Final

Volume 2 - Baseline Human Health Risk Assessment

TNT Areas A and C Remedial Investigation
Former Plum Brook Ordnance Works
Sandusky, Ohio

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Table of Contents

Page

List of Tables iv
List of Figures vi
List of Acronyms v
Executive Summary ES-1
1.0 Introduction 1-1
2.0 Data Evaluation 2-1
2.1 Identification of COPCs 2-3
2.1.1 Sorting the Analytical Data 2-3
2.1.2 Evaluating Data Quality 2-5
2.1.3 Frequency of Detection 2-6
2.1.4 Identifying Site-Related Chemicals 2-7
2.1.5 Risk-Based Screening 2-9
2.1.6 Evaluating Essential Nutrients 2-11
2.2 Developing Source-Term Concentrations 2-11
2.2.1 Soil, Surface Water, Sediment 2-12
2.2.2 Groundwater 2-14
2.3 Results of the Data Evaluation 2-14
2.3.1 TNT Area A 2-14
2.3.2 TNT Area C 2-18
3.0 Exposure Assessment 3-1
3.1 Conceptual Site Exposure Model 3-1
3.1.1 Physical Setting 3-2
3.1.1.1 TNT Area A 3-2
3.1.1.2 TNT Area C 3-3
3.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways . 3-3
3.1.3 Receptors and Exposure Pathways 3-4
3.1.3.1 Groundskeeper 3-5
3.1.3.2 Indoor Worker 3-6
3.1.3.3 Construction Worker 3-7

Table of Contents *(Continued)*

Page

3.1.3.4 On-Site Resident 3-8
3.1.3.5 Hunter 3-11
3.1.3.6 Other Receptors Not Considered 3-12
3.2 Quantification of Exposure-Point Concentrations 3-13
3.2.1 Exposure-Point Concentrations in Air 3-13
3.2.1.1 COPC Concentrations from Dust 3-13
3.2.1.2 COPC Concentrations in Indoor Air 3-15
3.2.1.3 VOC Concentrations from Subsurface Soil in Ambient Air . . 3-20
3.2.2 Exposure-Point Concentrations of COPCs in Venison 3-22
3.3 Quantification of Chemical Intake 3-24
3.3.1 Inhalation of COPCs in Air 3-24
3.3.2 Incidental Ingestion of COPCs in Soil 3-25
3.3.3 Incidental Ingestion of COPCs in Sediment 3-25
3.3.4 Dermal Contact with COPCs in Soil, Sediment, or Water 3-26
3.3.5 Consumption of Venison 3-27
4.0 Toxicity Evaluation 4-1
4.1 Cancer Evaluation 4-1
4.2 Evaluation of Noncancer Effects 4-4
4.3 Target Organ Toxicity 4-5
4.4 Dermal Toxicity Values 4-6
4.5 Sources of Toxicity Information Used in the Risk Assessment 4-6
4.6 Dinitrotoluenes 4-7
5.0 Risk Characterization 5-1
5.1 Cancer Risk 5-1
5.2 Noncancer Effects of Chemicals 5-3
5.3 Risk-Based Remediation Criteria Development 5-5
5.4 Risk Characterization Results and Discussion 5-8
5.4.1 TNT Area A 5-9
5.4.2 TNT Area C 5-13
6.0 Uncertainty Analysis 6-1

Table of Contents *(Continued)*

Page

7.0 Summary and Conclusions 7-1
7.1 TNT Area A 7-1
7.1.1 Sampling and Analysis 7-1
7.1.2 Risk Assessment Results 7-2
7.2 TNT Area C 7-3
7.2.1 Sampling and Analysis 7-3
7.2.2 Risk Assessment Results 7-4
7.3 Conclusions 7-5
8.0 References 8-1
Tables
Figures
Appendix A - Results of Mann-Whitney U-Tests for Background Testing of Metals in Soil
Appendix B - Risk Calculations
B.1 - Risk Calculations, TNT Area A
B.2 - Risk Calculations, TNT Area C
Appendix C - Toxicological Profiles for the Chemicals of Potential Concern

List of Tables

Table	Title	Follows Text
2-1	Summary of Samples Evaluated in the Baseline Human Health Risk Assessment, TNT Area A	
2-2	Summary of Samples Evaluated in the Baseline Human Health Risk Assessment, TNT Area C	
2-3	Background Concentrations of Metals in Soil	
2-4	Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil, TNT Area A	
2-5	Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil, TNT Area A	
2-6	Screening of VOCs from Subsurface Soil in Indoor Air, TNT Area A	
2-7	COPC Selection for Total Soil, TNT Area A	
2-8	Statistical Summary and COPC Selection for Chemicals Detected in Sediment at On-Site Locations, TNT Area A	
2-9	Statistical Summary and COPC Selection for Chemicals in Sediment at Off-Site Locations, TNT Area A	
2-10	Statistical Summary and COPC Selection of Chemicals Detected in Surface Water at On-Site Locations, TNT Area A	
2-11	Statistical Summary and COPC Selection of Chemicals Detected in a Single Surface Water Sample, TNT Area A	
2-12	Statistical Summary and COPC Selection of Chemicals Detected in a Single Off-Site Surface Water Sample, TNT Area A	
2-13	Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil, TNT Area C	
2-14	Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil, TNT Area C	
2-15	Screening of VOCs from Subsurface Soil in Indoor Air, TNT Area C	
2-16	COPC Selection for Total Soil, TNT Area C	
2-17	Statistical Summary and COPC Selection of Chemicals Detected in Sediment, TNT Area C	
2-18	Statistical Summary and COPC Selection of Chemicals Detected in Surface Water, TNT Area C	
3-1	Rceptor/Exposure Scenarios, TNT Areas A and C	

List of Tables *(Continued)*

Table	Title	Follows Text
3-2	Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors	
3-3	Chemical-Specific Physical Property Values Used in Exposure Assessment	
4-1	COPC-Specific Toxicity Values Used in Risk Assessment	
5-1	Summary of Total Hazard and Total Cancer Risk by Source Medium, TNT Area A	
5-2	Chemicals of Concern and Risk-Based Remediation Criteria, Construction Worker Exposure to Total Soil, TNT Area A	
5-3	Chemicals of Concern and Risk-Based Remediation Criteria, On-Site Resident Exposure to Total Soil, TNT Area A	
5-4	Summary by Building of Total Cancer Risk and Noncancer Hazard by Receptor, TNT Area A	
5-5	Summary of Total Hazard and Total Cancer Risk from Chemicals of Concern, TNT Area C	
5-6	Chemicals of Concern and Risk-Based Remediation Criteria, Groundskeeper Exposure to Surface Soil, TNT Area C	
5-7	Chemicals of Concern and Risk-Based Remediation Criteria, Indoor Worker Exposure to Surface Soil, TNT Area C	
5-8	Chemicals of Concern and Risk-Based Remediation Criteria, Adult Hunter Exposure to Surface Soil, TNT Area C	
5-9	Chemicals of Concern and Risk-Based Remediation Criteria, Construction Worker Exposure to Total Soil, TNT Area C	
5-10	Chemicals of Concern and Risk-Based Remediation Criteria, On-Site Resident Exposure to Total Soil, TNT Area C	
5-11	Chemicals of Concern and Risk-Based Remediation Criteria, Construction Worker Exposure to Sediment, TNT Area C	
5-12	Chemicals of Concern and Risk-Based Remediation Criteria, On-Site Resident Exposure to Sediment, TNT Area C	
5-13	Summary by Building of Total Cancer Risk and Noncancer Hazard by Receptor, TNT Area C	

List of Figures

Figure	Title	Follows Text
3-1	Human Health Conceptual Site Exposure Model, TNT Areas A and C	

