.017	0.029	NA	NA
Aroclor 1248	--	--	0.003	--	--	<0.001	--	--	<0.001	<0.001	0.180	<0.1
Arsenic	0.179	14.100	14.400	<0.001	0.009	0.006	<0.001	<0.001	0.048	0.063	5.100	<0.1
Barium	145.911	927.000	23.700	0.091	0.578	0.010	<0.001	0.031	0.053	0.763	20.800	<0.1
Benzo(b)fluoranthene	--	--	0.004	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	--	--	0.004	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Cadmium	38.863	7.040	19.525	0.024	0.004	0.008	<0.001	<0.001	0.001	0.038	1.450	<0.1
Calcium	59.455	5,720.000	36,000.000	0.037	3.568	14.971	0.108	0.190	1.198	20.072	NA	NA
Carbon disulfide	--	--	0.026	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Chloroethane	0.261	--	--	<0.001	--	--	<0.001	--	--	<0.001	NA	NA
Chloroform	--	--	0.035	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Chromium	3.608	80.200	6.585	0.002	0.050	0.003	<0.001	0.003	0.029	0.087	1.000	<0.1
Cobalt	<0.001	9.000	1.015	<0.001	0.006	<0.001	<0.001	<0.001	0.004	0.010	NA	NA
Copper	0.152	515.000	561.600	<0.001	0.321	0.234	<0.001	0.017	0.144	0.716	47.000	<0.1
Cyanide	--	--	1,620.000	--	--	0.674	--	--	0.004	0.678	NA	NA
Diethyl phthalate	--	--	0.734	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
DIMP	<0.001	--	--	<0.001	--	--	<0.001	--	--	<0.001	NA	NA
Dihlpane	0.001	--	--	<0.001	--	--	<0.001	--	--	<0.001	NA	NA
Fluorene	--	--	0.045	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Hexachlorobenzene	--	0.361	0.028	--	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Hexachloroethane	--	--	0.027	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Iron	52.523	35,600.000	616.000	0.033	22.207	0.256	0.095	1.184	5.123	28.899	NA	NA
Lead	8.070	1,780.000	6,405.600	0.005	1.110	2.664	<0.001	0.059	3.134	6.973	3.850	1.8
Magnesium	66.125	5,110.000	504.400	0.041	3.188	0.210	0.120	0.170	0.129	3.858	NA	NA
Manganese	1.073	160.000	18.990	<0.001	0.100	0.008	0.002	0.005	0.021	0.137	997.000	<0.1
Mercury	11.666	1.710	1.368	0.007	0.001	<0.001	<0.001	<0.001	<0.001	0.009	0.006	1.4
N-Nitrosodiphenylamine	--	--	0.188	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Nickel	3.566	35.200	5.070	0.002	0.022	0.002	<0.001	0.001	0.003	0.030	77.400	<0.1
Nitroglycerin	--	--	13.541	--	--	0.006	--	--	<0.001	0.006	NA	NA
Phenol	--	--	1.738	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Pyrene	--	0.362	0.010	--	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Selenium	28.468	1.760	9.256	0.018	0.001	0.004	<0.001	<0.001	<0.001	0.023	0.500	<0.1
Silver	<0.001	3.740	62.850	<0.001	0.002	0.026	<0.001	<0.001	0.001	0.030	NA	NA
Sodium	277.842	1,780.000	26.050	0.173	1.110	0.011	0.505	0.059	0.017	1.876	NA	NA
Tetrachloroethene	--	--	0.304	--	--	<0.001	--	--	<0.001	<0.001	NA	NA
Thallium	--	--	4.825	--	--	0.002	--	--	<0.001	0.003	NA	NA
Trichloroethene	42.629	0.029	1.142	0.027	<0.001	<0.001	0.002	<0.001	<0.001	0.029	NA	NA
Vinyl chloride	0.231	0.054	--	<0.001	<0.001	--	<0.001	<0.001	--	<0.001	NA	NA
Zinc	117,169.374	3,410.000	7,120.000	73.089	2.127	2.961	0.002	0.113	0.592	78.885	14.500	5.4

TABLE E.11 TBP: White-Footed Mouse

Contaminant	Insect	Vegetation	ADD from		ADD from	ADD from	ADD from	Benchmark ADD (mg/kg-d)	HQ
	Contaminant Concentration (mg/kg)	Contaminant Concentration (mg/kg)	Insect Ingestion (mg/k-d)	Vegetation Ingestion (mg/kg-d)	Drinking Water (mg/kg-d)	Soil Ingestion (mg/kg-d)	Total ADD (mg/kg-d)		
1,1 Oxathiane	--	--	--	--	0.002	--	0.002	NA	NA
1,1,2,2-Tetrachloroethane	1.008	1.008	0.263	0.190	0.635	0.023	1.111	NA	NA
1,1-Dichloroethene	0.084	0.084	0.022	0.016	--	<0.001	0.039	59.900	<0.1
1,4-Dichlorobenzene	--	--	--	--	--	--	--	NA	--
1,4-Dithiane	--	--	--	--	<0.001	--	<0.001	NA	NA
1,4-Oxathiane	--	--	--	--	0.001	--	0.001	NA	NA
2,4,6-Trichloroaniline	7.900	7.900	2.062	1.493	--	0.071	3.626	NA	NA
2,4-Dinitrotoluene	--	--	--	--	--	--	--	NA	--
2-Butanone	0.037	0.037	0.010	0.007	--	<0.001	0.017	NA	NA
2-Methylnaphthalene	0.007	0.007	0.002	0.001	--	0.011	0.014	NA	NA
2-Methylphenol	0.880	0.880	0.230	0.166	--	0.011	0.407	NA	NA
4,4'-DDE	--	--	--	--	--	--	--	NA	--
4-Methylphenol	0.928	0.928	0.242	0.175	--	0.011	0.429	NA	NA
Acetone	0.266	0.266	0.069	0.050	0.005	<0.001	0.125	20.000	<0.1
Aluminum	4.068	4.068	1.062	0.769	2.628	203.400	207.859	2.086	99.6
Antimony	5.511	5.511	1.438	1.042	0.005	4.509	6.994	0.135	51.8
Aroclor 1248	0.003	0.003	<0.001	<0.001	--	0.005	0.006	0.179	<0.1
Arsenic	0.500	14.400	0.130	2.722	0.005	12.960	15.817	0.136	116.3
Barium	0.725	23.700	0.189	4.479	0.082	14.220	18.970	13.550	1.4
Benzo(b)fluoranthene	0.004	0.004	<0.001	<0.001	--	0.011	0.013	NA	NA
Benzo(k)fluoranthene	0.004	0.004	<0.001	<0.001	--	0.011	0.013	NA	NA
Cadmium	4.569	19.525	1.192	3.690	0.002	0.320	5.204	1.926	2.7
Calcium	1,850.004	36,000.000	482.851	6,804.000	29.930	324.000	7,640.781	NA	NA
Carbon disulfide	0.026	0.026	0.007	0.005	--	<0.001	0.012	NA	NA
Chloroethane	--	--	--	--	0.018	--	0.018	NA	NA
Chloroform	0.035	0.035	0.009	0.007	--	<0.001	0.016	30.000	<0.1
Chromium	2.698	6.585	0.704	1.245	0.009	7.902	9.860	6.550	1.5
Cobalt	1.015	1.015	0.265	0.192	0.015	0.972	1.444	NA	NA
Copper	43.799	561.600	11.432	106.142	0.077	38.880	156.531	30.400	5.1
Cyanide	1,620.000	1,620.000	422.820	306.180	--	1.080	730.080	128.900	5.7
Diethyl phthalate	0.734	0.734	0.192	0.139	--	0.018	0.348	4,953.000	<0.1
DIMP	--	--	--	--	<0.001	--	<0.001	NA	NA
Dithiane	--	--	--	--	<0.001	--	<0.001	NA	NA
Fluorene	0.045	0.045	0.012	0.009	--	0.011	0.032	NA	NA
Hexachlorobenzene	0.028	0.028	0.007	0.005	--	0.028	0.041	NA	NA
Hexachloroethane	0.027	0.027	0.007	0.005	--	0.011	0.023	NA	NA
Iron	145.000	616.000	37.845	116.424	26.441	1,386.000	1,566.710	NA	NA
Lead	9.884	6,405.600	2.580	1,210.658	0.232	847.800	2,061.270	15.980	129.0
Magnesium	1,109.998	504.400	289.709	95.332	33.288	34.920	453.249	NA	NA
Manganese	46.900	18.990	12.241	3.589	0.540	5.697	22.067	176.000	0.1
Mercury	0.002	1.368	<0.001	0.259	<0.001	0.032	0.292	0.064	4.6
N-Nitrosodiphenylamine	0.188	0.188	0.049	0.035	--	0.011	0.096	NA	NA
Nickel	5.070	5.070	1.323	0.958	0.017	0.761	3.059	79.890	<0.1
Nitroglycerin	13.541	13.541	3.534	2.559	--	0.138	6.231	NA	NA
Phenol	1.738	1.738	0.453	0.328	--	0.011	0.793	NA	NA
Pyrene	0.010	0.010	0.003	0.002	--	0.011	0.016	NA	NA
Selenium	9.256	9.256	2.416	1.749	<0.001	0.064	4.230	0.399	10.6
Silver	62.850	62.850	16.404	11.879	0.001	0.377	28.661	NA	NA
Sodium	3,800.000	26.050	991.800	4.923	139.868	4.689	1,141.280	NA	NA
Tetrachloroethene	0.304	0.304	0.079	0.057	--	0.009	0.146	NA	NA
Thallium	4.825	4.825	1.259	0.912	--	0.174	2.345	NA	NA
Trichloroethene	1.142	1.142	0.298	0.216	0.528	0.025	1.067	0.756	1.4
Vinyl chloride	--	--	--	--	0.018	--	0.018	0.340	<0.1
Zinc	242.009	7,120.000	63.164	1,345.680	0.590	160.200	1,569.634	319.500	4.9

TABLE E.12 TBP: Muskrat

Contaminant	Sed Vegetation Contaminant Concentration (mg/kg)	SW Vegetation Contaminant Concentration (mg/kg)	ADD from Sediment Vegetation Ingestion (mg/kg-d)	ADD from SW Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Sediment Ingestion (mg/kg-d)	Total ADD (mg/kg-d)	Benchmark ADD (mg/kg-d)	HQ
1,1 Oxathiane	--	0.012	--	0.002	0.001	--	0.003	NA	NA
1,1,2,2-Tetrachloroethane	0.009	14.304	0.002	2.432	0.417	<0.001	2.851	NA	NA
1,1-Dichloroethene	--	--	--	--	--	--	--	18.854	--
1,4-Dichlorobenzene	0.003	--	<0.001	--	--	0.006	0.006	NA	NA
1,4-Dithiane	--	0.002	--	<0.001	<0.001	--	<0.001	NA	NA
1,4-Oxathiane	--	0.010	--	0.002	<0.001	--	0.003	NA	NA
2,4,6-Trichloroaniline	--	--	--	--	--	--	--	NA	NA
2,4-Dinitrotoluene	1.426	--	0.242	--	--	0.036	0.278	NA	NA
2-Butanone	0.200	--	0.034	--	--	0.003	0.037	NA	NA
2-Methylnaphthalene	--	--	--	--	--	--	--	NA	NA
2-Methylphenol	1.126	--	0.191	--	--	--	0.191	NA	NA
4,4'-DDE	<0.001	--	<0.001	--	--	<0.001	<0.001	NA	NA
4-Methylphenol	--	--	--	--	--	--	--	NA	NA
Acetone	2.660	0.035	0.452	0.006	0.003	0.003	0.465	7.440	<0.1
Aluminum	7.700	134.676	1.309	22.895	1.728	457.300	483.232	0.540	894.9
Antimony	0.175	0.246	0.030	0.042	0.003	0.270	0.345	0.047	7.3
Aroclor 1248	--	--	--	--	--	--	--	0.019	--
Arsenic	0.120	0.272	0.020	0.046	0.003	0.240	0.310	0.038	8.2
Barium	4.700	4.182	0.799	0.711	0.054	15.759	17.323	3.416	5.1
Benzo(b)fluoranthene	--	--	--	--	--	--	--	NA	NA
Benzo(k)fluoranthene	--	--	--	--	--	--	--	NA	NA
Cadmium	3.872	0.100	0.658	0.017	0.001	0.120	0.796	0.057	14.1
Calcium	841.000	205.000	142.970	34.850	19.680	97.240	294.740	NA	NA
Carbon disulfide	--	--	--	--	--	--	--	NA	NA
Chloroethane	--	0.070	--	0.012	0.012	--	0.024	NA	NA
Chloroform	--	--	--	--	--	--	--	9.427	--
Chromium	0.910	0.485	0.155	0.082	0.006	1.363	1.607	2.057	0.8
Cobalt	0.500	0.778	0.085	0.132	0.010	0.153	0.380	NA	NA
Copper	3.100	3.928	0.527	0.668	0.050	8.755	10.000	10.408	1.0
Cyanide	--	--	--	--	--	--	--	44.700	--
Diethyl phthalate	--	--	--	--	--	--	--	1,280.212	--
DIMP	--	<0.001	--	<0.001	<0.001	--	<0.001	NA	NA
Dithiane	--	0.004	--	<0.001	<0.001	--	<0.001	NA	NA
Fluorene	--	--	--	--	--	--	--	NA	NA
Hexachlorobenzene	0.003	--	<0.001	--	--	0.006	0.007	NA	NA
Hexachloroethane	--	--	--	--	--	--	--	NA	NA
Iron	22.000	1,354.990	3.740	230.348	17.386	605.200	856.674	NA	NA
Lead	0.580	11.896	0.099	2.022	0.153	30.260	32.534	5.030	6.5
Magnesium	509.000	1,705.896	86.530	290.002	21.888	86.870	485.290	NA	NA
Manganese	39.500	27.683	6.715	4.706	0.355	2.720	14.496	55.298	0.3
Mercury	0.650	0.013	0.110	0.002	<0.001	0.029	0.142	0.004	37.6
N-Nitrosodiphenylamine	--	--	--	--	--	--	--	NA	NA
Nickel	1.000	0.868	0.170	0.148	0.011	0.598	0.927	25.139	<0.1
Nitroglycerin	--	--	--	--	--	--	--	NA	NA
Phenol	--	--	--	--	--	--	--	NA	NA
Pyrene	0.003	--	<0.001	--	--	0.006	0.007	NA	NA
Selenium	0.110	0.025	0.019	0.004	<0.001	0.030	0.053	0.139	0.4
Silver	5.610	0.057	0.954	0.010	<0.001	0.064	1.028	NA	NA
Sodium	668.000	7,167.756	113.560	1,218.519	91.968	30.260	1,454.307	NA	NA
Tetrachloroethene	--	--	--	--	--	--	--	NA	NA
Thallium	--	--	--	--	--	--	--	NA	NA
Trichloroethene	0.012	1.387	0.002	0.236	0.347	<0.001	0.585	0.198	3.0
Vinyl chloride	0.083	0.072	0.014	0.012	0.012	<0.001	0.039	0.104	0.4
Zinc	26.900	30.227	4.573	5.139	0.388	57.970	68.069	100.546	0.7