List of Acronyms

ABS	dermal absorption factor
AF	adherence factor
ARAR	applicable or relevant and appropriate requirement
AT	averaging time
atm	atmospheres
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BSC	background screening criterion
BW	body weight
CDI	chronic daily intake
cm	centimeter
cm^2	square centimeter
COC	chemical of concern
COPC	chemical of potential concern
CSEM	conceptual site exposure model
days/week	days per week
days/year	days per year
DNT	dinitrotoluene
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
ECAO	Environmental Criteria and Assessment Office
ED	exposure duration
EF	exposure frequency
EPA	U.S. Environmental Protection Agency
EPC	exposure-point concentration
ET	exposure time
EU	exposure unit
FI	fraction
g	gram
g/kg-day	grams per kilogram of body weight per day
g/m^3	grams per cubic meter
GAF	gastrointestinal absorption factor

List of Acronyms *(Continued)*

HEAST	Health Effects Assessment Summary Tables
HI	hazard index
hours/day	hours per day
HQ	hazard quotient
IEUBK	integrated exposure uptake biokinetic
IR	ingestion rate
IRIS	Integrated Risk Information System
IT	IT Corporation
kg	kilogram
kg/day	kilograms per day
L/day	liters per day
L/kg	liters per kilogram
L/L	liters per liter
µg/mg	micrograms per milligram
m	meter
m^3	cubic meters
m^3/day	cubic meters per day
m^3/hour	cubic meters per hour
m/m	meters per meter
m/year	meters per year
MDC	maximum detected concentration
mg/cm^2	milligrams per square centimeter
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mg/mg	milligrams per milligram
NASA	National Aeronautics and Space Administration
NCEA	National Center for Environmental Assessment
OEPA	Ohio Environmental Protection Agency
PAH	polynuclear aromatic hydrocarbon
PBOW	Plum Brook Ordnance Works

List of Acronyms *(Continued)*

PC	permeability coefficient
PCB	polychlorinated biphenyl
PCDD	polycholorinated dibenzo-p-dioxins
PCDF	polycholorinated dibenzofurans
PRG	preliminary remediation goal
QC	quality control
RA	risk assessment
RAWP	risk assessment work plan
RBRC	risk-based remediation criteria
RBSC	risk-based screening concentration
RfC	reference concentration
RfD	reference dose
RME	reasonable maximum exposure
SA	surface area
SF	slope factor
SSL	soil screening level
STC	source-term concentration
SVOC	semivolatile organic compound
TNT	trinitrotoluene
UCL	upper confidence limit
URF	unit risk factor
USACE	U.S. Army Corps of Engineers
UTL	upper tolerance limit
VOC	volatile organic compound
WWII	World War II

Executive Summary

This report presents an assessment of potential human health risks related to U.S. Department of Defense activities at the former Plum Brook Ordnance Works (PBOW) located near Sandusky, Ohio. PBOW operated from 1941 to 1945 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. The facility is currently owned by the National Aeronautics and Space Administration (NASA), and portions of the facility are used by other agencies, including the Perkins Township Board of Education and the Ohio National Guard. Public access is restricted by a fence and security patrols except during the controlled annual deer hunting season.

TNT Area A consists of approximately 114 acres located in the east central portion of PBOW. This area was used during World War II as a manufacturing site for TNT and DNT. After the war, the site was maintained in an "as is" condition until the mid-1950s. Decommissioning and decontamination, begun in 1955, included removing soil around building catch basins, excavating and burning wooden and ceramic flume lines, and flushing and dismantling steam, flume, and drain lines. Burning was conducted in separate burning grounds rather than on TNT Area A proper. However, it is unclear where the various lines were flushed, or where or how flush water was disposed. The site, along with much of the rest of PBOW, was transferred to NASA in 1963. Additional decontamination was performed in 1966 in five stages:

1. Ground inspection and removal of obvious contamination
2. Digging up the ground at regular intervals and removing visible contamination
3. Burning old buildings and rough-grading the area
4. Decontamination of sump basins and removal of concrete
5. Further decontamination of previously decontaminated equipment for sale to outside buyers.

The decontamination was termed "substantial"; overall, more than 16,000 pounds of TNT were removed.

TNT Area A is partially wooded (less than 25 percent) and consists predominantly of large open areas of prairie grasslands. The Engineering Building is located in the central portion of TNT

Area A and is occupied currently by NASA employees. The site is slightly hilly, generally increasing in elevation from the southeast to northwest.

TNT Area A is crossed by Lindsey Ditch and smaller connecting ditches. The ditches are dry during periods with little rainfall.

TNT Area C consists of approximately 119 acres located on the western side of PBOW between Campbell Street and Ransom Road. This area was used during World War II as a manufacturing site for TNT and DNT. Virtually everything stated above regarding the decontamination, of TNT Area A can be restated for TNT Area C, except that decontamination of TNT Area C was not as thorough as decontamination of TNT Area A.

The site is heavily wooded with small areas of open grasslands. It is gently hilly. There are no buildings on site and the area is not currently used by NASA.

TNT Area C is crossed by small intermittent streams that flow into Pipe Creek. The ditches and streams on TNT Areas A and C are too small to support sport fishing; however, both sites provide habitat for deer and other wildlife.

Current use of the PBOW facility is classified as industrial for the purpose of the risk assessment (RA). Because future use is uncertain, the RA includes the assumption that the facility could be developed for residential use. Groundskeeper, construction worker and hunter scenarios were evaluated under the current site-use assumption; groundskeeper, construction worker, indoor worker, hunter (including a child venison consumer) and on-site residential scenarios were evaluated as plausible future exposure scenarios. The groundskeeper was evaluated for exposure to surface soil. The construction worker was evaluated for exposure to surface and subsurface soil (the mixture was termed "total soil"), surface water and sediment. The adult hunter was evaluated for exposure to surface soil by direct contact and indirectly by ingestion of venison (deer graze vegetation growing on contaminated soil). The on-site resident was evaluated as the upper bound on exposure to total soil, surface water and sediment.

The evaluations of TNT Areas A and C are summarized separately. Soil samples were taken from the areas around each of the former process buildings at TNT Area A where contamination was thought to have been possible. Surface water and sediment samples were taken mostly from

Lindsey Ditch; however, additional samples were taken from Plum Brook to ascertain whether contamination with nitroaromatics was a current concern in this body of water that flows off-site to Lake Erie.

The analytical results revealed that the soil was contaminated with substantial levels of nitroaromatics, polychlorinated biphenyls (PCB), and polyaromatic hydrocarbons (PAH). Also, high levels of lead were observed in the soil in areas associated with three of the buildings. The PCBs may have been released from transformers and other electrical equipment during building demolition and burning. The PAHs may have formed during the burning process. Lead flashing was used in the buildings and may have been used to seal pipe joints; its appearance in soil probably reflects its release during building demolition.

Contamination in on-site surface water and sediment at TNT Area A was considerably less than contamination in soil. The sediment samples from Plum Brook, however, had levels of PAHs substantially higher than those observed on site, suggesting that their presence is unrelated to the Army activities. Furthermore, Plum Brook crosses beneath two major highways and flows past two filling stations and a large parking lot frequently occupied by large trucks, all of which are known to be significant sources of PAHs. Therefore, the PAHs in the sediment were attributed to erosion and runoff from the highway, filling stations and parking lot, and sediment from Plum Brook was not evaluated in the risk assessment. Further details regarding the PAHs in sediment are presented in Section 2.3.1.

The initial RA combined all surface soil and all total soil as single data sets for all of TNT Area A to reflect the reasonable expectation that a groundskeeper and hunter would be randomly and uniformly exposed over the entire area. The RA showed that the groundskeeper, hunter and indoor worker would be unlikely to experience adverse health effects. However, there was concern that adverse effects could be experienced by the construction worker and on-site resident, due entirely to contamination in soil. Risk-based remedial criteria (RBRC) were developed for the chemicals identified as risk drivers.

Because the risk results for the construction worker and resident exceeded acceptable levels, the soil data were re-combined to form exposure units (EU) based on each of the former building locations at TNT Area A. An EU is an area over which a receptor is expected to be uniformly and randomly exposed. The EU approach reduces the likelihood that analytical data from

uncontaminated or lightly contaminated areas could obscure the data from more heavily contaminated areas where receptors are more likely to be exposed (see Section 2.1.1 for more detail). Several building areas passed the re-evaluation; i.e., adverse effects were not expected to be experienced by these receptors. However, several other building areas did not pass.