TABLE E.13 TBP: Eastern Cottontail

Contaminant	Vegetation Contaminant Concentration (mg/kg)	Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	Total ADD (mg/kg-d)	Benchmark	
						ADD (mg/kg-d)	HQ
1,1 Oxathiane	--	--	<0.001	--	<0.001	NA	NA
1,1,2,2-Tetrachloroethane	1.008	0.155	0.163	0.024	0.342	NA	NA
1,1-Dichloroethene	0.084	0.013	--	<0.001	0.014	22.000	<0.1
1,4-Dichlorobenzene	--	--	--	--	--	NA	--
1,4-Dithiane	--	--	<0.001	--	<0.001	NA	NA
1,4-Oxathiane	--	--	<0.001	--	<0.001	NA	NA
2,4,6-Trichloroaniline	7.900	1.215	--	0.077	1.292	NA	NA
2,4-Dinitrotoluene	--	--	--	--	--	NA	--
2-Butanone	0.037	0.006	--	<0.001	0.006	NA	NA
2-Methylnaphthalene	0.007	0.001	--	0.012	0.013	NA	NA
2-Methylphenol	0.880	0.135	--	0.012	0.147	NA	NA
4,4'-DDE	--	--	--	--	--	NA	--
4-Methylphenol	0.928	0.143	--	0.012	0.155	NA	NA
Acetone	0.266	0.041	0.001	<0.001	0.042	7.300	<0.1
Aluminum	4.068	0.626	0.675	218.977	220.278	0.767	287.2
Antimony	5.511	0.848	0.001	4.854	5.703	0.050	114.1
Aroclor 1248	0.003	<0.001	--	0.006	0.006	0.066	<0.1
Arsenic	14.400	2.215	0.001	13.952	16.169	0.050	323.4
Barium	23.700	3.645	0.021	15.309	18.975	4.000	4.7
Benzo(b)fluoranthene	0.004	<0.001	--	0.012	0.013	NA	NA
Benzo(k)fluoranthene	0.004	<0.001	--	0.012	0.013	NA	NA
Cadmium	19.525	3.003	<0.001	0.344	3.347	0.709	4.7
Calcium	36,000.000	5,536.705	7.692	348.812	5,893.210	NA	NA
Carbon disulfide	0.026	0.004	--	<0.001	0.004	NA	NA
Chloroethane	--	--	0.005	--	0.005	NA	NA
Chloroform	0.035	0.005	--	<0.001	0.006	11.000	<0.1
Chromium	6.585	1.013	0.002	8.507	9.522	2.410	4.0
Cobalt	1.015	0.156	0.004	1.046	1.206	NA	NA
Copper	561.600	86.373	0.020	41.857	128.250	11.200	11.5
Cyanide	1,620.000	249.152	--	1.163	250.314	47.400	5.3
Diethyl phthalate	0.734	0.113	--	0.019	0.132	1,822.000	<0.1
DIMP	--	--	<0.001	--	<0.001	NA	NA
Dithiane	--	--	<0.001	--	<0.001	NA	NA
Fluorene	0.045	0.007	--	0.012	0.019	NA	NA
Hexachlorobenzene	0.028	0.004	--	0.030	0.034	NA	NA
Hexachloroethane	0.027	0.004	--	0.012	0.016	NA	NA
Iron	616.000	94.739	6.796	1,492.142	1,593.677	NA	NA
Lead	6,405.600	985.164	0.060	912.726	1,897.950	5.880	322.8
Magnesium	504.400	77.575	8.555	37.594	123.725	NA	NA
Manganese	18.990	2.921	0.139	6.133	9.193	65.000	0.1
Mercury	1.368	0.210	<0.001	0.035	0.245	0.024	10.2
N-Nitrosodiphenylamine	0.188	0.029	--	0.012	0.041	NA	NA
Nickel	5.070	0.780	0.004	0.819	1.603	29.400	<0.1
Nitroglycerin	13.541	2.082	--	0.148	2.231	NA	NA
Phenol	1.738	0.267	--	0.012	0.279	NA	NA
Pyrene	0.010	0.002	--	0.012	0.014	NA	NA
Selenium	9.256	1.424	<0.001	0.069	1.493	0.147	10.2
Silver	62.850	9.666	<0.001	0.406	10.072	NA	NA
Sodium	26.050	4.006	35.948	5.048	45.002	NA	NA
Tetrachloroethene	0.304	0.047	--	0.010	0.056	NA	NA
Thallium	4.825	0.742	--	0.187	0.929	NA	NA
Trichloroethene	1.142	0.176	0.136	0.027	0.338	0.278	1.2
Vinyl chloride	--	--	0.005	--	0.005	0.125	<0.1
Zinc	7,120.000	1,095.037	0.152	172.468	1,267.657	117.600	10.8

TABLE E.14 TBP: White-Tailed Deer

Contaminant	Vegetation Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil		Benchmark ADD (mg/kg-d)	HQ
				Ingestion (mg/kg-d)	Total ADD (mg/kg-d)		
1,1 Oxathiane	--	--	<0.001	--	<0.001	NA	NA
1,1,2,2-Tetrachloroethane	1.008	0.005	0.007	<0.001	0.011	NA	NA
1,1-Dichloroethene	0.084	<0.001	--	<0.001	<0.001	8.400	<0.1
1,4-Dichlorobenzene	--	--	--	--	--	NA	--
1,4-Dithiane	--	--	<0.001	--	<0.001	NA	NA
1,4-Oxathiane	--	--	<0.001	--	<0.001	NA	NA
2,4,6-Trichloroaniline	7.900	0.035	--	<0.001	0.036	NA	NA
2,4-Dinitrotoluene	--	--	--	--	--	NA	--
2-Butanone	0.037	<0.001	--	<0.001	<0.001	NA	NA
2-Methylnaphthalene	0.007	<0.001	--	<0.001	<0.001	NA	NA
2-Methylphenol	0.880	0.004	--	<0.001	0.004	NA	NA
4,4'-DDE	--	--	--	--	--	NA	--
4-Methylphenol	0.928	0.004	--	<0.001	0.004	NA	NA
Acetone	0.266	0.001	<0.001	<0.001	0.001	2.800	<0.1
Aluminum	4.068	0.018	0.028	2.022	2.068	0.293	7.1
Antimony	5.511	0.025	<0.001	0.045	0.070	0.019	3.7
Aroclor 1248	0.003	<0.001	--	<0.001	<0.001	0.005	<0.1
Arsenic	14.400	0.064	<0.001	0.129	0.193	0.019	10.2
Barium	23.700	0.106	<0.001	0.141	0.248	1.500	0.2
Benzo(b)fluoranthene	0.004	<0.001	--	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	0.004	<0.001	--	<0.001	<0.001	NA	NA
Cadmium	19.525	0.087	<0.001	0.003	0.091	0.271	0.3
Calcium	36,000.000	161.047	0.316	3.221	164.584	NA	NA
Carbon disulfide	0.026	<0.001	--	<0.001	<0.001	NA	NA
Chloroethane	--	--	<0.001	--	<0.001	NA	NA
Chloroform	0.035	<0.001	--	<0.001	<0.001	4.200	<0.1
Chromium	6.585	0.029	<0.001	0.079	0.108	0.920	0.1
Cobalt	1.015	0.005	<0.001	0.010	0.014	NA	NA
Copper	561.600	2.512	<0.001	0.387	2.900	4.300	0.7
Cyanide	1,620.000	7.247	--	0.011	7.258	18.100	0.4
Diethyl phthalate	0.734	0.003	--	<0.001	0.003	696.000	<0.1
DIMP	--	--	<0.001	--	<0.001	NA	NA
Dithiane	--	--	<0.001	--	<0.001	NA	NA
Fluorene	0.045	<0.001	--	<0.001	<0.001	NA	NA
Hexachlorobenzene	0.028	<0.001	--	<0.001	<0.001	NA	NA
Hexachloroethane	0.027	<0.001	--	<0.001	<0.001	NA	NA
Iron	616.000	2.756	0.279	13.778	16.813	NA	NA
Lead	6,405.600	28.656	0.002	8.428	37.086	2.240	16.6
Magnesium	504.400	2.256	0.352	0.347	2.955	NA	NA
Manganese	18.990	0.085	0.006	0.057	0.147	25.000	<0.1
Mercury	1.368	0.006	<0.001	<0.001	0.006	0.009	0.7
N-Nitrosodiphenylamine	0.188	<0.001	--	<0.001	<0.001	NA	NA
Nickel	5.070	0.023	<0.001	0.008	0.030	11.220	<0.1
Nitroglycerin	13.541	0.061	--	0.001	0.062	NA	NA
Phenol	1.738	0.008	--	<0.001	0.008	NA	NA
Pyrene	0.010	<0.001	--	<0.001	<0.001	NA	NA
Selenium	9.256	0.041	<0.001	<0.001	0.042	0.056	0.8
Silver	62.850	0.281	<0.001	0.004	0.285	NA	NA
Sodium	26.050	0.117	1.478	0.047	1.641	NA	NA
Tetrachloroethene	0.304	0.001	--	<0.001	0.001	NA	NA
Thallium	4.825	0.022	--	0.002	0.023	NA	NA
Trichloroethene	1.142	0.005	0.006	<0.001	0.011	0.106	0.1
Vinyl chloride	--	--	<0.001	--	<0.001	0.048	<0.1
Zinc	7,120.000	31.851	0.006	1.593	33.450	44.900	0.7

TABLE E.15 TBP: Red Fox

Contaminant	Insect Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Insect Ingestion (mg/kg-d)	ADD from Small Mammal Ingestion (mg/kg-d)	ADD from Eastern Cottontail Ingestion (mg/kg-d)	ADD from Insectivorous Bird Ingestion (mg/kg-d)	ADD from Herbivorous Bird Ingestion (mg/kg-d)	ADD from Omnivorous Bird Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	Total ADD (mg/kg-d)	Benchmark ADD (mg/kg-d)	HQ
1,1-Oxathiane	-	-	0.002	<0.001	0.002	0.002	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	NA	NA
1,1,2,2-Tetrachloroethane	1.008	1.008	1.111	0.091	2.171	2.292	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	NA	NA
1,1-Dichloroethene	0.084	0.084	0.039	0.004	0.128	0.133	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	3.100	<0.1
1,4-Dichlorobenzene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NA	-
1,4-Dithiane	-	-	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	NA	NA
1,4-Oxathiane	-	-	0.001	<0.001	<0.001	0.001	-	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	NA	NA
2,4,6-Trichloroaniline	7.900	7.900	3.626	0.334	12.104	12.488	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	NA	NA
2,4-Dichlorodurene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NA	-
2-Buranone	0.037	0.037	0.017	0.002	0.057	0.058	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
2-Methylphenanthrene	0.007	0.007	0.014	<0.001	0.026	0.087	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
2-Methylphenol	0.880	0.880	0.407	0.037	1.353	1.414	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
4,4'-DDE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.420	-
4-Methylphenol	0.828	0.828	0.429	0.039	1.425	1.486	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Acetone	0.265	0.266	0.125	0.012	0.409	0.410	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	5.300	<0.1
Aluminum	4.068	4.068	207.859	0.371	283.519	1,382.783	<0.001	<0.001	0.023	0.024	0.004	0.021	0.003	0.213	0.269	0.551	0.5
Anilmony	5.511	5.511	6.994	0.234	14.473	38.842	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	0.007	0.036	0.2
Aroclor 1248	0.003	0.003	0.050	<0.001	0.011	0.039	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	0.010	<0.1
Aroclor 1254	0.500	14.400	1.548	0.022	39.403	100.994	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	0.002	0.014	0.019	0.036	0.5
Barium	0.725	23.700	5.055	0.037	55.315	118.197	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.015	0.022	2.800	<0.1
Benzofluoranthene	0.004	0.004	0.013	<0.001	0.021	0.082	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Benzofluoranthene	0.004	0.004	0.013	<0.001	0.021	0.082	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Benzofluoranthene	4.569	19.525	0.410	0.194	30.112	22.745	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.509	<0.1
Cadmium	1,850.004	36,000.000	7,640.781	80.587	55,166.460	36,174.302	0.027	2.096	0.828	0.639	0.001	0.560	0.037	0.339	5.381	NA	NA
Calcium	0.026	0.026	0.012	0.001	0.040	0.041	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Carbon disulfide	-	-	0.018	0.001	0.018	0.018	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	NA	NA
Chloroethane	0.035	0.035	0.016	0.001	0.054	0.057	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	7.900	<0.1
Chloroform	2.698	6.585	2.657	0.115	20.695	61.037	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.008	0.011	1.730	<0.1
Chromium	1.015	1.015	1.444	0.044	2.871	8.124	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.002	NA	NA
Cobalt	43.799	561.600	155.531	1.860	906.237	801.539	<0.001	0.033	0.017	0.014	0.014	0.012	<0.001	0.041	0.131	8.000	<0.1
Copper	1,620.000	1,620.000	730.080	68.589	2,469.659	2,463.659	0.024	0.094	0.027	0.001	0.038	0.038	-	0.001	0.303	34.100	<0.1
Cyanide	0.734	0.734	0.348	0.031	1.140	1.237	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1,310.000	<0.1
Diethyl phthalate	-	-	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	NA	NA
DHP	-	-	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	NA	NA
Dibutyl	-	-	<0.001	<0.001	<0.001	<0.001	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	NA	NA
Fluorene	0.045	0.045	0.032	0.002	0.084	0.145	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Hexachlorobenzene	0.028	0.028	0.041	0.001	0.081	0.232	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Hexachloroethane	0.027	0.027	0.023	0.001	0.055	0.116	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Iron	145.000	616.000	1,566.710	8.136	2,834.314	10,038.506	0.002	0.036	0.170	0.173	0.044	0.155	0.032	1.451	2.093	NA	NA
Lead	9.884	6,405.600	1,433	0.436	10,892.207	11,575.499	<0.001	0.373	<0.001	0.206	0.168	0.179	<0.001	0.888	1.814	4.220	0.4
Magnesium	1,109.998	504.400	453.249	49.510	845.789	1,402.715	0.016	0.029	0.049	0.013	0.022	0.041	<0.001	0.037	0.221	NA	NA
Manganese	48.900	18.990	22.067	2.028	37.080	84.838	<0.001	0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.008	0.014	46.000	<0.1
Mercury	0.002	1.368	0.292	<0.001	2.123	1.468	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	<0.1
N-Nitrosodiphenylamine	0.188	0.188	0.096	0.008	0.300	0.361	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Nickel	5.070	5.070	3.059	0.216	8.750	12.860	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	21.120	<0.1
Nitrophenol	13.541	13.541	6.231	0.573	20.788	21.512	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	0.003	NA	NA
Phenol	1.738	1.738	0.793	0.074	2.656	2.717	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Pyrene	0.010	0.010	0.016	<0.001	0.031	0.091	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Selenium	9.256	9.256	4.230	0.392	14.156	14.502	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.012	<0.1
Shver	62.850	62.850	28.661	2.661	96.043	98.081	<0.001	0.004	0.003	0.001	0.002	0.001	<0.001	0.005	0.007	NA	NA
Sodium	3,900.000	26.050	1,141.280	171.449	180.051	2,499.954	0.056	0.002	0.124	0.005	0.003	0.039	0.171	0.005	<0.001	NA	NA
Tetrachloroethene	0.304	0.304	0.146	0.013	0.474	0.523	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	<0.001	NA	NA
Thallium	4.825	4.825	2.345	0.204	7.569	8.507	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	0.001	0.200	<0.1
Trichloroethane	1.142	1.142	1.067	0.088	2.277	2.413	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	NA
Vinyl chloride	-	-	0.018	0.001	0.018	0.018	-	-	<0.001	<0.001	<0.001	<0.001	<0.001	-	<0.001	0.090	<0.1
Zinc	242.009	7,120.000	1,569.634	10.291	11,039.414	7,723.387	0.004	0.414	0.137	<0.001	0.171	0.120	<0.001	0.168	1.184	84.500	<0.1

TABLE E.16 WPP: Vegetation

Contaminant	SPTF	Plant Tissue Concentration (mg/kg)	Soil Concentration (mg/kg)	Soil Benchmark for Vegetation (mg/kg)	HQ
Aluminum	1.80E-04	4.392	24,400.000	NA	NA
Antimony	1.10E-02	0.032	2.900	5	0.6
Benzo(a)anthracene	5.61E-03	0.001	0.262	NA	NA
Benzo(a)pyrene	3.04E-03	<0.001	0.254	NA	NA
Benzo(b)fluoranthene	3.04E-03	0.001	0.338	NA	NA
Benzo(k)fluoranthene	3.04E-03	0.001	0.332	NA	NA
bis(2-ethylhexyl)phthalate	2.69E-05	<0.001	0.324	NA	NA
Cadmium	5.50E-01	1.485	2.700	10	0.3
Chromium	7.50E-03	0.272	36.200	3.5	10.3
Chrysene	5.54E-03	0.002	0.290	NA	NA
Copper	1.30E-01	8.749	67.300	100	0.7
Fluoranthene	1.43E-02	0.004	0.282	NA	NA
Indeno(1,2,3-cd)pyrene	1.70E-03	<0.001	0.262	NA	NA
Iron	4.00E-03	148.800	37,200.000	NA	NA
Lead	6.80E-02	15.708	231.000	100	2.3
Magnesium	1.30E-01	312.000	2,400.000	NA	NA
Mercury	3.80E-01	0.050	0.132	0.3	0.4
Nickel	6.00E-02	1.038	17.300	20	0.9
Pyrene	8.13E-03	0.002	0.257	NA	NA
Sodium	5.00E-02	29.950	599.000	NA	NA
Zinc	4.00E-01	235.200	588.000	10	58.8

TABLE E.17 WPP: Leopard Frog

Contaminant	Surface Water Concentration (µg/L)	BCF	Estimated Leopard Frog Tissue Concentrations (mg/kg)	Method for Deriving Tissue Concentration
Aluminum	8390.00	1.10E+01	92.290	Calculated
Antimony	10.00	1.00E+00	0.010	Calculated
Benzo(a)anthracene	--	1.17E+04	--	--
Benzo(a)pyrene	--	2.38E+04	--	--
Benzo(b)fluoranthene	--	2.38E+04	--	--
Benzo(k)fluoranthene	--	2.38E+04	--	--
bis(2-ethylhexyl)phthalate	--	1.19E+07	--	--
Cadmium	--	2.00E+02	--	--
Chromium	16.00	1.00E+01	14.37	Measured
Chrysene	--	1.08E+04	--	--
Copper	52.30	5.00E+01	2.615	Calculated
Fluoranthene	--	3.12E+03	--	--
Indeno(1,2,3-cd)pyrene	--	5.13E+04	--	--
Iron	28400.00	1.00E+02	2,840.000	Calculated
Lead	76.10	7.50E+01	2.000	Measured
Magnesium	131000.00	5.00E+01	6,550.000	Calculated
Mercury	0.10	3.00E+03	0.200	Measured
Nickel	--	1.00E+02	--	--
Pyrene	--	2.80E+03	--	--
Sodium	1120000.00	1.00E+02	112,000.000	Calculated
Zinc	411.00	2.28E+02	93.708	Calculated

TABLE E.18 WPP: Red-Spotted Newt

Contaminant	Invertebrate Food Contaminant Concentration (mg/kg)	ADD from Dermal Contact with Soil (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food Ingestion (mg/kg-d)	Total ADD (mg/kg-d)
Aluminum	4.39	590.86	5283.04	0.05	5873.95
Antimony	0.03	0.07	0.63	<0.01	0.70
Benzo(a)anthracene	<0.01	<0.01	0.06	<0.01	0.06
Benzo(a)pyrene	<0.01	<0.01	0.05	<0.01	0.06
Benzo(b)fluoranthene	<0.01	<0.01	0.07	<0.01	0.08
Benzo(k)fluoranthene	<0.01	<0.01	0.07	<0.01	0.08
bis(2-ethylhexyl)phthalate	<0.01	<0.01	0.07	<0.01	0.08
Cadmium	1.49	0.07	0.58	0.02	0.67
Chromium	0.27	0.88	7.84	<0.01	8.72
Chrysene	<0.01	<0.01	0.06	<0.01	0.07
Copper	8.75	1.63	14.57	0.09	16.30
Fluoranthene	<0.01	<0.01	0.06	<0.01	0.07
Indeno(1,2,3-cd)pyrene	<0.01	<0.01	0.06	<0.01	0.06
Iron	148.80	900.82	8054.46	1.61	8956.90
Lead	15.71	5.59	50.02	0.17	55.78
Magnesium	312.00	58.12	519.64	3.38	581.14
Mercury	0.05	<0.01	0.03	<0.01	0.03
Nickel	1.04	0.42	3.75	0.01	4.18
Pyrene	<0.01	<0.01	0.06	<0.01	0.06
Sodium	29.95	14.51	129.69	0.32	144.52
Zinc	235.20	14.24	127.31	2.55	144.10

TABLE E.19 WPP: American Kestrel

Contaminant	Soil Invertebrate Concentration (mg/kg)	Snake Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Soil Ingestion (mg/kg-d)	ADD from Snake Ingestion (mg/kg-d)	ADD from Small Mammals Ingestion (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Kestrel Benchmark ADD (mg/kg-d)	HQ
Aluminum	4.392	12.762	222.801	1.477	304.554	1491.370	0.026	0.013	1.304	0.003	0.568	2.780	0.059	4.694	4.753	109.70	<0.1
Antimony	0.032	0.003	0.042	0.008	0.085	0.226	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	NA	NA
Benzo(a)anthracene	0.001	<0.001	0.003	<0.001	0.005	0.018	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(a)pyrene	<0.001	<0.001	0.003	<0.001	0.004	0.017	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(b)fluoranthene	0.001	<0.001	0.004	<0.001	0.006	0.022	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	0.001	<0.001	0.003	<0.001	0.006	0.022	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
bis(2-ethylhexyl)phthalate	<0.001	<0.001	0.003	<0.001	0.004	0.020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	1.10	<0.1
Cadmium	1.485	0.016	0.693	0.334	2.290	2.421	0.009	<0.001	0.004	<0.001	0.004	0.005	--	0.022	0.022	1.45	<0.1
Chromium	0.272	0.022	0.450	0.062	0.855	2.616	0.002	<0.001	0.003	<0.001	0.002	0.005	<0.001	0.011	0.011	1.00	<0.1
Chrysene	0.002	<0.001	0.003	<0.001	0.006	0.020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Copper	8.749	0.138	4.550	1.969	14.124	17.398	0.053	<0.001	0.027	0.004	0.026	0.032	<0.001	0.142	0.142	47.00	<0.1
Fluoranthene	0.004	<0.001	0.004	<0.001	0.010	0.023	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	0.33	<0.1
Indeno(1,2,3-cd)pyrene	<0.001	<0.001	0.003	<0.001	0.004	0.017	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Iron	148.800	40.463	405.906	35.090	682.504	2491.912	0.895	0.040	2.375	0.065	1.272	4.646	0.200	9.294	9.494	NA	NA
Lead	15.708	0.279	9.159	3.533	26.696	37.932	0.095	<0.001	0.054	0.007	0.050	0.071	<0.001	0.275	0.276	1.13	0.2
Magnesium	312.000	61.533	181.126	77.756	521.764	638.500	1.877	0.061	1.080	0.145	0.973	1.190	0.920	5.307	6.227	NA	NA
Mercury	0.050	0.002	0.024	0.011	0.078	0.084	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.45	<0.1
Nickel	1.038	0.018	0.623	0.233	1.788	2.630	0.006	<0.001	0.004	<0.001	0.003	0.005	--	0.019	0.019	77.40	<0.1
Pyrene	0.002	<0.001	0.003	<0.001	0.006	0.019	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	0.33	<0.1
Sodium	29.950	864.727	182.389	72.248	209.608	238.743	0.180	0.862	1.067	0.135	0.391	0.445	7.869	3.080	10.949	NA	NA
Zinc	235.200	3.212	111.192	52.863	364.712	393.312	1.415	0.003	0.651	0.099	0.680	0.733	0.003	3.581	3.584	14.50	0.2

TABLE E.20 WPP: Red-Tailed Hawk

Contaminant	Snake Concentration (mg/kg)	Mouse Concentration (mg/kg)	Insectivorous Bird Concentration (mg/kg)	Herbivorous Bird Concentration (mg/kg)	Omnivorous Bird Concentration (mg/kg)	ADD from Snake Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Rabbits (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Hawk Benchmark ADD (mg/kg-d)	HQ
Aluminum	12,762	222,801	1,477	304,554	1491,370	0.002	0.161	0.089	<0.001	0.010	0.047	0.005	0.309	0.314	109,700	<0.1
Anilimony	0.003	0.042	0.008	0.085	0.226	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Benzo(a)anthracene	<0.001	0.003	<0.001	0.005	0.018	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(a)pyrene	<0.001	0.003	<0.001	0.004	0.017	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(b)fluoranthene	<0.001	0.004	<0.001	0.006	0.022	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	<0.001	0.003	<0.001	0.006	0.022	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
bis(2-ethylhexyl)phthalate	<0.001	0.003	<0.001	0.004	0.020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	1,100	<0.1
Cadmium	0.016	0.693	0.334	2,290	2,421	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	1,450	<0.1
Chromium	0.022	0.450	0.062	0.855	2,616	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1,000	<0.1
Chrysene	<0.001	0.003	<0.001	0.006	0.020	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,331	<0.1
Copper	0.138	4,550	1,969	14,124	17,398	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	47,000	<0.1
Fluoranthene	<0.001	0.004	<0.001	0.010	0.023	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	0,331	<0.1
Indeno(1,2,3-cd)pyrene	<0.001	0.003	<0.001	0.004	0.017	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Iron	40,463	405,906	35,090	682,504	2491,912	0.006	0.294	0.144	0.001	0.021	0.078	0.018	0.545	0.563	NA	NA
Lead	0.279	9,159	3,533	26,696	37,932	<0.001	0.007	0.002	<0.001	<0.001	0.001	<0.001	0.011	0.011	1,130	<0.1
Magnesium	61,533	181,126	77,756	521,764	638,500	0.009	0.131	0.029	0.002	0.016	0.020	0.084	0.207	0.291	NA	NA
Mercury	0.002	0.024	0.011	0.078	0.084	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	77,400	<0.1
Nickel	0.018	0.623	0.233	1,788	2,630	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	0,331	<0.1
Pyrene	<0.001	0.003	<0.001	0.006	0.019	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Sodium	864,727	182,389	72,248	209,608	238,743	0.125	0.132	0.020	0.002	0.007	0.007	0.714	0.293	1,007	14,500	<0.1
Zinc	3,212	111,192	52,863	364,712	393,312	<0.001	0.081	0.016	0.002	0.011	0.012	<0.001	0.122	0.122	NA	<0.1