Lead was identified as a chemical of potential concern (COPC) in soil at TNT Area A. Its average concentration is below levels of concern for industrial site use, but above levels of concern for residential site use. Examination of the raw data revealed that lead in soil exceeds levels of concern for residential use only at three former building locations.

TNT Area C was evaluated in much the same way as TNT Area A. Soil samples were taken from the areas around each of the former process buildings. Surface water and sediment samples were taken from several intermittent waterways (ditches) on TNT Area C.

The analytical results revealed that the soil was contaminated with substantial levels of nitroaromatics, PAHs, and PCBs. Also, high levels of lead were observed in the soil in areas associated with three of the buildings. Nitroaromatics and PAHs were present in sediment taken on site at TNT Area C. Groundwater was not sampled; it will be evaluated in a site-wide investigation in the future.

The initial RA combined all surface soil and all total soil as single data sets for all of TNT Area C, as described for TNT Area A. Risk estimates suggested that the child venison consumer would be unlikely to experience adverse effects. However, there was concern that the groundskeeper, indoor worker and adult hunter could experience adverse effects due to direct exposure to surface soil, and that the construction worker and on-site resident could experience adverse health effects, due largely to contamination in total soil, but with a significant contribution from sediment. The risk from exposure to sediment is due almost entirely to an exceptionally high detection of TNT at one of 15 sample locations. The risk associated with exposure to surface water was negligible.

Because the risk results for the construction worker and resident exceeded acceptable levels, the total soil data were re-combined to form EUs based on each of the former building locations, as described above for TNT Area A. Some building areas passed the re-evaluation, but many more did not.

Lead was identified as a COPC in soil. Its average concentration was below levels of concern for industrial or residential site use. Examination of the raw data revealed that lead concentrations in soil exceed levels of concern for residential use only at three former building locations.

In conclusion, significant contamination at TNT Area A is limited to soil. Contamination in soil poses no unacceptable risk for a groundskeeper or hunter, including a child who consumes venison from deer harvested on site, and adverse effects from exposure are unlikely. Similarly, the areas around several former buildings pose no unacceptable risk for a construction worker or on-site resident, and adverse effects from exposure are unlikely. The areas around other buildings, however, pose unacceptable cancer risk and/or noncancer hazard for a construction worker or on-site resident, raising concern for the occurrence of adverse effects.

Significant contamination at TNT Area C is limited to soil, and sediment at only one sample location. Contamination in surface soil poses unacceptable risk for a groundskeeper, indoor worker and adult hunter, raising concern for the occurrence of adverse effects, but not for a child who consumes venison from deer harvested on site. Contamination in total soil poses unacceptable risk for a construction worker and on-site resident. The areas around several former buildings pose no unacceptable risk for a construction worker or on-site resident, and adverse effects from exposure are unlikely. The areas around several other buildings, however, pose unacceptable cancer risk and/or noncancer hazard for a construction worker or on-site resident, raising concern for the occurrence of adverse effects.

It should be noted that exposure to groundwater, which is plausible for several receptor scenarios relevant to TNT Areas A and C, was not evaluated, which represents a major data gap in this RA. Groundwater will be evaluated in a site-wide investigation in the future.

1.0 Introduction

Chemical contamination related to former U.S. Department of Defense (DOD) activities has been documented at the former Plum Brook Ordnance Works (PBOW) located near Sandusky, Ohio (IT Corporation [IT], 1997). PBOW operated from 1941 to 1945 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. Some of the areas used by the DOD were decontaminated in the 1950s and 1960s; other areas have been decommissioned but not decontaminated. The site is currently owned by the National Aeronautics and Space Administration (NASA) and is operated as the Plum Brook Station of the Glenn Research Center, which is headquartered in Cleveland, Ohio. In 1978 NASA declared approximately 2,152 acres of land as excess . The Perkins Township Board of Education acquired 46 acres of the excess for use as a bus transportation center. The Ohio National Guard has an agreement with the U.S. Army's General Services Administration to use 604 acres of the facility. The areas surrounding PBOW are predominantly agricultural and residential. The facility is currently surrounded by a chain-link fence, and the perimeter is regularly patrolled. Access by authorized personnel is limited to established checkpoints. Public access is restricted except during the controlled annual deer hunting season.

Two deep or bedrock groundwater aquifer systems are utilized for drinking water in the area, a carbonate aquifer to the west and a shale aquifer to the east (IT, 1997). PBOW is located within the transition of the two systems. Upwards of 170 private drinking water wells permitted by the Erie County Health Department are located within four miles of PBOW. Permits are not required for agricultural wells. The Erie County Health Department does not permit using surface water as private drinking water. Lake Erie and Sandusky Bay, located approximately 3.5 miles north of PBOW, are used for recreational swimming, fishing, and boating. A shallow groundwater system within the unconsolidated material atop the bedrock exists under much of the site. The shallow groundwater system is not used for drinking water. All risk evaluation of groundwater is deferred to the site-wide groundwater investigation delivery order, scheduled to commence in July 2001.

In this risk assessment (RA), the term 'facility' refers to the entire former PBOW property, and the term 'site' refers to an area within PBOW under investigation, in this case, TNT Area A or TNT Area C. Current use of the PBOW facility is classified as industrial for the purpose of

identifying plausible human receptors and exposure pathways for evaluation in the RA. Dames & Moore (1997) describes potential future uses of all or portions of the facility as:

- Continued industrial use (NASA activities and programs).
- Recreational use of portions of the site by hunters and fishermen.
- Portions of the site may be sold to state or local government or private individuals (no site-use restrictions were mentioned).
- Parts of the facility may be used for residential or agricultural purposes.
- Parts of the facility may be used for training by the National Guard.
- Construction activities may be performed during development of any of the sites.

In summary, future use of TNT Areas A and C is considered to be industrial or residential for the purposes of developing receptor and exposure scenarios. It is assumed that the deep groundwater aquifer systems may be developed as a source of potable water. Earlier investigations summarized by Dames & Moore (1997) indicate that soil at TNT Areas A and C is heavily contaminated with nitroaromatic compounds, particularly in the areas of the former process buildings.

The RA is based on U.S. Environmental Protection Agency (EPA), USACE, and Ohio Environmental Protection Agency (OEPA) guidance, including, but not limited to, the following:

- Ohio Environmental Protection Agency (OEPA), 1993, ***Closure Plan Review Guidance for RCRA Facilities***, Interim Final, OEPA Division of Hazardous Waste Management, September 1.
- U.S. Army Corps of Engineers (USACE), 1995, ***Risk Assessment Handbook, Volume I: Human Health Evaluation***, Engineer Manual EM 200-1-4.
- U.S. Environmental Protection Agency (EPA), 1989a, ***Risk Assessment Guidance for Superfund***, Volume I, Human Health Evaluation Manual (Part A), Interim Final, Office of Emergency and Remedial Response, Washington, DC, EPA/540/1-89/002.
- U.S. Environmental Protection Agency (EPA), 1991, ***Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors***, Interim Final, Office of Solid Waste and Emergency Response, OSWER Directive: 9285.6-03.

- U.S. Environmental Protection Agency (EPA), 1992a, ***Supplemental Guidance to RAGS: Calculating the Concentration Term***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9285.7-081.

- U.S. Environmental Protection Agency (EPA), 1992b, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, including Supplemental Guidance dated August 18, 1992.

- U.S. Environmental Protection Agency (EPA), 1992c, "Guidance on Risk Characterization for Risk Managers and Risk Assessors," Memorandum from F. Henry Habicht II, Deputy Administrator, to Assistant Administrators, Regional Administrators, February 26, 1992.