TABLE E.21 WPP: American Robin

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	Total ADD (mg/kg-d)	Robin Benchmark ADD (mg/kg-d)	HQ
Aluminum	4.392	4.392	2.670	4.006	1.175	1483.520	1491.370	109.70	13.59
Antimony	0.032	0.032	0.019	0.029	0.001	0.176	0.226	NA	NA
Benzo(a)anthracene	0.001	0.001	<0.001	0.001	--	0.016	0.018	NA	NA
Benzo(a)pyrene	<0.001	<0.001	<0.001	<0.001	--	0.015	0.017	NA	NA
Benzo(b)fluoranthene	0.001	0.001	<0.001	<0.001	--	0.021	0.022	NA	NA
Benzo(k)fluoranthene	0.001	0.001	<0.001	<0.001	--	0.020	0.022	NA	NA
bis(2-ethylhexyl)phthalate	<0.001	<0.001	<0.001	<0.001	--	0.020	0.020	1.10	<0.1
Cadmium	1.485	1.485	0.903	1.354	--	0.164	2.421	1.45	1.67
Chromium	0.272	0.272	0.165	0.248	0.002	2.201	2.616	1.00	2.62
Chrysene	0.002	0.002	<0.001	0.001	--	0.018	0.020	NA	NA
Copper	8.749	8.749	5.319	7.979	0.007	4.092	17.398	47.00	0.37
Fluoranthene	0.004	0.004	0.002	0.004	--	0.017	0.023	0.33	<0.1
Indeno(1,2,3-cd)pyrene	<0.001	<0.001	<0.001	<0.001	--	0.016	0.017	NA	NA
Iron	148.800	148.800	90.470	135.706	3.976	2261.760	2491.912	NA	NA
Lead	15.708	15.708	9.550	14.326	0.011	14.045	37.932	1.13	33.57
Magnesium	312.000	312.000	189.696	284.544	18.340	145.920	638.500	NA	NA
Mercury	0.050	0.050	0.030	0.046	<0.001	0.008	0.084	0.45	0.19
Nickel	1.038	1.038	0.631	0.947	--	1.052	2.630	77.40	<0.1
Pyrene	0.002	0.002	0.001	0.002	--	0.016	0.019	0.33	<0.1
Sodium	29.950	29.950	18.210	27.314	156.800	36.419	238.743	NA	NA
Zinc	235.200	235.200	143.002	214.502	0.058	35.750	393.312	14.50	27.12

TABLE E.22 WPP: Tree Swallow

Contaminant	Insect Contaminant Concentration (mg/kg)	ADD from Insect Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Tree Swallow Benchmark ADD (mg/kg-d)	HQ
Aluminum	4.392	0.987	0.491	0.987	1.477	109.70	<0.1
Antimony	0.032	0.007	<0.001	0.007	0.008	NA	NA
Benzo(a)anthracene	0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(a)pyrene	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(b)fluoranthene	0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	0.001	<0.001	--	<0.001	<0.001	NA	NA
bis(2-ethylhexyl)phthalate	<0.001	<0.001	--	<0.001	<0.001	1.10	<0.1
Cadmium	1.485	0.334	--	0.334	0.334	1.45	0.2
Chromium	0.272	0.061	<0.001	0.061	0.062	1.00	<0.1
Chrysene	0.002	<0.001	--	<0.001	<0.001	NA	NA
Copper	8.749	1.966	0.003	1.966	1.969	47.00	<0.1
Fluoranthene	0.004	<0.001	--	<0.001	<0.001	0.33	<0.1
Indeno(1,2,3-cd)pyrene	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Iron	148.800	33.429	1.661	33.429	35.090	NA	NA
Lead	15.708	3.529	0.004	3.529	3.533	1.13	3.1
Magnesium	312.000	70.092	7.664	70.092	77.756	NA	NA
Mercury	0.050	0.011	<0.001	0.011	0.011	0.45	<0.1
Nickel	1.038	0.233	--	0.233	0.233	77.40	<0.1
Pyrene	0.002	<0.001	--	<0.001	<0.001	0.33	<0.1
Sodium	29.950	6.728	65.520	6.728	72.248	NA	NA
Zinc	235.200	52.839	0.024	52.839	52.863	14.50	3.6

TABLE E.23 WPP: Mallard

Contaminant	Invertebrate Food Contaminant Concentration	Vegetation Contaminant Concentration	ADD from Invertebrate Ingestion	ADD from Vegetation Ingestion	ADD from Drinking Water	ADD from Incidental Soil Ingestion	ADD from Food Ingestion	Total ADD	Mallard ADD Benchmark	HQ
	(mg/kg)	(mg/kg)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)	(mg/kg-d)	
Aluminum	562.091	4.392	0.510	0.003	0.006	1.181	0.513	1.701	109.70	<0.1
Antimony	<0.001	0.032	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Benzo(a)anthracene	--	0.001	--	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Benzo(a)pyrene	--	<0.001	--	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Benzo(b)fluoranthene	--	0.001	--	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	--	0.001	--	<0.001	--	<0.001	<0.001	<0.001	NA	NA
bis(2-ethylhexyl)phthalate	--	<0.001	--	<0.001	--	<0.001	<0.001	<0.001	1.10	<0.1
Cadmium	--	1.485	--	<0.001	--	<0.001	<0.001	0.001	1.45	<0.1
Chromium	0.891	0.272	<0.001	<0.001	<0.001	0.002	<0.001	0.003	1.00	<0.1
Chrysene	--	0.002	--	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Copper	0.015	8.749	<0.001	0.005	<0.001	0.003	0.005	0.009	47.00	<0.1
Fluoranthene	--	0.004	--	<0.001	--	<0.001	<0.001	<0.001	0.33	<0.1
Indeno(1,2,3-cd)pyrene	--	<0.001	--	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Iron	8.237	148.800	0.007	0.090	0.022	1.801	0.098	1.920	NA	NA
Lead	0.993	15.708	<0.001	0.010	<0.001	0.011	0.010	0.022	1.13	<0.1
Magnesium	37.993	312.000	0.034	0.189	0.100	0.116	0.223	0.440	NA	NA
Mercury	0.714	0.050	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.45	<0.1
Nickel	--	1.038	--	<0.001	--	<0.001	<0.001	0.001	77.40	<0.1
Pyrene	--	0.002	--	<0.001	--	<0.001	<0.001	<0.001	0.33	<0.1
Sodium	324.826	29.950	0.295	0.018	0.859	0.029	0.313	1.201	NA	NA
Zinc	115.147	235.200	0.105	0.142	<0.001	0.028	0.247	0.276	14.50	<0.1

TABLE E.24 WPP: White-Footed Mouse

Contaminant	Insect Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Insect Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from			Total ADD (mg/kg-d)	Mouse Benchmark ADD (mg/kg-d)	HQ
					Drinking Water (mg/kg-d)	Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)			
Aluminum	4.392	4.392	1.146	0.830	1.225	219.600	1.976	222.801	2.140	104.1
Antimony	0.032	0.032	0.008	0.006	0.001	0.026	0.014	0.042	0.138	0.3
Benzo(a)anthracene	0.001	0.001	<0.001	<0.001	--	0.002	<0.001	0.003	NA	NA
Benzo(a)pyrene	<0.001	<0.001	<0.001	<0.001	--	0.002	<0.001	0.003	1.080	<0.1
Benzo(b)fluoranthene	0.001	0.001	<0.001	<0.001	--	0.003	<0.001	0.004	NA	NA
Benzo(k)fluoranthene	0.001	0.001	<0.001	<0.001	--	0.003	<0.001	0.003	NA	NA
bis(2-ethylhexyl)phthalate	<0.001	<0.001	<0.001	<0.001	--	0.003	<0.001	0.003	19.800	<0.1
Cadmium	1.485	1.485	0.388	0.281	--	0.024	0.668	0.693	1.930	0.4
Chromium	0.272	0.272	0.071	0.051	0.002	0.326	0.122	0.450	6.550	<0.1
Chrysene	0.002	0.002	<0.001	<0.001	--	0.003	<0.001	0.003	NA	NA
Copper	8.749	8.749	2.283	1.654	0.008	0.606	3.937	4.550	30.400	0.1
Fluoranthene	0.004	0.004	0.001	<0.001	--	0.003	0.002	0.004	138.000	<0.1
Indeno(1,2,3-cd)pyrene	<0.001	<0.001	<0.001	<0.001	--	0.002	<0.001	0.003	1.110	<0.1
Iron	148.800	148.800	38.837	28.123	4.146	334.800	66.960	405.906	NA	NA
Lead	15.708	15.708	4.100	2.969	0.011	2.079	7.069	9.159	15.980	0.6
Magnesium	312.000	312.000	81.432	58.968	19.126	21.600	140.400	181.126	NA	NA
Mercury	0.050	0.050	0.013	0.009	<0.001	0.001	0.023	0.024	2.600	<0.1
Nickel	1.038	1.038	0.271	0.196	--	0.156	0.467	0.623	79.890	<0.1
Pyrene	0.002	0.002	<0.001	<0.001	--	0.002	<0.001	0.003	83.000	<0.1
Sodium	29.950	29.950	7.817	5.661	163.520	5.391	13.478	182.389	NA	NA
Zinc	235.200	235.200	61.387	44.453	0.060	5.292	105.840	111.192	319.500	0.3

TABLE E.25 WPP: Eastern Cottontail

Contaminant	Vegetation Contaminant Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Cottontail Benchmark ADD (mg/kg-d)	HQ
Aluminum	4.392	1.746	0.814	611.147	1.746	613.707	0.767	800.1
Antimony	0.032	0.013	<0.001	0.073	0.013	0.086	0.050	1.7
Benzo(a)anthracene	0.001	<0.001	--	0.007	<0.001	0.007	NA	NA
Benzo(a)pyrene	<0.001	<0.001	--	0.006	<0.001	0.007	0.400	<0.1
Benzo(b)fluoranthene	0.001	<0.001	--	0.008	<0.001	0.009	NA	NA
Benzo(k)fluoranthene	0.001	<0.001	--	0.008	<0.001	0.009	NA	NA
bis(2-ethylhexyl)phthalate	<0.001	<0.001	--	0.008	<0.001	0.008	7.300	<0.1
Cadmium	1.485	0.590	--	0.068	0.590	0.658	0.709	0.9
Chromium	0.272	0.108	0.002	0.907	0.108	1.016	2.410	0.4
Chrysene	0.002	<0.001	--	0.007	<0.001	0.008	NA	NA
Copper	8.749	3.478	0.005	1.686	3.478	5.169	11.200	0.5
Fluoranthene	0.004	0.002	--	0.007	0.002	0.009	NA	NA
Indeno(1,2,3-cd)pyrene	<0.001	<0.001	--	0.007	<0.001	0.007	NA	NA
Iron	148.800	59.159	2.755	931.748	59.159	993.662	NA	NA
Lead	15.708	6.245	0.007	5.786	6.245	12.038	5.330	2.3
Magnesium	312.000	124.042	12.707	60.113	124.042	196.862	NA	NA
Mercury	0.050	0.020	<0.001	0.003	0.020	0.023	0.024	1.0
Nickel	1.038	0.413	--	0.433	0.413	0.846	29.400	<0.1
Pyrene	0.002	<0.001	--	0.006	<0.001	0.007	NA	NA
Sodium	29.950	11.907	108.640	15.003	11.907	135.550	NA	NA
Zinc	235.200	93.509	0.040	14.728	93.509	108.276	117.600	0.9

TABLE E.26 WPP: White-Tailed Deer

Contaminant	Vegetation Contaminant Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from		Total ADD (mg/kg-d)	Deer ADD Benchmark (mg/kg-d)	HQ
				Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)			
Aluminum	4.392	0.104	0.283	11.584	0.104	11.971	0.293	40.9
Antimony	0.032	<0.001	<0.001	0.001	<0.001	0.002	0.019	0.1
Benzo(a)anthracene	0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Benzo(a)pyrene	<0.001	<0.001	--	<0.001	<0.001	<0.001	0.015	<0.1
Benzo(b)fluoranthene	0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
bis(2-ethylhexyl)phthalate	<0.001	<0.001	--	<0.001	<0.001	<0.001	2.800	<0.1
Cadmium	1.485	0.035	--	0.001	0.035	0.037	0.271	0.1
Chromium	0.272	0.006	<0.001	0.017	0.006	0.024	0.920	<0.1
Chrysene	0.002	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Copper	8.749	0.208	0.002	0.032	0.208	0.241	4.300	<0.1
Fluoranthene	0.004	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Indeno(1,2,3-cd)pyrene	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Iron	148.800	3.532	0.957	17.660	3.532	22.150	NA	NA
Lead	15.708	0.373	0.003	0.110	0.373	0.485	2.240	0.2
Magnesium	312.000	7.406	4.415	1.139	7.406	12.961	NA	NA
Mercury	0.050	0.001	<0.001	<0.001	0.001	0.001	0.009	0.1
Nickel	1.038	0.025	--	0.008	0.025	0.033	11.220	<0.1
Pyrene	0.002	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Zinc	235.200	5.583	0.014	0.279	5.583	5.876	44.900	0.1

TABLE E.27 WPP: Red Fox

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Rabbits (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Fox ADD Benchmark (mg/kg-d)	HQ
Aluminum	4.392	4.392	222.801	1.477	304.554	1491.370	<0.001	0.001	0.128	<0.001	<0.001	0.025	0.122	0.008	1.220	0.278	1.508	0.551	2.7
Antimony	0.032	0.032	0.042	0.008	0.085	0.226	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.036	<0.1
Benzo(a)anthracene	0.001	0.001	0.003	<0.001	0.005	0.018	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Benzo(a)pyrene	<0.001	<0.001	0.003	<0.001	0.004	0.017	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	0.290	<0.1
Benzo(b)fluoranthene	0.001	0.001	0.004	<0.001	0.006	0.022	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	0.001	0.001	0.003	<0.001	0.006	0.022	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
bis(2-ethylhexyl)phthalate	<0.001	<0.001	0.003	<0.001	0.004	0.020	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	--	<0.001	0.004	0.004	5.200	<0.1
Cadmium	1.485	1.485	0.693	0.334	2.290	2.421	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	0.002	0.002	0.509	<0.1
Chromium	0.272	0.272	0.450	0.062	0.855	2.616	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002	0.004	1.730	<0.1
Chrysene	0.002	0.002	0.003	<0.001	0.006	0.020	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Copper	8.749	8.749	4.550	1.969	14.124	17.398	<0.001	0.003	0.003	0.006	<0.001	0.001	0.001	<0.001	0.003	0.015	0.019	8.000	<0.1
Fluoranthene	0.004	0.004	0.004	<0.001	0.010	0.023	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Indeno(1,2,3-cd)pyrene	<0.001	<0.001	0.003	<0.001	0.004	0.017	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Iron	148.800	148.800	405.906	35.090	682.504	2491.912	0.012	0.046	0.233	--	0.003	0.056	0.205	0.027	1.860	0.555	2.441	NA	NA
Lead	15.708	15.708	9.159	3.533	26.696	37.932	0.001	0.005	0.005	0.003	<0.001	0.002	0.003	<0.001	0.012	0.020	0.032	4.220	<0.1
Magnesium	312.000	312.000	181.126	77.756	521.764	638.500	0.025	0.096	0.104	--	0.006	0.043	0.052	0.124	0.120	0.327	0.571	NA	NA
Mercury	0.050	0.050	0.024	0.011	0.078	0.084	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	<0.1
Nickel	1.038	1.038	0.623	0.233	1.788	2.630	<0.001	<0.001	<0.001	0.017	<0.001	<0.001	<0.001	--	<0.001	0.018	0.019	21.120	<0.1
Pyrene	0.002	0.002	0.003	<0.001	0.006	0.019	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Sodium	29.950	29.950	182.389	72.248	209.608	238.743	0.002	0.009	0.105	--	0.006	0.017	0.020	1.062	0.030	0.159	1.251	NA	NA
Zinc	235.200	235.200	111.192	52.863	364.712	393.312	0.018	0.073	0.064	0.068	0.004	0.030	0.032	<0.001	0.029	0.289	0.319	84.500	<0.1

TABLE E.28 RCP: Vegetation

Contaminant	SPTF	Plant Tissue Concentration (mg/kg)	Soil Contaminant Concentration (mg/kg)	Soil Benchmark for Vegetation (mg/kg)	Media- Based HQ
Aluminum	1.80E-04	4.100	26300.00	NA	NA
Antimony	1.10E-02	0.024	2.21	5	0.4
Cadmium	5.50E-01	3.740	6.80	10	0.7
Chromium	7.50E-03	0.970	191.00	3.5	54.6
Copper	1.30E-01	3.700	1770.00	100	17.7
Iron	4.00E-03	17.100	19000.00	NA	NA
Lead	6.80E-02	0.180	1070.00	100	10.7
Magnesium	1.30E-01	317.000	1910.00	NA	NA
Mercury	3.80E-01	0.046	0.12	0.3	0.4
Nickel	6.00E-02	1.200	20.00	20	1.0
Silver	1.50E+00	13.515	9.01	2	4.5
Sodium	5.00E-02	46.000	649.00	NA	NA
Zinc	4.00E-01	21.100	385.00	10	38.5

TABLE E.29 RCP: Leopard Frog

Contaminant	Surface Water Concentration (µg/L)	BCF	Estimated Leopard Frog Tissue Concentrations (mg/kg)
Aluminum	406.00	1.10E+01	4.47
Antimony	--	1.00E+00	--
Cadmium	--	2.00E+02	--
Chromium	--	1.00E+01	--
Copper	24.60	5.00E+01	1.23
Iron	1540.00	1.00E+02	154.00
Lead	1.33	7.50E+01	0.10
Magnesium	170000.00	5.00E+01	8,500.00
Mercury	--	3.00E+03	--
Nickel	--	1.00E+02	--
Silver	--	1.50E+02	--
Sodium	1100000.00	1.00E+02	110,000.00
Zinc	34.20	2.28E+02	7.80

TABLE E.30 RCP: Red-Spotted Newt

Contaminant	Invertebrate Food Contaminant Concentration (mg/kg)	ADD from Dermal Contact with Soil (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food Ingestion (mg/kg-d)	Total ADD (mg/kg-d)
Aluminum	4.10	1,273.75	5694.42	0.04	6968.21
Antimony	0.02	0.11	0.48	<0.01	0.59
Cadmium	3.74	0.33	1.47	0.04	1.84
Chromium	0.97	9.25	41.35	0.01	50.62
Copper	46.00	85.72	383.24	0.50	469.46
Iron	37.50	920.20	4113.84	0.41	5034.44
Lead	1.30	51.82	231.67	0.01	283.51
Magnesium	950.00	92.50	413.55	10.29	516.34
Mercury	0.05	<0.01	0.03	<0.01	0.03
Nickel	1.20	0.97	4.33	0.01	5.31
Silver	13.52	0.44	1.95	0.15	2.53
Sodium	731.00	31.43	140.52	7.92	179.87
Zinc	253.00	18.65	83.36	2.74	104.75

TABLE E.31 RCP: American Robin

Contaminant	Soil	Vegetation	ADD from Soil	ADD from	ADD from	ADD from	ADD from	Total ADD	Robin	HQ
	Invertebrate Contaminant Concentration (mg/kg)	Contaminant Concentration (mg/kg)	Invertebrate Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Drinking Water (mg/kg-d)	Incidental Soil Ingestion (mg/kg-d)			Benchmark ADD (mg/kg-d)	
Aluminum	4.100	4.100	2.493	3.739	0.057	1599.040	6.232	1605.329	109.70	14.6
Antimony	0.024	0.024	0.015	0.022	--	0.134	0.037	0.171	NA	NA
Cadmium	3.740	3.740	2.274	3.411	--	0.413	5.685	6.098	1.45	4.2
Chromium	0.970	0.970	0.590	0.885	--	11.613	1.474	13.087	1.00	13.1
Copper	46.000	3.700	27.968	3.374	0.003	107.616	31.342	138.962	47.00	3.0
Iron	37.500	17.100	22.800	15.595	0.216	1155.200	38.395	1193.811	NA	NA
Lead	1.300	0.180	0.790	0.164	<0.001	65.056	0.955	66.011	1.13	58.4
Magnesium	950.000	317.000	577.600	289.104	23.800	116.128	866.704	1006.632	NA	NA
Mercury	0.046	0.046	0.028	0.042	--	0.007	0.069	0.077	0.45	0.2
Nickel	1.200	1.200	0.730	1.094	--	1.216	1.824	3.040	77.40	<0.1
Silver	13.515	13.515	8.217	12.326	--	0.548	20.543	21.091	165.61	0.1
Sodium	731.000	46.000	444.448	41.952	154.000	39.459	486.400	679.859	NA	NA
Zinc	253.000	21.100	153.824	19.243	0.005	23.408	173.067	196.480	14.50	13.6

TABLE E.32 RCP: White-Footed Mouse

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Mouse Benchmark ADD (mg/kg-d)	HQ
Aluminum	4.10	4.10	1.070	0.775	0.059	236.700	1.845	238.604	2.140	111.5
Antimony	0.02	0.02	0.006	0.005	--	0.020	0.011	0.031	0.138	0.2
Cadmium	3.74	3.74	0.976	0.707	--	0.061	1.683	1.744	1.930	0.9
Chromium	0.97	0.97	0.253	0.183	--	1.719	0.437	2.156	6.550	0.3
Copper	46.00	3.70	12.006	0.699	0.004	15.930	12.705	28.639	30.400	0.9
Iron	37.50	17.10	9.788	3.232	0.225	171.000	13.019	184.244	NA	NA
Lead	1.30	0.18	0.339	0.034	<0.001	9.630	0.373	10.004	15.980	0.6
Magnesium	950.00	317.00	247.950	59.913	24.820	17.190	307.863	349.873	NA	NA
Mercury	0.05	0.05	0.012	0.009	--	0.001	0.021	0.022	2.600	<0.1
Nickel	1.20	1.20	0.313	0.227	--	0.180	0.540	0.720	79.890	<0.1
Silver	13.52	13.52	3.527	2.554	--	0.081	6.082	6.163	45.450	0.1
Sodium	731.00	46.00	190.791	8.694	160.600	5.841	199.485	365.926	NA	NA
Zinc	253.00	21.10	66.033	3.988	0.005	3.465	70.021	73.491	319.500	0.2

TABLE E.33 RCP: Eastern Cottontail

Contaminant	Vegetation Contaminant Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Cottontail Benchmark ADD (mg/kd-d)	HQ
Aluminum	4.100	1.115	0.027	450.714	1.115	451.856	0.767	589.1
Antimony	0.024	0.007	--	0.038	0.007	0.044	0.050	0.9
Cadmium	3.740	1.017	--	0.117	1.017	1.134	0.709	1.6
Chromium	0.970	0.264	--	3.273	0.264	3.537	2.410	1.5
Copper	3.700	1.006	0.002	30.333	1.006	31.341	11.200	2.8
Iron	17.100	4.652	0.102	325.611	4.652	330.365	NA	NA
Lead	0.180	0.049	<0.001	18.337	0.049	18.386	5.330	3.4
Magnesium	317.000	86.231	11.283	32.732	86.231	130.246	NA	NA
Mercury	0.046	0.012	--	0.002	0.012	0.014	0.024	0.6
Nickel	1.200	0.326	--	0.343	0.326	0.669	29.400	<0.1
Silver	13.515	3.676	--	0.154	3.676	3.831	NA	NA
Sodium	46.000	12.513	73.005	11.122	12.513	96.640	NA	NA
Zinc	21.100	5.740	0.002	6.598	5.740	12.340	117.600	0.1

TABLE E.34 RCP: White-Tailed Deer

Contaminant	Vegetation Contaminant Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Deer ADD Benchmark (mg/kg-d)	HQ
Aluminum	4.100	0.032	0.005	4.162	0.032	4.199	0.293	14.3
Antimony	0.024	<0.001	--	<0.001	<0.001	<0.001	0.019	<0.1
Cadmium	3.740	0.030	--	0.001	0.030	0.031	0.271	0.1
Chromium	0.970	0.008	--	0.030	0.008	0.038	0.920	<0.1
Copper	3.700	0.029	<0.001	0.280	0.029	0.310	4.300	<0.1
Iron	17.100	0.135	0.017	3.007	0.135	3.159	NA	NA
Lead	0.180	0.001	<0.001	0.169	0.001	0.171	2.240	<0.1
Magnesium	317.000	2.508	1.910	0.302	2.508	4.720	NA	NA
Mercury	0.046	<0.001	--	<0.001	<0.001	<0.001	0.009	<0.1
Nickel	1.200	0.009	--	0.003	0.009	0.013	11.220	<0.1
Silver	13.515	0.107	--	0.001	0.107	0.108	NA	NA
Sodium	46.000	0.364	12.358	0.103	0.364	12.825	NA	NA
Zinc	21.100	0.167	<0.001	0.061	0.167	0.228	44.900	<0.1

TABLE E.35 RCP: Red Fox

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Rabbits (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Fox ADD Benchmark (mg/kg-d)	HQ
Aluminum	4.100	4.100	238.604	0.315	326.097	1605.329	<0.001	<0.001	0.046	0.087	<0.001	0.009	0.044	<0.001	0.438	0.186	0.624	0.551	1.1
Antimony	0.024	0.024	0.031	0.002	0.064	0.171	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	0.036	<0.1
Cadmium	3.740	3.740	0.100	0.280	5.767	6.098	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	0.001	0.001	0.509	<0.1
Chromium	0.970	0.970	5.250	0.073	3.797	13.087	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	--	0.003	0.002	0.005	1.730	<0.1
Copper	46.000	3.700	28.639	3.445	27.151	138.962	0.001	<0.001	0.005	0.006	<0.001	<0.001	0.004	<0.001	0.029	0.018	0.047	8.000	<0.1
Iron	37.500	17.100	184.244	2.838	257.248	1193.811	<0.001	0.002	0.035	0.063	<0.001	0.007	0.033	<0.001	0.317	0.141	0.458	NA	NA
Lead	1.300	0.180	0.510	0.097	13.285	66.011	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	0.002	<0.001	0.018	0.006	0.024	4.220	<0.1
Magnesium	950.000	317.000	349.873	74.456	528.866	1006.632	0.025	0.033	0.067	0.025	0.002	0.014	0.028	0.054	0.032	0.194	0.279	NA	NA
Mercury	0.046	0.046	0.022	0.003	0.071	0.077	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	0.010	<0.1
Nickel	1.200	1.200	0.720	0.090	2.067	3.040	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	21.120	<0.1
Silver	13.515	13.515	6.163	1.012	20.652	21.091	<0.001	0.001	0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	0.005	0.005	NA	NA
Sodium	731.000	46.000	365.926	76.191	231.812	679.859	0.019	0.005	0.070	0.019	0.002	0.006	0.019	0.348	0.011	0.140	0.498	NA	NA
Zinc	253.000	21.100	73.491	18.947	36.758	196.480	0.007	0.002	0.014	0.002	<0.001	0.001	0.005	<0.001	0.006	0.032	0.039	84.500	<0.1