The remainder of this document is organized as follows. Section 2.0, Data Evaluation, describes the selection of chemicals of potential concern (COPC) for each medium of interest and estimation of source-term concentrations (STC) for each COPC in each medium. (Please note: to increase clarity, the acronym COPC will be used for the singular, and COPCs will be used for the plural.) COPCs are the chemicals that are identified as site-related (Section 2.1.4), and potentially capable of contributing significantly to risk (Section 2.1.5) and are carried forward to quantitative evaluation in the RA. The STC is a conservative estimate of the average concentration of a COPC, statistically calculated from the analytical results of all samples for a particular environmental medium, such as surface soil (Section 2.2). It is the concentration to which receptors are exposed during *direct* contact with the medium, such as dermal contact with surface soil. The STC is also used as the input concentration for transport models that estimate concentrations in *indirect* media. For example, the STC in soil is input into the dust-loading equation (Equation 3.1, Section 3.2.1.1) to estimate the concentration of COPC in dust-laden air.

Section 3.0, Exposure Assessment, describes the exposure scenarios and the rationale by which plausible receptors are selected, the pathways by which they may be exposed, the exposure-point concentrations (EPC) of the COPCs, and the estimated dose or contact rates for each of the COPCs. The EPC is the concentration of chemical in an environmental medium to which receptors are exposed. Since it is calculated as a conservative estimate of average, it is identical to the STC when used for direct exposure pathways, such as dermal contact with surface soil. It is calculated with transport models for indirect exposure. In the example in the previous paragraph, the output from the dust-loading equation is the EPC in air of a COPC identified in

soil. It is assumed to reflect a conservative estimate of average because it is based on the STC, which is a conservative estimate of average.

Section 4.0, Toxicity Evaluation, describes the adverse health effects associated with each of the COPCs, and the dose-response evaluation, i.e., the relationship between dose or contact rate and the magnitude of the adverse effect.

Section 5.0, Risk Characterization, combines the output of the exposure assessment and the toxicity evaluation to quantify cancer risk and noncancer hazard to each receptor, identifies chemicals of concern (COC), identifies applicable or relevant and appropriate requirements (ARAR) for the COCs, and develops risk-based remediation criteria (RBRC) for the COCs. (Please note: to increase clarity, the acronym COC will be used for the singular, and COCs will be used for the plural.) COCs are the chemicals that contribute significantly to unacceptable risk or hazard estimates. ARARs are standards, criteria, guidelines or recommended concentrations from relevant federal and state environmental laws. They may or may not be entirely or partially risk based. RBRCs are concentrations which, if left in place, will not result in unacceptable risk estimates for the receptor scenario on which they are based.

Section 6.0, Uncertainty Analysis, describes the uncertainty associated with the components of the RA. Section 7.0, Summary and Conclusions, briefly summarizes the RA protocol and results and interprets the results in light of the uncertainty about their estimation to draw realistic conclusions regarding risk to human health. Section 8.0, References, presents the references used in the preparation of this document.

2.0 Data Evaluation

Environmental samples evaluated in the RA for TNT Area A, including surface soil, subsurface soil, sediment and surface water, are summarized in Table 2-1. Generally, samples included in the RA are the samples identified in Volume 1, *Report of Findings*, Part I (TNT Area A), Table 2-1, with the following notes and exceptions:

- Several pages of soil screening samples in Volume 1, *Report of Findings*, Part I, Table 2-1, designated in the Comments column as Initial Screening Samples, Delineation Samples, or Subsurface Screening Samples were not validated and were not evaluated in the RA.
- Soil samples designated as Surface Confirmation Samples and Subsurface Confirmation Samples were validated and were evaluated in the RA, except as noted below:
  - Four soil samples designated field splits (FS in the Comment column) were not evaluated in the RA.
  - Surface soil and subsurface soil did not follow the designations in Volume 1, *Report of Findings*, Part I, Table 2-1; surface and subsurface soil were redefined as explained below.
- All sediment samples in Volume 1, *Report of Findings*, Part I, Table 2-1, were evaluated in the RA except one field split.
- All surface water samples in Volume 1, *Report of Findings*, Part I, Table 2-1, were evaluated in the RA.
- All groundwater evaluation is deferred to a site-wide groundwater delivery order to be addressed at a later date.

A soil sampling interval is defined by the upper and lower depths from which that sample was taken. For example, a sample may be taken from 0.25 to 1.25 feet below ground surface (ft bgs), in which case 0.25 ft bgs is the upper end of the sampling interval and 1.25 ft bgs is the lower end of the sampling interval. Ideally, to be consistent with the potential for direct exposure, surface soil should be defined as samples taken from 0 to 1 ft bgs, and subsurface soil should be defined as samples taken from 1 to 10 ft bgs for direct exposure pathways. Examination of the sampling intervals (Table 2-1), however, reveals that some samples were taken from depth

intervals that crossed the 1 ft ideal lower end of the interval for surface soil. Investigation at the buildings indicated that up to 3 feet of fill (sand) was placed over the concrete foundations following building demolition. Because of this, soil samples were collected at deeper intervals that reflect the original ground surface during the PBOW operational period. For example, some samples were taken from 0.5 to 1.5 ft bgs or 1 to 2 ft bgs. Deeper sampling intervals (e.g., 0.25 ft) reflect the fact that surface debris (rocks, roots, etc.) was removed prior to sampling. Also, there were fewer surface soil samples than subsurface soil samples. At TNT Area A, only one soil sample fell within the ideal 0 to 1 ft bgs interval. Therefore, to deal logically and consistently with sampling depth intervals that crossed 1 ft bgs and to increase the size of the surface soil data sets, surface soil is re-defined as samples whose lower end of the sampling interval is less than or equal to 2 ft bgs. Subsurface soil is re-defined as samples whose lower end of the sampling interval is greater than 2 ft bgs but not greater than 10 ft bgs, regardless of the upper end of the sampling interval. For example, sample number AA0431 at TNT Area A, taken from 1.5 to 2.5 ft bgs, is classified as a subsurface soil sample. The 10 ft bgs limit for subsurface soil reflects the maximum practical depth for direct exposure; i.e., it is unlikely that future development or construction activity would require excavation beyond 10 ft bgs.

Environmental samples evaluated in the RA for TNT Area C, including surface soil, subsurface soil, sediment and surface water, are summarized in Table 2-2. Generally, samples included in the RA are the samples identified in Volume 1, *Report of Findings*, Part II (TNT Area C), Table 2-1, with the following notes and exceptions:

- Several pages of soil screening samples in Volume 1, *Report of Findings*, Part II, Table 2-1, designated in the Comments column as Initial Screening Samples, Delineation Samples, or Subsurface Screening Samples were not validated and were not evaluated in the RA.

- Soil samples designated as Confirmation Samples and Subsurface Confirmation Samples were validated and were evaluated in the RA, except as noted below:

  - Four soil samples designated field splits (FS in the Comment column) were not evaluated in the RA.

  - Surface soil and subsurface soil did not follow the designations in Volume 1, *Report of Findings*, Part II, Table 2-1; surface and subsurface soil were redefined as explained above.

- All sediment samples in Volume 1, *Report of Findings*, Part II, Table 2-1, were evaluated in the RA except two field splits.

- All surface water samples in Volume 1, *Report of Findings*, Part II, Table 2-1, were evaluated in the RA except two field splits.

- All groundwater evaluation is deferred to a site-wide groundwater delivery order to be addressed at a later date.

All sampling and analysis were conducted in accordance with the quality assurance project plan and the health and safety plans included in the approved work plans (IT, 1996a,b,c; 2000a,b). Environmental media samples were delivered under chain of custody to the laboratories for analysis according to EPA-specified methods. The analysis and data reports followed the methods specified, and the data were validated as described in the work plans.

2.1 Identification of COPCs

COPCs are the chemicals that are identified as site-related and potentially capable of contributing significantly to risk, and are carried forward to quantitative evaluation in the RA. The following subsections describe their identification. Prior to initiation of the RA, a list of chemicals present in site samples was compiled. This initial list includes all chemicals detected in any site medium. COPCs are selected from this list as follows.