TABLE E.36 PB: Vegetation

Contaminant	SPTF	Plant Tissue Concentration (mg/kg)	Soil Concentration (mg/kg)	Benchmark (mg/kg)	Media- Based HQ
Acetone	1.33E+01	0.089	0.007	NA	NA
Aluminum	1.80E-04	3.312	18400.000	NA	NA
Antimony	1.10E-02	0.019	1.750	5	0.4
Benzo(k)fluoranthene	3.04E-03	<0.001	0.208	NA	NA
Cadmium	5.50E-01	1.925	3.500	10	0.4
Copper	1.30E-01	9.737	74.900	100	0.7
Cyanide	1.35E+01	35.100	2.600	NA	NA
Endrin Aldehyde	5.61E-03	<0.001	0.008	NA	NA
Iron	4.00E-03	62.000	15500.000	NA	NA
Lead	6.80E-02	4.066	59.800	100	0.6
Magnesium	1.30E-01	138.756	1067.352	NA	NA
Manganese	3.00E-02	13.170	439.000	330	1.3
Mercury	3.80E-01	0.049	0.130	0.3	0.4
Nickel	6.00E-02	0.864	14.400	20	0.7
Sodium	5.00E-02	4.225	84.500	NA	NA
Zinc	4.00E-01	76.000	190.000	10	19.0

TABLE E.37 PB: American Kestrel

Contaminant	Insect Contaminant Concentration (mg/kg)	Snake Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Insect Ingestion (mg/kg-d)	ADD from Snake Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Kestrel Benchmark ADD (mg/kg-d)	HQ
Acetone	0.089	<0.001	0.040	0.009	0.135	0.135	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Aluminum	3.312	8.670	167.333	0.388	5.267	1123.987	0.009	0.004	0.452	<0.001	0.005	0.967	0.005	1.437	1.442	109.700	<0.1
Antimony	0.019	<0.001	0.024	0.002	0.029	0.136	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	<0.001	<0.001	0.002	<0.001	<0.001	0.014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Cadmium	1.925	0.020	0.898	0.200	2.926	3.139	0.005	<0.001	0.002	<0.001	0.003	0.003	--	0.013	0.013	1.450	<0.1
Copper	37.200	0.359	12.224	3.857	14.800	36.052	0.103	<0.001	0.033	0.003	0.013	0.031	--	0.184	0.184	47.000	<0.1
Cyanide	35.100	0.340	15.818	3.639	53.352	53.510	0.097	<0.001	0.043	0.003	0.046	0.046	--	0.235	0.235	NA	NA
Endrin Aldehyde	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Iron	71.600	8.126	170.345	7.505	94.661	1042.898	0.199	0.004	0.460	0.006	0.081	0.897	0.010	1.648	1.658	NA	NA
Lead	0.125	0.034	1.340	0.013	6.182	7.421	<0.001	<0.001	0.004	<0.001	0.005	0.006	<0.001	0.016	0.016	1.130	<0.1
Magnesium	911.000	24.069	295.502	98.509	231.909	766.328	2.530	0.011	0.798	0.085	0.200	0.659	0.486	4.283	4.769	NA	NA
Manganese	11.600	0.336	9.495	1.208	20.045	45.782	0.032	<0.001	0.026	0.001	0.017	0.039	<0.001	0.116	0.116	997.000	<0.1
Mercury	0.049	<0.001	0.023	0.005	0.075	0.083	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	0.450	<0.1
Nickel	0.864	0.015	0.518	0.090	1.313	2.189	0.002	<0.001	0.001	<0.001	0.001	0.002	--	0.007	0.007	77.400	<0.1
Sodium	771.000	126.195	369.230	110.722	166.022	637.359	2.141	0.058	0.997	0.095	0.143	0.548	3.697	3.983	7.680	NA	NA
Zinc	188.000	1.766	65.146	19.494	115.524	195.172	0.522	<0.001	0.176	0.017	0.099	0.168	<0.001	0.983	0.983	14.500	<0.1

TABLE E.38 PB: Red-Tailed Hawk

Contaminant	Snake Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Snake Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Rabbits (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Hawk Benchmark ADD (mg/kg-d)	HQ
Acetone	<0.001	0.040	0.009	0.135	0.135	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Aluminum	8.670	167.333	0.388	5.267	1123.987	<0.001	0.056	0.009	<0.001	<0.001	0.016	<0.001	0.082	0.083	109.70	<0.1
Antimony	<0.001	0.024	0.002	0.029	0.136	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Benzo(k)fluoranthene	<0.001	0.002	<0.001	<0.001	0.014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Cadmium	0.020	0.898	0.200	2.926	3.139	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	1.45	<0.1
Copper	0.359	12.224	3.857	14.800	36.052	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	--	0.005	0.005	47.00	<0.1
Cyanide	0.340	15.818	3.639	53.352	53.510	<0.001	0.005	<0.001	<0.001	<0.001	<0.001	--	0.008	0.008	NA	NA
Endrin Aldehyde	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Iron	8.126	170.345	7.505	94.661	1042.898	<0.001	0.057	0.009	<0.001	0.001	0.015	<0.001	0.083	0.084	NA	NA
Lead	0.034	1.340	0.013	6.182	7.421	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.13	<0.1
Magnesium	24.069	295.502	98.509	231.909	766.328	0.002	0.099	0.005	0.001	0.003	0.011	0.044	0.121	0.165	NA	NA
Manganese	0.336	9.495	1.208	20.045	45.782	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	0.005	997.00	<0.1
Mercury	<0.001	0.023	0.005	0.075	0.083	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	0.45	<0.1
Nickel	0.015	0.518	0.090	1.313	2.189	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	77.40	<0.1
Zinc	1.766	65.146	19.494	115.524	195.172	<0.001	0.022	0.002	<0.001	0.002	0.003	<0.001	0.029	0.029	14.50	<0.1

TABLE E.39 PB: American Robin

Contaminant	Soil	Vegetation	ADD from		ADD from		ADD from		Robin	
	Invertebrate Food Concentration (mg/kg)	Contaminant Concentration (mg/kg)	Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Benchmark ADD (mg/kg-d)	HQ
Acetone	0.089	0.089	0.054	0.081	--	<0.001	0.135	0.135	NA	NA
Aluminum	3.312	3.312	2.014	3.021	0.232	1118.720	5.034	1123.987	109.700	10.2
Antimony	0.019	0.019	0.012	0.018	--	0.106	0.029	0.136	NA	NA
Benzo(k)fluoranthene	<0.001	<0.001	<0.001	<0.001	--	0.013	<0.001	0.014	NA	NA
Cadmium	1.925	1.925	1.170	1.756	--	0.213	2.926	3.139	1.450	2.2
Copper	37.200	9.737	22.618	8.880	--	4.554	31.498	36.052	47.000	0.8
Cyanide	35.100	35.100	21.341	32.011	--	0.158	53.352	53.510	NA	NA
Endrin Aldehyde	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Iron	71.600	62.000	43.533	56.544	0.421	942.400	100.077	1042.898	NA	NA
Lead	0.125	4.066	0.076	3.709	<0.001	3.636	3.785	7.421	1.130	6.6
Magnesium	911.000	138.756	553.888	126.545	21.000	64.895	680.433	766.328	NA	NA
Manganese	11.600	13.170	7.053	12.011	0.026	26.691	19.064	45.782	997.000	<0.1
Mercury	0.049	0.049	0.030	0.045	--	0.008	0.075	0.083	0.450	0.2
Nickel	0.864	0.864	0.525	0.788	--	0.876	1.313	2.189	77.400	<0.1
Sodium	771.000	4.225	468.768	3.853	159.600	5.138	472.621	637.359	NA	NA
Zinc	188.000	76.000	114.304	69.312	0.004	11.552	183.616	195.172	14.500	13.5

TABLE E.40 PB: Tree Swallow

Contaminant	Insect Contaminant Concentration (mg/kg)	ADD from Insect Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Tree Swallow Benchmark ADD (mg/kg-d)	HQ
Acetone	0.089	0.009	--	--	0.009	0.009	NA	NA
Aluminum	3.312	0.343	0.045	--	0.343	0.388	109.70	<0.1
Antimony	0.019	0.002	--	--	0.002	0.002	NA	NA
Benzo(k)fluoranthene	<0.001	<0.001	--	--	<0.001	<0.001	NA	NA
Cadmium	1.925	0.200	--	--	0.200	0.200	1.45	0.1
Copper	37.200	3.857	--	--	3.857	3.857	47.00	<0.1
Cyanide	35.100	3.639	--	--	3.639	3.639	NA	NA
Endrin Aldehyde	<0.001	<0.001	--	--	<0.001	<0.001	NA	NA
Iron	71.600	7.424	0.081	--	7.424	7.505	NA	NA
Lead	0.125	0.013	<0.001	--	0.013	0.013	1.13	<0.1
Magnesium	911.000	94.459	4.050	--	94.459	98.509	NA	NA
Manganese	11.600	1.203	0.005	--	1.203	1.208	997.00	<0.1
Mercury	0.049	0.005	--	--	0.005	0.005	0.45	<0.1
Nickel	0.864	0.090	--	--	0.090	0.090	77.40	<0.1
Sodium	771.000	79.942	30.780	--	79.942	110.722	NA	NA
Zinc	188.000	19.493	<0.001	--	19.493	19.494	14.50	1.3

TABLE E.41 PB: White-Footed Mouse

Contaminant	Insect	Vegetation	ADD from Soil	ADD from	ADD from	ADD from	Total ADD	Mouse Benchmark	HQ
	Contaminant Concentration (mg/kg)	Contaminant Concentration (mg/kg)	Invertebrate Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Drinking Water (mg/kg-d)	Incidental Soil Ingestion (mg/kg-d)			
Acetone	0.089	0.089	0.023	0.017	--	<0.001	0.040	20.00	<0.1
Aluminum	3.312	3.312	0.864	0.626	0.242	165.600	1.490	2.09	80.2
Antimony	0.019	0.019	0.005	0.004	--	0.016	0.009	0.14	0.2
Benzo(k)fluoranthene	<0.001	<0.001	<0.001	<0.001	--	0.002	<0.001	NA	NA
Cadmium	1.925	1.925	0.502	0.364	--	0.032	0.866	1.93	0.5
Copper	37.200	9.737	9.709	1.840	--	0.674	11.549	30.40	0.4
Cyanide	35.100	35.100	9.161	6.634	--	0.023	15.795	128.90	0.1
Endrin Aldehyde	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Iron	71.600	62.000	18.688	11.718	0.439	139.500	30.406	NA	NA
Lead	0.125	4.066	0.033	0.769	<0.001	0.538	0.801	15.98	<0.1
Magnesium	911.000	138.756	237.771	26.225	21.900	9.606	263.996	NA	NA
Manganese	11.600	13.170	3.028	2.489	0.028	3.951	5.517	176.00	<0.1
Mercury	0.049	0.049	0.013	0.009	--	0.001	0.022	2.60	<0.1
Nickel	0.864	0.864	0.226	0.163	--	0.130	0.389	79.89	<0.1
Sodium	771.000	4.225	201.231	0.799	166.440	0.761	202.030	NA	NA
Zinc	188.000	76.000	49.068	14.364	0.004	1.710	63.432	319.50	0.2

TABLE E.42 PB: Eastern Cottontail

Contaminant	Vegetation Contaminant Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental		Total ADD (mg/kg-d)	Cottontail Benchmark ADD (mg/kg-d)	HQ
				Soil Ingestion (mg/kg-d)	Food Ingestion (mg/kg-d)			
Acetone	0.089	0.033	--	<0.001	0.033	0.033	7.30	<0.1
Aluminum	3.312	1.247	0.153	138.606	1.247	140.006	0.77	182.5
Antimony	0.019	0.007	--	0.013	0.007	0.020	0.05	0.4
Benzo(k)fluoranthene	<0.001	<0.001	--	0.002	<0.001	0.002	NA	NA
Cadmium	1.925	0.725	--	0.026	0.725	0.751	0.71	1.1
Copper	9.737	3.667	--	0.564	3.667	4.232	11.20	0.4
Cyanide	35.100	13.220	--	0.020	13.220	13.240	47.40	0.3
Endrin Aldehyde	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Iron	62.000	23.352	0.277	116.760	23.352	140.389	NA	NA
Lead	4.066	1.532	<0.001	0.450	1.532	1.983	5.88	0.3
Magnesium	138.756	52.262	13.784	8.040	52.262	74.086	NA	NA
Manganese	13.170	4.960	0.017	3.307	4.960	8.285	65.00	0.1
Mercury	0.049	0.019	--	<0.001	0.019	0.020	0.96	<0.1
Nickel	0.864	0.325	--	0.108	0.325	0.434	29.40	<0.1
Sodium	4.225	1.591	104.760	0.637	1.591	106.988	NA	NA
Zinc	76.000	28.625	0.003	1.431	28.625	30.059	117.60	0.3

TABLE E.43 PB: White-Tailed Deer

Contaminant	Vegetation Contaminant Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Deer ADD Benchmark (mg/kg-d)	HQ
Acetone	0.089	<0.001	--	<0.001	<0.001	<0.001	2.80	<0.1
Aluminum	3.312	0.036	0.026	4.032	0.036	4.094	0.29	14.0
Antimony	0.019	<0.001	--	<0.001	<0.001	<0.001	0.02	<0.1
Benzo(k)fluoranthene	<0.001	<0.001	--	<0.001	<0.001	<0.001		NA
Cadmium	1.925	0.021	--	<0.001	0.021	0.022	0.27	<0.1
Copper	9.737	0.107	--	0.016	0.107	0.123	4.30	<0.1
Cyanide	35.100	0.385	--	<0.001	0.385	0.385	18.10	<0.1
Endrin Aldehyde	<0.001	<0.001	--	<0.001	<0.001	<0.001		NA
Iron	62.000	0.679	0.047	3.396	0.679	4.122		NA
Lead	4.066	0.045	<0.001	0.013	0.045	0.058	2.24	<0.1
Magnesium	138.756	1.520	2.333	0.234	1.520	4.087		NA
Manganese	13.170	0.144	0.003	0.096	0.144	0.243	25.00	<0.1
Mercury	0.049	<0.001	--	<0.001	<0.001	<0.001	0.01	<0.1
Nickel	0.864	0.009	--	0.003	0.009	0.013	11.22	<0.1
Sodium	4.225	0.046	17.733	0.019	0.046	17.798		NA
Zinc	76.000	0.833	<0.001	0.042	0.833	0.875	44.90	<0.1