2.1.1 Sorting the Analytical Data

The data for each chemical are sorted by medium. Chemicals for which all samples yield nondetects in all samples from a medium are considered not to be present and are not evaluated further for that medium. Surface soil and subsurface soil are evaluated as separate media, although it appears that the rough grading performed during earlier remedial activities may have covered substantial surface contamination and largely obscured the distinction between surface and subsurface soil. Surface and subsurface soil data are combined for assessment of exposures under the construction worker and residential site-use scenarios, which involve excavation and mixing of surface and subsurface soil. This approach seems particularly justified, considering the mixing of soil horizons described above. Combined surface and subsurface soil data are termed "total soil" in the RA. The combination was formed by selecting as COPC for total soil each COPC identified in either surface or subsurface soil. The higher STC estimated for the chemical in surface or subsurface soil was selected as the STC for total soil. This approach to total soil accounts for the likelihood that surface and subsurface soil would not be perfectly

blended for receptor exposure, but that exposure to either may predominate, at least for a period of time or at different locations within the exposure unit (EU). It also permits identification of the strata (surface or subsurface soil) requiring further attention in the case that COCs are identified.

TNT Areas A and C are approximately 114 and 119 acres in size, respectively (please see Section 1.2 of Part I, Volume I). The size of these areas may require special care to ensure that "hot spots," areas of unusually high contaminant concentrations, are adequately identified and evaluated. It is reasonable to expect that a groundskeeper and hunter may be exposed randomly and uniformly across the entire site as a result of his normal duties or activities. Therefore, it is appropriate to include all the surface soil data from across the entire site in the data set for these receptors. A hot spot analysis is not relevant for these receptors, because the high concentrations are appropriately averaged with lower concentrations in development of the STC. A construction worker, on the other hand, may be exposed to a much smaller area during excavation, building, or installation of underground utilities. Likewise, a resident is unlikely to be exposed randomly and uniformly across the entire site, because a homestead may consist of as little as one-quarter acre. It is possible, when a reasonable exposure area for a given receptor is less than the entire area from which samples are taken, for the larger clean or lightly contaminated areas to obscure the risk associated with continuous exposure to small, heavily contaminated areas. This situation may give rise to the need for a hot spot or EU analysis. An EU is an area where a receptor would spend most of his time and over which he is expected to be uniformly and randomly exposed.

The need for an EU analysis, as well as the number of EUs to analyze, is largely a matter of judgment. If the STCs approximate the maximum detected concentrations (MDC), *and* the risk estimates are clearly within acceptable limits, there is probably no need for an EU analysis. However, if either of these conditions is not met, an EU analysis may be helpful. The EU approach ensures that areas of unusually high risk are not overlooked. The additional information provided by EU analysis may permit limiting remediation to a small number of circumscribed areas, thereby reducing cost and increasing efficiency without sacrificing protectiveness. One approach to the EU analysis is to separate the analytical data spatially into a number of reasonably sized EUs and developing STCs and risk estimates for each. At this time, however, it is unclear where EU borders may fall, should the sites be developed in the future. Therefore, a more practical approach, used herein, is to evaluate the area associated with each of the former process building as a separate EU.

2.1.2 Evaluating Data Quality

The quality of the analytical data is evaluated to select data for inclusion in the RA. Data quality is expressed by the assignment of qualifier codes during the analytical laboratory QC process or during data validation that reflect the level of confidence in the data. Some of the more common qualifiers and their meanings are (EPA 1989a):

U - Chemical was analyzed for but not detected; the associated value is the sample quantitation limit.

J - Value is estimated, probably below the contract-required quantitation limit.

N - The analysis indicates an analyte for which there is presumptive evidence to make a tentative identification.

NJ - The analysis indicates a "tentatively identified analyte," and the reported value represents its approximate concentration.

UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R - QC indicates that the data are unusable (chemical may or may not be present).

B - The concentration in the sample is not sufficiently higher than concentration in the blank, using the five-times, ten-times (5x, 10x) rule: A chemical is considered a nondetect unless its concentration exceeds five times the blank concentration. For common laboratory contaminants (acetone, 2-butanone [methyl ethyl ketone], methylene chloride, toluene, and the phthalate esters), the sample concentration must exceed ten times the blank concentration to be considered a detection.

"J," "N" and "NJ" qualified data is used in the RA; "R" data and "B" qualified data are not. The handling of "U" qualified data (nondetects) in the RA is described below. The use of data with other less-common qualifiers was evaluated on a case-by-case basis. Generally, data for which the identity of the chemical is unclear are not used in the RA. When confidence is reasonably high that the chemical is present, but the actual concentration is somewhat in question, the data generally are used in the RA.

Occasionally, chemicals may be analyzed under two different analytical programs. For example, the DNTs were analyzed by EPA Method 8330 for nitroaromatics as well as EPA Method 8270C

for semivolatile organic compounds (SVOC). EPA Method 8330 returns concentration values for total DNT, but does not return isomer-specific data. EPA Method 8270C, on the other hand, returns concentration values for the 2,4- and 2,6-isomers, but does not return a value for total DNT. For each medium evaluated, it is necessary to choose the results provided by one analytical method, rather than both, to avoid double-counting and overestimating risk. Therefore, a rationale is developed to ensure that the most appropriate choice is consistently made.

The reporting limits for total DNT by Method 8330 are consistently lower than those for Method 8270B, suggesting that Method 8330 is likely to be more sensitive. Examination of the raw data (TNT Area A: Volume 1, *Report of Findings*, Part II, Appendix D; TNT Area C: Volume 1, *Report of Findings*, Part III, Appendix D) reveals that concentrations reported for total DNT sometimes exceed the sum of the concentrations of the 2,4- and 2,6-isomers. In other cases, the sum of the concentrations of the 2,4- and 2,6-isomers exceeds the concentration reported for total DNT. No explanation is immediately apparent for this inconsistency, but it is clear that the analytical results from one given method cannot be selected for use in all cases because the full potential for risk may be overlooked. Therefore, the method that yields the more conservative result will be selected for each medium on an individual basis. In other words, the MDC for total DNT is compared with the sum of the MDCs for 2,4- and 2,6-DNT. The method yielding the larger value will be used.

It should be noted that different oral reference doses (RfD) are available for the 2,4- and 2,6-isomers. Selection of the appropriate oral RfD to apply when the total DNT results from Method 8330 is used is described in Section 4.

2.1.3 Frequency of Detection

As stated above, when confidence is high that a given chemical is present, the data generally are used in the RA. For most chemicals, their identification at concentrations above levels in blanks (considering the 5x, 10x rule; see above) is presumptive evidence of their presence. However, chemicals that are reported infrequently, e.g., in less than 5 percent of the samples, may be artifacts in the data that do not reflect the presence of the chemical in question. Generally, chemicals that are reported only at low concentrations in less than 5 percent of the samples from a given medium are dropped from further consideration, unless their presence is expected based

on historical information about the site. Chemicals detected infrequently at high concentrations may identify the existence of "hot spots" and are retained in the evaluation.

2.1.4 Identifying Site-Related Chemicals

Identifying site-related chemicals is a matter of professional judgment that must be exercised for each chemical individually. Most organic chemicals are included in the list of site-related chemicals, because most organic chemicals of interest are not naturally occurring. However, there are exceptions, such as pesticides and herbicides present in soil in agricultural areas in which these chemicals are or were used in crop production. Polyaromatic hydrocarbons (PAH) in soil, a class of organic compounds which form from natural or anthropogenic combustion of organic matter, including fossil fuels, and are generally ubiquitous in the environment, may be another exception. Plum Brook Station under NASA operation routinely performs controlled burning in various areas of the former PBOW facility. This burning may release PAHs to the atmosphere that travel downwind and deposit on soil at other areas such as TNT Areas A and C.