TABLE E.44 PB: Red Fox

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Rabbits (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Fox ADD Benchmark (mg/kg-d)	HQ
Acetone	0.089	0.089	0.040	0.009	0.135	0.135	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	5.30	<0.1
Aluminum	3.312	3.312	167.333	0.388	5.267	1123.987	<0.001	<0.001	0.044	<0.001	<0.001	<0.001	0.043	<0.001	0.425	0.088	0.513	0.55	0.9
Antimony	0.019	0.019	0.024	0.002	0.029	0.136	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	0.04	<0.1
Benzo(k)fluoranthene	<0.001	<0.001	0.002	<0.001	<0.001	0.014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Cadmium	1.925	1.925	0.898	0.200	2.926	3.139	<0.001	<0.001	<0.001	0.175	<0.001	<0.001	<0.001	--	<0.001	0.175	0.176	0.51	0.3
Copper	37.200	9.737	12.224	3.857	14.800	36.052	0.001	0.001	0.003	0.004	<0.001	<0.001	0.001	--	0.002	0.012	0.013	8.00	<0.1
Cyanide	35.100	35.100	15.818	3.639	53.352	53.510	0.001	0.005	0.004	<0.001	<0.001	0.002	0.002	--	<0.001	0.015	0.015	34.10	<0.1
Endrin Aldehyde	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.037	<0.001	<0.001	<0.001	--	<0.001	0.037	0.037	NA	NA
Iron	71.600	62.000	170.345	7.505	94.661	1042.898	0.003	0.009	0.045	<0.001	<0.001	0.004	0.040	0.001	0.358	0.101	0.460	NA	NA
Lead	0.125	4.066	1.340	0.013	6.182	7.421	<0.001	<0.001	<0.001	0.020	<0.001	<0.001	<0.001	<0.001	0.001	0.021	0.022	4.22	<0.1
Magnesium	911.000	138.756	295.502	98.509	231.909	766.328	0.033	0.020	0.078	0.002	0.004	0.009	0.029	0.066	0.025	0.175	0.265	NA	NA
Manganese	11.600	13.170	9.495	1.208	20.045	45.782	<0.001	0.002	0.003	<0.001	<0.001	<0.001	0.002	<0.001	0.010	0.007	0.018	46.00	<0.1
Mercury	0.049	0.049	0.023	0.005	0.075	0.083	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	0.01	<0.1
Nickel	0.864	0.864	0.518	0.090	1.313	2.189	<0.001	<0.001	<0.001	0.028	<0.001	<0.001	<0.001	--	<0.001	0.028	0.029	21.12	<0.1
Sodium	771.000	4.225	369.230	110.722	166.022	637.359	0.028	<0.001	0.098	<0.001	0.004	0.006	0.024	0.499	0.002	0.161	0.662	NA	NA
Zinc	188.000	76.000	65.146	19.494	115.524	195.172	0.007	0.011	0.017	--	<0.001	0.004	0.007	<0.001	0.004	0.047	0.052	84.50	<0.1

TABLE E.45 SBDG: Leopard Frog

Contaminant	Surface Water Concentration (µg/L)	BCF	Estimated Leopard Frog Tissue Concentrations (mg/kg)	Method for Deriving Tissue Concentration
Aluminum	256.00	1.10E+01	2.82	Calculated
Iron	5260.00	1.00E+02	526.00	Calculated
Lead	1.63	7.50E+01	0.12	Calculated
Zinc	67.40	2.28E+02	15.37	Calculated

TABLE E.46 SBDG: American Robin (Drinking Water Only)

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Robin Benchmark ADD (mg/kg-d)	HQ
Aluminum	--	--	--	--	0.036	--	--	0.036	109.70	<0.1
Iron	--	--	--	--	0.736	--	--	0.736	NA	NA
Lead	--	--	--	--	<0.001	--	--	<0.001	1.13	<0.1
Zinc	--	--	--	--	0.009	--	--	0.009	14.50	<0.1

TABLE E.47 SBDG: White-Footed Mouse (Drinking Water Only)

Contaminant	Insect Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Insect Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Mouse Benchmark ADD (mg/kg-d)	HQ
Aluminum	--	--	--	--	0.037	--	--	0.037	2.14	<0.1
Iron	--	--	--	--	0.768	--	--	0.768	NA	NA
Lead	--	--	--	--	<0.001	--	--	<0.001	15.98	<0.1
Zinc	--	--	--	--	0.010	--	--	0.010	319.50	<0.1

TABLE E.48 SBDG: Eastern Cottontail (Drinking Water Only)

Contaminant	Vegetation Contaminant Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Cottontail Benchmark ADD (mg/kg-d)	HQ
Aluminum	--	--	0.006	--	--	0.006	0.77	<0.1
Iron	--	--	0.130	--	--	0.130	NA	NA
Lead	--	--	<0.001	--	--	<0.001	5.33	<0.1
Zinc	--	--	0.002	--	--	0.002	117.60	<0.1

TABLE E.49 SBDG: White-Tailed Deer (Drinking Water Only)

Contaminant	Vegetation Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Deer ADD Benchmark (mg/kg-d)	HQ
Aluminum	--	--	0.001	--	--	0.001	0.29	<0.1
Iron	--	--	0.022	--	--	0.022	NA	NA
Lead	--	--	<0.001	--	--	<0.001	2.24	<0.1
Zinc	--	--	<0.001	--	--	<0.001	44.90	<0.1

TABLE E.50 SBDG: Red Fox

Contaminant	Soil Invertebrate Food Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Fox ADD Benchmark (mg/kg-d)	HQ
Aluminum	--	--	0.037	0.002	0.036	0.036	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.55	<0.1
Iron	--	--	0.768	0.038	0.736	0.736	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NA	NA
Lead	--	--	<0.1	<0.1	<0.1	<0.1	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	4.22	<0.1
Zinc	--	--	0.010	<0.1	0.009	0.009	--	--	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	84.50	<0.1

TABLE E.51 RPDG: Vegetation

Contaminant	SPTF	Plant Tissue Concentration (mg/kg)	Soil Contaminant Concentration (mg/kg)	Plant Soil Benchmark (mg/kg)	Media- Based HQ
2,4-Dinitrotoluene	6.76E-01	0.771	1.140	NA	NA
Aluminum	1.80E-04	1.531	8507.436	NA	NA
Antimony	1.10E-02	0.010	0.894	5	0.2
Cadmium	5.50E-01	--	--	10	--
Chromium	7.50E-03	0.093	12.371	3.5	3.5
Copper	1.30E-01	1.729	13.299	100	0.1
Iron	4.00E-03	55.507	13876.644	NA	NA
Lead	6.80E-02	2.095	30.801	100	0.3
Magnesium	1.30E-01	115.635	889.499	NA	NA
Manganese	3.00E-02	3.450	115.000	330	0.3
Mercury	3.80E-01	0.040	0.106	0.3	0.4
Nickel	6.00E-02	0.435	7.248	20	0.4
RDX	1.23E-01	--	--	NA	NA
Silver	1.50E+00	15.450	10.300	2	5.2
Sodium	5.00E-02	2.230	44.600	NA	NA
Zinc	4.00E-01	32.760	81.900	10	8.2

TABLE E.52 RPDG: Red-Spotted Newt

Contaminant	Invertebrate Food Contaminant Concentration (mg/kg)	ADD from Dermal Contact with Soil (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food Ingestion (mg/kg-d)	Total ADD (mg/kg-d)
2,4-Dinitrotoluene	0.771	0.055	0.247	0.008	0.31
Aluminum	1.531	412.027	1842.012	0.017	2254.06
Antimony	0.010	0.043	0.194	<0.001	0.24
Cadmium	--	--	--	--	--
Chromium	0.093	0.599	2.679	0.001	3.28
Copper	1.729	0.644	2.880	0.019	3.54
Iron	55.507	672.066	3004.541	0.601	3677.21
Lead	2.095	1.492	6.669	0.023	8.18
Magnesium	115.635	43.080	192.593	1.252	236.92
Manganese	3.450	5.570	24.900	0.037	30.51
Mercury	0.040	0.005	0.023	<0.001	0.03
Nickel	0.435	0.351	1.569	0.005	1.93
RDX	--	--	--	--	--
Silver	15.450	0.499	2.230	0.167	2.90
Sodium	2.230	2.160	9.657	0.024	11.84
Zinc	32.760	3.967	17.733	0.355	22.05

TABLE E.53 RPDG: American Robin

Contaminant	Soil	Vegetation	ADD from Soil		ADD from		ADD from		ADD from		Robins Benchmark ADD (mg/kg-d)	HQ
	Invertebrate Food Concentration (mg/kg)	Contaminant Concentration (mg/kg)	Invertebrate Ingestion (mg/kg-d)	Vegetation Ingestion (mg/kg-d)	Drinking Water (mg/kg-d)	Incidental Soil Ingestion (mg/kg-d)	Food (mg/kg-d)	Total ADD (mg/kg-d)	Food (mg/kg-d)	Total ADD (mg/kg-d)		
2,4-Dinitrotoluene	0.771	0.771	0.202	0.304	--	0.030	0.506	0.536	NA	NA	NA	NA
Aluminum	1.531	1.531	0.402	0.603	1.833	223.504	1.006	226.343	109.70	2.1	2.1	2.1
Antimony	0.010	0.010	0.003	0.004	--	0.023	0.006	0.030	NA	NA	NA	NA
Cadmium	--	--	--	--	<0.001	--	--	<0.001	1.45	<0.1	<0.1	<0.1
Chromium	0.093	0.093	0.024	0.037	0.002	0.325	0.061	0.388	1.00	0.4	0.4	0.4
Copper	1.729	1.729	0.454	0.681	0.005	0.349	1.136	1.489	47.00	<0.1	<0.1	<0.1
Iron	55.507	55.507	14.582	21.874	11.554	364.562	36.456	412.572	NA	NA	NA	NA
Lead	2.095	2.095	0.550	0.825	0.014	0.809	1.376	2.199	1.13	1.9	1.9	1.9
Magnesium	115.635	115.635	30.379	45.569	7.380	23.369	75.948	106.697	NA	NA	NA	NA
Manganese	3.450	3.450	0.906	1.360	0.318	3.021	2.266	5.605	997.00	<0.1	<0.1	<0.1
Mercury	0.040	0.040	0.011	0.016	<0.001	0.003	0.026	0.029	0.45	<0.1	<0.1	<0.1
Nickel	0.435	0.435	0.114	0.171	0.004	0.190	0.286	0.480	77.40	<0.1	<0.1	<0.1
RDX	--	--	--	--	<0.001	--	--	<0.001	NA	NA	NA	NA
Silver	15.450	15.450	4.059	6.088	<0.001	0.271	10.147	10.418	165.61	<0.1	<0.1	<0.1
Sodium	2.230	2.230	0.586	0.879	51.057	1.172	1.465	53.693	NA	NA	NA	NA
Zinc	32.760	32.760	8.607	12.910	0.035	2.152	21.516	23.703	14.50	1.6	1.6	1.6

TABLE E.54 RPDG: American Kestrel

Contaminant	Insect Contaminant Concentration (mg/kg)	Snake Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Ingestion Insect (mg/kg-d)	ADD from Ingestion Snake (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Kestrel Benchmark ADD (mg/kg-d)	HQ
2,4-Dinitrotoluene	0.771	0.001	0.357	0.008	1.185	0.536	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Aluminum	1.531	1.361	81.680	0.095	110.020	226.343	<0.001	<0.001	0.021	<0.001	0.009	0.019	0.010	0.050	0.060	109.70	<0.1
Antimony	0.010	<0.001	0.012	<0.001	0.026	0.030	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Cadmium	--	<0.001	0.020	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.45	<0.1
Chromium	0.093	0.005	3.200	0.001	0.297	0.388	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.00	<0.1
Copper	1.729	0.008	0.909	0.018	2.800	1.489	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	47.00	<0.1
Iron	55.507	22.501	177.754	1.061	279.850	412.572	0.015	0.001	0.047	<0.001	0.023	0.035	0.060	0.121	0.181	NA	NA
Lead	2.095	0.025	0.930	0.022	3.590	2.199	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	1.13	<0.1
Magnesium	115.635	8.020	77.853	1.486	203.661	106.697	0.031	<0.001	0.020	<0.001	0.017	0.009	0.038	0.078	0.117	NA	NA
Manganese	3.450	0.272	3.355	0.049	7.379	5.605	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.003	0.005	997.00	<0.1
Mercury	0.040	0.003	0.019	<0.001	0.063	0.029	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.45	<0.1
Nickel	0.435	0.009	0.272	0.005	0.759	0.480	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	77.40	<0.1
RDX	--	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Silver	15.450	0.023	7.045	0.156	23.609	10.418	0.004	<0.001	0.002	<0.001	0.002	<0.001	<0.001	0.009	0.009	165.61	<0.1
Sodium	2.230	94.974	124.629	2.238	122.092	53.693	<0.001	0.004	0.033	<0.001	0.010	0.004	0.266	0.052	0.319	NA	NA
Zinc	32.760	0.190	15.564	0.332	50.873	23.703	0.009	<0.001	0.004	<0.001	0.004	0.002	<0.001	0.019	0.019	14.50	<0.1