In addition, any class of organic compound may be considered to be anthropogenic background if site concentrations are below or comparable to upgradient concentrations. For example, consider the hypothetical situation in which concentrations of 2,4-DNT in the water in a creek meandering across TNT Area A are comparable to upgradient concentrations. In this case it is probably appropriate to conclude that 2,4-DNT is not a site-related chemical. Since the 2,4-DNT in the creek does not reflect activities at TNT Area A, it is inappropriate to select the compound as a site-related chemical for TNT Area A and to develop RBRCs for it, because remediation at TNT Area A will not address the source of the contamination. Site-specific background data sufficient to develop background screening criteria (BSC) (see below) are required to declare any organic chemical to be present at background levels, i.e., to be selected as a background COPC rather than as a site-related chemical.

As a practical matter, background data sufficient for developing BSC are available only for inorganic chemicals. Therefore, no organic chemicals, including pesticides, herbicides or PAHs, are judged to be present at background levels and de-selected from the list of site-related chemicals. In other words, all organic chemicals are subject to risk-based screening for selection as COPCs. Organic chemicals judged to be present at background levels are discussed in the uncertainty section.

Resolving the site-related issue for metals is more difficult, because metals are naturally present in most environmental media. Historical data regarding site activities, processes, disposal practices, and inadvertent releases can provide much useful information, particularly to confirm the selection of a metal as a site-related chemical. Eliminating a metal from the site-related chemical list, however, requires confidence in the adequacy of the historical data. Frequently the historical data are incomplete; therefore, statistical techniques are often used as tools to aid the exercise of professional judgment. The statistical techniques generally involve comparing the site data with background data. This is frequently done in two steps.

The first step is considered a screening step, in which the MDC of a metal in site data is compared with its BSC. The upper tolerance limit (UTL) of the background data set (see below) is generally adopted as the BSC. It is a theoretical upper bound on background concentration. A chemical whose MDC is less than or equal to its BSC is designated a background chemical and is not subjected to risk-based screening or included in the quantitative RA. A chemical whose MDC exceeds the UTL may be designated a site-related chemical and subjected to risk-based screening, or a more rigorous statistical analysis may be performed. The more rigorous statistical analysis consists of comparing the site and background data sets to determine if both are drawn from the same population. This approach is more consistent with the selection of site-related chemicals for an RA than the screening approach described above, because receptors are more likely to be exposed to an area represented by multiple samples than by a single sample. The Mann-Whitney U-test is used for this purpose.

Development of a UTL depends on the nature of the background data set, which is tested for normality or lognormality. The Shapiro-Wilk test (EPA, 1992d) is used to test the nature of the distribution using the software package STATISTICA™. If the background data set fits neither a normal nor a lognormal distribution, it is considered to be nonparametric. The UTL is the concentration, with a probability of 0.95 (or a confidence of 95 percent), that will capture (or cover) 95 percent of background samples if a sufficiently large number of samples were taken. The UTL for a normal distribution is calculated as follows (EPA, 1989b):

$$UTL = \bar{x} + Ks \qquad \text{Eq. 2.1}$$

where:

UTL	=	upper tolerance limit of background concentration, calculated
$\bar{x}$	=	arithmetic mean of the concentrations in the data set
K	=	tolerance factor (Appendix B of EPA, 1989b)
s	=	standard deviation.

The same equation is used to estimate the UTL for lognormal background data sets, but the data are log-transformed before the arithmetic mean and standard deviation are calculated.

There is considerable uncertainty about the development of a UTL because of limitations of sample size and the presence (usually) of a great deal of variation. It is not uncommon for UTL values derived as described above to exceed the MDC of background. In these cases, as well as for nonparametric distributions, the MDC, rather than the UTL, is adopted as the BSC.

An IT (1998) site investigation of the Acid Areas included evaluation of background soil data applicable to the entire PBOW facility. BSCs for soil, developed from these data, are compiled in Table 2-3. Neither facility-wide nor site-specific background data for sediment or surface water are available for TNT Areas A or C.

2.1.5 Risk-Based Screening

Risk-based screening for human health is introduced to focus the assessment on the chemicals that may contribute significantly to overall risk, and to remove from quantification those chemicals whose contribution is clearly insignificant. In this screen, the MDC is compared to the appropriate risk-based screening concentration (RBSC). If the MDC is less than or equal to the RBSC, the chemical in this medium is not considered further, because it is very unlikely that it would contribute significant risk. If the MDC exceeds the RBSC, the chemical is considered to be a COPC and is evaluated in the RA.

OEPA prefers to develop RBSCs from EPA (2000) Region IX preliminary remediation goals (PRG), which are risk-based concentrations that reflect standard scenarios for exposure to various media. EPA (2000) PRGs for potential carcinogens are based on a cancer risk of 1E-6, which is considered to be a point of departure below which risks are deemed insignificant. EPA (2000) PRGs for noncancer effects are based on a hazard index (HI) of 1, the threshold level at or below which adverse effects are not expected to occur. RBSCs are developed by adjusting the

PRGs downward by an order of magnitude to reflect a cancer risk of 1E-7 or an HI of 0.1. A cancer risk of 1E-7 is chosen to be consistent with OEPA's policy to quantify the risk of any chemical that may contribute to a total cancer risk (summed across all chemicals and media) of 1E-6. An HI of 0.1 is chosen to provide additional protection for simultaneous exposure to multiple chemicals.

RBSCs for soil are developed by adjusting EPA (2000) "Residential Soil" PRGs downward as described above. The soil RBSCs are applied to both surface and subsurface soil. EPA (2000) PRGs are not available for sediment from which to develop RBSCs. However, the routes by which receptors may be exposed to sediment (e.g., incidental ingestion, dermal contact) are similar to those for soil, so that the RBSCs developed for soil could be applied to sediment. Exposure to soil, however, is likely to be a great deal more intensive than exposure to sediment, because soil is more available and a receptor would be expected to spend much more time in contact with soil. In other words, the RBSCs for soil are probably too restrictive and could be increased greatly and remain sufficiently protective for exposure to sediment. Therefore, the soil RBSCs are increased by an order of magnitude for use as sediment RBSCs, and are assumed to reflect a cancer risk of 1E-7 or an HI of 0.1 when applied to sediment, consistent with OEPA policy as explained above.

Similarly, EPA (2000) PRGs are available for "Tap Water," but not for surface water to which exposure is only incidental (i.e., surface water that is not used as a source of potable water). However, the routes by which receptors may be incidentally exposed to surface water (e.g., ingestion, dermal contact, inhalation of airborne volatiles) are similar to those for potable water, so that the tap water PRGs could be used to develop RBSCs for surface water. Exposure to surface water, however, is likely to be a great deal less intensive than exposure to tap water, because tap water is used for drinking water, bathing and many other household uses. Therefore, the tap water PRGs without downward adjustment are adopted as RBRCs for surface water, and are assumed to reflect a cancer risk of 1E-7 or an HI of 0.1 when applied to surface water, consistent with OEPA policy as explained above.

Certain receptors (e.g., indoor worker, resident) may be exposed to volatile organic compounds (VOC) in indoor air that volatilize from subsurface soil and penetrate the foundation or slab on which the building is constructed. Airborne concentrations, estimated as described in Section 3.2.1.2, are compared with ambient air RBSCs. Ambient air RBSCs are EPA (2000) Region IX ambient air PRGs adjusted to reflect a cancer risk of 1E-7 and a HI of 0.1.

The risk-based screening described above assumes that the RBSCs are based on relevant exposure routes for their respective receptor scenarios. The sediment RBSCs, which address incidental ingestion and dermal contact, may not be sufficiently conservative to screen sediment in water bodies from which fish are harvested for human consumption, because the sediment RBSCs do not address the indirect exposure pathway, i.e., bioaccumulation of contaminants by fish. Similarly, the surface water RBSCs, which address ingestion of water, dermal contact and inhalation of airborne volatiles, may not be sufficiently conservative to screen surface water from which fish are harvested, because the surface water RBSCs do not address bioconcentration of contaminants by fish. Experience has shown that the potential for significant bioconcentration in aquatic food chains is largely limited to mercury and certain highly lipophilic and persistent organic chemicals such as organochlorine pesticides, PCBs and polychlorinated dibenzo-p-dioxins/dibenzofurans (PCDD/PCDF). (Please see individual chemical Toxicological Profiles in Appendix C for documentation of the potential for bioconcentration in aquatic food chains.) Therefore, these chemicals will be selected as COPCs in sediment and surface water bodies from which fish are taken for human consumption, even if their MDCs are below their RBSCs.

2.1.6 Evaluating Essential Nutrients

Evaluating essential nutrients is a special form of risk-based screening applied to certain ubiquitous elements that are generally considered to be required human nutrients. Essential nutrients such as calcium, iron, magnesium, potassium, and sodium are usually eliminated as COPC because they are generally considered innocuous in environmental media. Other essential nutrients, including chloride, iodine, and phosphorus, may be eliminated as COPC, provided that their presence in a particular medium is shown to be unlikely to cause adverse effects on human health. Should members of this latter group be selected as site-related chemicals, an exposure analysis will be performed, whereby a daily dose of chemical from ingestion of the medium in question is calculated. The dose will be compared with levels known or expected to be safe or toxic, and/or with recommended daily allowances, depending on the availability of data.

2.2 Developing Source-Term Concentrations

The STC is a conservative estimate of the average concentration of a COPC, statistically calculated from the analytical results of all samples for a particular environmental medium within an exposure unit.

2.2.1 Soil, Surface Water, Sediment

Because of the uncertainty associated with characterizing contamination in environmental media, both the mean and the upper confidence limit (UCL) on the mean are usually estimated for each COPC in each medium of interest. The upper 95 percent confidence limit on the mean is generally referred to as the UCL. In general, unusually high values are included in the calculation of the UCL, because high values seldom appear as statistical outliers in environmental data. Inclusion of outliers increases the overall conservatism of the risk estimate.

Data sets consisting of five or more data points are tested for normality and lognormality with the Shapiro-Wilk test as described above. Statistical analysis is performed only on those chemicals identified as background or site-related COPC. The UCL is calculated for a normal distribution as follows (EPA, 1992a):

$$UCL = \bar{x} + t_{1-\alpha,n-1}\left(\frac{s}{\sqrt{n}}\right) \qquad \text{Eq. 2.2}$$

where:

UCL	=	upper 95th confidence limit on the arithmetic mean concentration (calculated)
$\bar{x}$	=	sample arithmetic mean
t_1	=	critical value for Student's *t*-test
α	=	0.05 (95 percent confidence limit for a one-tailed test)
n	=	number of samples in the data set
s	=	sample standard deviation.

The UCL is calculated for a lognormal distribution as follows (Gilbert, 1987):

$$UCL = e^{\left(\bar{y} + (0.5 \cdot s_y^2) + \left[H_{0.95} \cdot \frac{s_y}{(n-1)^{0.5}}\right]\right)} \qquad \text{Eq. 2.3}$$

where:

UCL	=	upper 95th confidence limit on the arithmetic mean concentration (calculated)
$\bar{y}$	=	$\sum y/n$ = sample arithmetic mean of the log-transformed data, y = ln x
s_y	=	sample standard deviation of the log-transformed data
n	=	number of samples in the data set
$H_{0.95}$	=	value for computing the one-sided upper 95 percent confidence limit on a lognormal mean from standard statistical tables.

If the data distribution is nonparametric, the data point selected as the nonparametric UCL will be estimated as the 95 percent UCL rank order on the arithmetic mean of the data set. It will be estimated by ranking the data observations from smallest to largest. The arithmetic mean will be converted to a percentile by interpolation. The rank order of the data point selected as the UCL will be estimated from the following equation (Gilbert, 1987):

$$u = p(n + 1) + Z_{1-\alpha}\sqrt{np(1 - p)} \qquad \text{Eq. 2.4}$$

where:

u	=	rank order of value selected as the UCL (calculated)
p	=	percentile corresponding to the arithmetic mean
n	=	number of samples in the data set
α	=	confidence limit (95 percent)
$Z_{1-\alpha}$	=	normal deviate variable.

Analytical data from field duplicates are averaged with originals to yield one result for use in the statistical manipulations.

Generally, the detection limit is the lowest concentration of a chemical that can be "seen" above the normal, random noise of an analytical instrument or method. Analytical results are presented as nondetects ("U" qualifier) whenever chemical concentrations in samples do not exceed the reporting limits for the analytical procedures for those samples. To apply the statistical procedures described above, a concentration value must be assigned to nondetects. Generally, nondetects are assumed to be present at one-half the reporting limit (EPA, 1989a). However, judgment is used in those cases where the detection limit is unusually high. For example, elevated detection limits that exceed the MDC due to matrix interference or sample dilution may be eliminated from the data set and not used in the estimation of the STC. No data points were eliminated from use in STC estimation in this evaluation.

The UCL or MDC, whichever is smaller, is selected as the STC and is understood to represent a conservative estimate of average for use in the RA or in various transport models used to estimate EPCs. If the data set consists of fewer than five data points, the MDC is selected as the STC.

2.2.2 Groundwater

All risk evaluation of groundwater, including developing the protocol for the evaluation, is deferred to the site-wide groundwater delivery order, which is pending.

2.3 Results of the Data Evaluation

2.3.1 TNT Area A

Soil. Eight surface soil and 31 subsurface soil samples were analyzed for metals, nitroaromatics, PCBs, SVOCs and VOCs (Table 2-1). The term "metals" in this RA are understood to include metalloids such as arsenic, nonmetallic elements such as selenium, and alkaline earth elements such as calcium. In surface soil, twenty metals were detected (Table 2-4), but lead was the only metal selected as a COPC, because its MDC exceeded both its BSC and RBSC. Seven nitroaromatics were identified in 1 to 5 surface soil samples. The MDC of total DNT (7.36 mg/kg) exceeded the sum of the MDCs for 2,4- and 2,6-DNT (2.03 mg/kg + 0.694 mg/kg = 2.724 mg/kg); therefore, the analytical result for total DNT was used instead of the results for the individual isomers. Four nitroaromatics were selected as COPCs. Aroclor 1260 was the only PCB identified in surface soil; it also was selected as a COPC. SVOCs, identified in one to four samples each, included two phthalate esters and eight PAHs. Three PAHs were selected as COPCs. Six VOCs were identified in one to eight samples each at concentrations well below their RBSCs; none were selected as COPCs.

In subsurface soils, twenty-three metals were detected (Table 2-5). Concentrations of chromium, lead and thallium exceeded their BSCs and RBSCs; however, the Mann-Whitney U-test (Appendix A) demonstrated that chromium and thallium concentrations were comparable to background. Therefore, lead is selected as the only metal COPC in subsurface soil at TNT Area A. Ten nitroaromatics were identified in 5 to 18 samples each. The sum of the MDCs for 2,4- and 2,6-DNT (8,912 mg/kg + 10,274 mg/kg = 19,186 mg/kg) exceeded the MDC of total DNT (2,708 mg/kg) ; therefore, the analytical results for the individual DNT isomers were used instead of the result for total DNT. Eight nitroaromatics were selected as COPCs. Aroclor 1260 was the only PCB identified in subsurface soil; it also was selected as a COPC. SVOCs, identified in one to four samples each, include two phthalate esters and 12 PAHs. Four PAHs were selected as COPCs. Seven VOCs were identified in 1 to 26 samples each at concentrations well below their

RBSCs; none were selected as COPCs for direct exposure pathways (Table 2-5) or for vapor intrusion into indoor air (Table 2-6).