TABLE E.55 RPDG: Red-Tailed Hawk

Contaminant	Snake Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Ingestion Snake (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Rabbits (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Hawk Benchmark ADD (mg/kg-d)	HQ
2,4-Dinitrotoluene	0.001	0.357	0.008	1.185	0.536	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Aluminum	1.361	81.680	0.095	110.020	226.343	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.004	109.700	<0.1
Antimony	<0.001	0.012	<0.001	0.026	0.030	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	NA	NA
Cadmium	<0.001	0.020	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.450	<0.1
Chromium	0.005	3.200	0.001	0.297	0.388	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.000	<0.1
Copper	0.008	0.909	0.018	2.800	1.489	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	47.000	<0.1
Iron	22.501	177.754	1.061	279.850	412.572	<0.001	0.006	<0.001	<0.001	<0.001	<0.001	0.005	0.007	0.012	NA	NA
Lead	0.025	0.930	0.022	3.590	2.199	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.130	<0.1
Magnesium	8.020	77.853	1.486	203.661	106.697	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	0.003	0.003	0.007	NA	NA
Manganese	0.272	3.355	0.049	7.379	5.605	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	997.000	<0.1
Mercury	0.003	0.019	<0.001	0.063	0.029	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.450	<0.1
Nickel	0.009	0.272	0.005	0.759	0.480	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	77.400	<0.1
RDX	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Silver	0.023	7.045	0.156	23.609	10.418	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	165.610	<0.1
Sodium	94.974	124.629	2.238	122.092	53.693	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	0.024	0.005	0.029	NA	NA
Zinc	0.190	15.564	0.332	50.873	23.703	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	14.500	<0.1

TABLE E.56 RPDG: White-Footed Mouse

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Mouse Benchmark ADD (mg/kg-d)	HQ
2,4-Dinitrotoluene	0.771	0.771	0.201	0.146	--	0.010	0.347	0.357	NA	NA
Aluminum	1.531	1.531	0.400	0.289	4.424	76.567	0.689	81.680	2.14	38.2
Antimony	0.010	0.010	0.003	0.002	--	0.008	0.004	0.012	0.14	<0.1
Cadmium	--	--	--	--	<0.001	--	--	<0.001	1.93	<0.1
Chromium	0.093	0.093	0.024	0.018	0.006	0.111	0.042	0.159	6.55	<0.1
Copper	1.729	1.729	0.451	0.327	0.011	0.120	0.778	0.909	30.40	<0.1
Iron	55.507	55.507	14.487	10.491	27.886	124.890	24.978	177.754	NA	NA
Lead	2.095	2.095	0.547	0.396	0.033	0.277	0.943	1.253	15.98	<0.1
Magnesium	115.635	115.635	30.181	21.855	17.812	8.005	52.036	77.853	NA	NA
Manganese	3.450	3.450	0.900	0.652	0.768	1.035	1.553	3.355	219.29	<0.1
Mercury	0.040	0.040	0.011	0.008	<0.001	<0.001	0.018	0.019	2.60	<0.1
Nickel	0.435	0.435	0.114	0.082	0.011	0.065	0.196	0.272	79.89	<0.1
RDX	--	--	--	--	<0.001	--	--	<0.001	NA	NA
Silver	15.450	15.450	4.032	2.920	<0.001	0.093	6.953	7.045	45.45	0.2
Sodium	2.230	2.230	0.582	0.421	123.224	0.401	1.004	124.629	NA	NA
Zinc	32.760	32.760	8.550	6.192	0.085	0.737	14.742	15.564	319.50	<0.1

TABLE E.57 RPDG: Eastern Cottontail

Contaminant	Vegetation Contaminant Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental		ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Cottontail Benchmark ADD (mg/kg-d)	HQ
				Soil Ingestion (mg/kg-d)					
2,4-Dinitrotoluene	0.771	0.028	--	0.003		0.028	0.031	NA	NA
Aluminum	1.531	0.056	0.271	19.626		0.056	19.953	0.77	26.0
Antimony	0.010	<0.001	--	0.002		<0.001	0.002	0.05	<0.1
Cadmium	--	--	<0.001	--		--	<0.001	0.71	<0.1
Chromium	0.093	0.003	<0.001	0.029		0.003	0.032	2.41	<0.1
Copper	1.729	0.063	<0.001	0.031		0.063	0.095	11.20	<0.1
Iron	55.507	2.033	1.706	32.013		2.033	35.752	NA	NA
Lead	2.095	0.077	0.002	0.071		0.077	0.150	5.33	<0.1
Magnesium	115.635	4.234	1.090	2.052		4.234	7.376	NA	NA
Manganese	3.450	0.126	0.047	0.265		0.126	0.439	65.00	<0.1
Mercury	0.040	0.001	<0.001	<0.001		0.001	0.002	0.02	<0.1
Nickel	0.435	0.016	<0.001	0.017		0.016	0.033	29.40	<0.1
RDX	--	--	<0.001	--		--	<0.001	NA	NA
Silver	15.450	0.566	<0.001	0.024		0.566	0.590	NA	NA
Sodium	2.230	0.082	7.540	0.103		0.082	7.725	NA	NA
Zinc	32.760	1.200	0.005	0.189		1.200	1.394	117.60	<0.1

TABLE E.58 RPDG: White-Tailed Deer

Contaminant	Vegetation Contaminant Concentration (mg/kg)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental		ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Deer ADD Benchmark (mg/kg-d)	HQ
				Soil Ingestion (mg/kg-d)					
2,4-Dinitrotoluene	0.771	<0.001	--	<0.001		<0.001	<0.001	NA	NA
Aluminum	1.531	0.002	0.046	0.181		0.002	0.229	0.293	0.78
Antimony	0.010	<0.001	--	<0.001		<0.001	<0.001	0.019	<0.1
Cadmium	--	--	<0.001	--		--	<0.001	0.271	<0.1
Chromium	0.093	<0.001	<0.001	<0.001		<0.001	<0.001	0.920	<0.1
Copper	1.729	0.002	<0.001	<0.001		0.002	0.002	4.300	<0.1
Iron	55.507	0.059	0.289	0.296		0.059	0.644	NA	NA
Lead	2.095	0.002	<0.001	<0.001		0.002	0.003	2.240	<0.1
Magnesium	115.635	0.123	0.185	0.019		0.123	0.327	NA	NA
Manganese	3.450	0.004	0.008	0.002		0.004	0.014	25.000	<0.1
Mercury	0.040	<0.001	<0.001	<0.001		<0.001	<0.001	0.009	<0.1
Nickel	0.435	<0.001	<0.001	<0.001		<0.001	<0.001	11.220	<0.1
RDX	--	--	<0.001	--		--	<0.001	NA	NA
Silver	15.450	0.016	<0.001	<0.001		0.016	0.017	NA	NA
Sodium	2.230	0.002	1.276	<0.001		0.002	1.280	NA	NA
Zinc	32.760	0.035	<0.001	0.002		0.035	0.038	44.900	<0.1

TABLE E.59 RPDG: Red Fox

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Rabbits (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Fox ADD Benchmark (mg/kg-d)	HQ
2,4-Dinitrotoluene	0.771	0.771	0.357	0.008	1.185	0.536	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Aluminum	1.531	1.531	81.680	0.095	110.020	226.343	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.001	0.019	0.004	0.024	0.55	<0.1
Antimony	0.010	0.010	0.012	<0.001	0.026	0.030	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	0.04	<0.1
Cadmium	--	--	0.020	<0.001	<0.001	<0.001	--	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	0.51	<0.1
Chromium	0.093	0.093	3.200	0.001	0.297	0.388	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.73	<0.1
Copper	1.729	1.729	0.909	0.018	2.800	1.489	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	8.00	<0.1
Iron	55.507	55.507	177.754	1.061	279.850	412.572	<0.001	<0.001	0.005	<0.001	<0.001	0.001	0.002	0.008	0.031	0.009	0.048	NA	NA
Lead	2.095	2.095	0.930	0.022	3.590	2.199	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	4.22	<0.1
Magnesium	115.635	115.635	77.853	1.486	203.661	106.697	<0.001	0.002	0.002	<0.001	<0.001	<0.001	<0.001	0.005	0.002	0.005	0.013	NA	NA
Manganese	3.450	3.450	3.355	0.049	7.379	5.605	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	46.00	<0.1
Mercury	0.040	0.040	0.019	<0.001	0.063	0.029	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	<0.1
Nickel	0.435	0.435	0.272	0.005	0.759	0.480	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	21.12	<0.1
RDX	--	--	<0.001	<0.001	<0.001	<0.001	--	--	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Silver	15.450	15.450	7.045	0.156	23.609	10.418	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
Sodium	2.230	2.230	124.629	2.238	122.092	53.693	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	0.036	<0.001	0.004	0.040	NA	NA
Zinc	32.760	32.760	15.564	0.332	50.873	23.703	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	84.50	<0.1

TABLE E.60 RPTS: Red-Spotted Newt

Contaminant	Invertebrate Food Contaminant Concentration (mg/kg)	ADD from Dermal Contact with Soil (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food Ingestion (mg/kg-d)	Total ADD (mg/kg-d)
Aluminum	4.39	1181.73	5283.04	0.05	6464.81
Benzo(b)fluoranthene	<0.01	0.02	0.07	<0.01	0.09
Iron	148.80	1801.65	8054.46	1.61	9857.72
Lead	15.71	11.19	50.02	0.17	61.37
Magnesium	312.00	116.24	519.64	3.38	639.26
Manganese	9.06	14.63	65.39	0.10	80.11
Mercury	0.05	<0.01	0.03	<0.01	0.04
Nickel	1.04	0.84	3.75	0.01	4.59
Zinc	235.20	28.48	127.31	2.55	158.34

TABLE E.61 RPTS: American Robin

Contaminant	Soil Invertebrate Contaminant Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	Total ADD (mg/kg-d)	Robin Benchmark ADD (mg/kg-d)	HQ
Aluminum	4.392	4.392	2.670	4.006	1.175	1483.520	1491.370	109.70	13.6
Benzo(b)fluoranthene	0.001	0.001	<0.001	<0.001	--	0.021	0.022	0.33	<0.1
Iron	148.800	148.800	90.470	135.706	3.976	2261.760	2491.912	NA	NA
Lead	15.708	15.708	9.550	14.326	0.011	14.045	37.932	1.13	33.6
Magnesium	312.000	312.000	189.696	284.544	18.340	145.920	638.500	NA	NA
Manganese	9.060	9.060	5.508	8.263	0.070	18.362	32.203	997.00	<0.1
Mercury	0.050	0.050	0.030	0.046	<0.001	0.008	0.084	0.45	0.2
Nickel	1.038	1.038	0.631	0.947	--	1.052	2.630	77.40	<0.1
Zinc	235.200	235.200	143.002	214.502	0.058	35.750	393.312	14.50	27.1

TABLE E.62 RPTS: White-Footed Mouse

Contaminant	Soil Invertebrate Food Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Mouse Benchmark ADD (mg/kg-d)	HQ
Aluminum	4.392	4.392	1.146	0.830	1.225	219.600	1.976	222.801	2.14	104.1
Benzo(b)fluoranthene	0.001	0.001	<0.001	<0.001	--	0.003	<0.001	0.004	1.11	<0.1
Iron	148.800	148.800	38.837	28.123	4.146	334.800	66.960	405.906	NA	NA
Lead	15.708	15.708	4.100	2.969	0.011	2.079	7.069	9.159	15.98	0.6
Magnesium	312.000	312.000	81.432	58.968	19.126	21.600	140.400	181.126	NA	NA
Manganese	9.060	9.060	2.365	1.712	0.073	2.718	4.077	6.868	219.29	<0.1
Mercury	0.050	0.050	0.013	0.009	<0.001	0.001	0.023	0.024	2.60	<0.1
Nickel	1.038	1.038	0.271	0.196	--	0.156	0.467	0.623	79.89	<0.1
Zinc	235.200	235.200	61.387	44.453	0.060	5.292	105.840	111.192	319.50	0.3

TABLE E.63 RPTS: Red Fox

Contaminant	Soil Invertebrate Food Concentration (mg/kg)	Vegetation Contaminant Concentration (mg/kg)	Mouse Contaminant Concentration (mg/kg)	Insectivorous Bird Contaminant Concentration (mg/kg)	Herbivorous Bird Contaminant Concentration (mg/kg)	Omnivorous Bird Contaminant Concentration (mg/kg)	ADD from Soil Invertebrate Ingestion (mg/kg-d)	ADD from Vegetation Ingestion (mg/kg-d)	ADD from Ingestion of Small Mammals (mg/kg-d)	ADD from Ingestion of Rabbits (mg/kg-d)	ADD from Ingestion of Insectivorous Birds (mg/kg-d)	ADD from Ingestion of Herbivorous Birds (mg/kg-d)	ADD from Ingestion of Omnivorous Birds (mg/kg-d)	ADD from Drinking Water (mg/kg-d)	ADD from Incidental Soil Ingestion (mg/kg-d)	ADD from Food (mg/kg-d)	Total ADD (mg/kg-d)	Fox ADD Benchmark (mg/kg-d)	HQ
Aluminum	4.392	4.392	222.801	0.544	304.554	1491.370	<0.001	<0.001	0.047	0.098	<0.001	0.009	0.045	0.003	0.449	0.200	0.652	0.55	1.2
Benzo(b)fluoranthene	0.001	0.001	0.004	<0.001	0.006	0.022	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	NA	NA
Iron	148.800	148.800	405.906	12.911	682.504	2491.912	0.004	0.017	0.086	0.159	<0.001	0.021	0.075	0.010	0.684	0.362	1.056	NA	NA
Lead	15.708	15.708	9.159	1.300	26.696	37.932	<0.001	0.002	0.002	0.002	<0.001	<0.001	0.001	<0.001	0.004	0.008	0.012	4.22	<0.1
Magnesium	312.000	312.000	181.126	28.610	521.764	638.500	0.009	0.035	0.038	0.031	<0.001	0.016	0.019	0.046	0.044	0.150	0.240	NA	NA
Manganese	9.060	9.060	6.868	0.760	17.513	32.203	<0.001	0.001	0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.006	0.006	0.012	46.00	<0.1
Mercury	0.050	0.050	0.024	0.004	0.078	0.084	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	<0.1
Nickel	1.038	1.038	0.623	0.086	1.788	2.630	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--	<0.001	<0.001	<0.001	21.12	<0.1
Zinc	235.200	235.200	111.192	19.451	364.712	393.312	0.007	0.027	0.024	0.017	<0.001	0.011	0.012	<0.001	0.011	0.098	0.109	84.50	<0.1