The construction worker and resident may be exposed to a combination of surface and subsurface soil. Therefore, surface and subsurface soil data sets are combined to form a hypothetical medium termed "total soil." COPCs for total soil for TNT Area A (Table 2-7) include all COPCs in surface soil (Table 2-4) and all COPCs in subsurface soil (Table 2-5). The STC for each COPC in total soil is the larger of the values estimated for surface or subsurface soil. Total DNT was selected as a COPC for surface soil, but 2,4- and 2,6-DNT were selected as COPCs in subsurface soil. The sum of the MDCs for 2,4- and 2,6-DNT in subsurface soil (8,912 mg/kg + 10,274 mg/kg = 19,186 mg/kg) exceeded the MDC of total DNT in surface soil (7.36 mg/kg); therefore, to avoid double-counting, the individual DNT isomers were selected as COPCs and total DNT is not selected. The DNT isomer STCs estimated for subsurface soil are adopted for total soil.

Unusually high concentrations of lead were observed, particularly in subsurface soil. Lead is not believed to have been used in the manufacture of explosives, but lead was used in the construction of the former process buildings. Lead sheets, probably used as flashing around external pipes, etc., were observed in soil during excavations at TNT Area A and at the burning grounds, suggesting fairly wide-spread use of lead in buildings at the facility. Lead also may have been used to seal pipe joints.

Concentrations of nitroaromatics were consistently higher in subsurface soils than in surface soils, which may reflect, at least in part, the potential for these compounds to leach. Concentrations of PAHs were also consistently higher in subsurface soils, which is unexpected because these compounds generally sorb strongly to surface soil and resist migration. It is likely that the rough grading described in Section 3.1.1.1 may have buried former surface soils containing higher levels of nitroaromatics and PAHs. PAHs form during combustion of organic matter and may be present as a result of burning the buildings formerly used in production of explosives. The source of the PCBs is not clear, since these compounds are not used in production of explosives. Their presence may represent release from transformers or other electrical equipment during demolition of the buildings.

Sediment. Fifteen sediment samples were taken for evaluation in the RA and were analyzed for the same parameters as soil (Table 2-1). Ten samples were taken from locations within the boundaries of TNT Area A, primarily from Lindsey Ditch and its connections. It was anecdotally reported that Plum Brook, which leads northeast from the PBOW facility, ran red, indicating the presence of impurities from TNT manufacturing, during World War II (WW II) when the facility was in operation. The off-site sediment samples were taken by request of the landowners to determine whether previous or ongoing contaminant transport poses a current threat to receptors outside the boundary of the facility. Although Plum Brook is not geologically or in any other way related to TNT Area A, it was decided to evaluate the off-site segment of the brook at this time, and five sediment samples were taken from Plum Brook approximately 2 to 3 miles from the border of the facility. The on-site and off-site sediment sample sets are evaluated separately.

Neither facility-wide nor site-specific background data are available for sediment. However, waterways on TNT Area A are intermittent, so that the sediment is not continually covered with water and at times is indistinguishable from the surrounding soil. This suggests that the "sediment" may reflect the geochemical characteristics of soil as much as sediment. Therefore, in the absence of background data specific for sediment, soil background data (Table 2-3) were used to identify site-related chemicals in sediment for evaluation in the RA.

Twenty-one metals were detected in the 10 on-site sediment samples from Lindsey Ditch (Table 2-8); however, no metals were selected as COPCs when soil background data were used to screen for site-related chemicals. Although the concentration of lead exceeds its BSC in soil, suggesting that a site-related contribution from surrounding soil had occurred, the MDC is well below the RBSC, and it is concluded that lead in on-site sediment does not pose a threat to human health. Six nitroaromatics were identified in one to seven samples. The MDC of total DNT (0.576 mg/kg) exceeded the sum of the MDCs for 2,4- and 2,6-DNT (0.147 mg/kg + 0.0844 mg/kg = 0.2314 mg/kg); therefore, the analytical result for total DNT was used instead of the results for the individual isomers. Concentrations of the nitroaromatics were all below their respective RBSCs so that none were selected as COPCs. Aroclor 1260 was the only PCB identified in on-site sediment; its MDC exceeded its RBSC and it was selected as a COPC. SVOCs, identified in one to two samples, include one phthalate ester and seven PAHs. Only one PAH, benzo(a)pyrene, was selected as a COPC because its MDC exceeded its RBSC. Three

VOCs were identified in one to seven samples at concentrations well below their RBSCs; none were selected as COPCs.

Twenty metals were detected in the five off-site sediment samples from Plum Brook (Table 2-9); however, no metals were selected as COPCs when soil background data were used to screen for site-related chemicals. Nitrobenzene was identified as the only nitroaromatic in off-site sediment. Its MDC was below the RBSC and the compound was not selected as a COPC. Aroclor 1260 was the only PCB identified in off-site sediment; its MDC was below the RBSC and it was not selected as a COPC. SVOCs, identified in one to four samples include one phthalate ester and 16 PAHs. Five PAHs had MDCs greater than their RBSCs and were selected as COPCs. Two VOCs were identified in two to four samples at concentrations well below their RBSCs; neither was selected as a COPC.

PAH concentrations in off-site sediment in Plum Brook are approximately an order of magnitude greater than those measured in on-site sediment at either TNT Area A or C. This observation suggests that the presence of PAHs in off-site sediment is unrelated to the Army activities, either the manufacture of explosives or the burning and decontamination activities that followed. This interpretation is supported by the observation that Plum Brook, upgradient of off-site sampling locations, courses beneath two major highways (U.S. 25 and State Route 2), passes Plum Brook Country Club, and flows past two filling stations, one of which has a parking lot frequented by large trucks. It is well known that diesel fuel and emissions from internal combustion engines (particularly diesel) contain substantial levels of PAHs. Also, runoff from highways and parking lots paved with asphalt contains substantial levels of PAHs. These observations and facts lead to the conclusion that the highways and parking lots, rather than Army activities on PBOW, are the source of the PAHs found in off-site sediment. Therefore, the off-site sediment is not evaluated further in the RA.

Surface Water. Ten surface water samples were taken (Table 2-1). Nine were analyzed for the same parameters as soil and sediment; the tenth was analyzed only for nitroaromatics. Eight samples were collocated with the on-site sediment samples discussed above; the other two on-site sediment sampling locations were dry. One sample, analyzed only for nitroaromatics, was taken from a small pool of red-tinged water present in a tire track left by a backhoe near the location of former Building 146. This location is at the lowest point of TNT Area A and is usually wet and marshy from the discharge of shallow groundwater to the surface.

One surface water sample was collocated with the off-site sediment samples in Plum Brook discussed above; the other 4 off-site sediment sampling locations were dry. Each of these three surface water data sets , on-site surface water, tire track surface water sample, and off-site surface water, was evaluated separately.

Nineteen metals were detected in the eight on-site surface water samples collocated with the sediment samples (Table 2-10); arsenic and manganese were the only metals selected as COPCs. Two nitroaromatics were identified in one to two samples each. One nitroaromatic, 4-amino-2,6-DNT, was selected as a COPC. SVOCs were limited to di-n-butyl phthalate identified in two of eight samples. VOCs were limited to acetone and carbon disulfide. The SVOCs and VOCs were present at concentrations well below their RBSCs and were not selected as COPCs. The COPCs in the on-site surface water samples are evaluated in the RA.

Four nitroaromatics were identified in the single on-site surface water sample from the tire track (Table 2-11). Three were present at concentrations sufficient to be selected as COPCs. The number of nitroaromatics present and their concentrations were greater in this sample than in the other on-site surface water samples. For example, the concentration of TNT in the tire track sample was 11,000 μg/L, indicating gross contamination; TNT was not detected in the samples from Lindsey Ditch. The results of the analysis of surface water in the tire track are not used in the RA, because the sample is considered to reflect the level of contamination of the underlying shallow groundwater aquifer near Former Building 146. Groundwater will be evaluated in a site-wide investigation in the future.

Fifteen metals were detected in the single off-site surface water sample collocated with the sediment samples from Plum Brook described above (Table 2-12). None of the metals were selected as COPCs. Neither nitroaromatics or SVOCs were detected at this off-site location. Acetone was the only VOC identified, but its concentration was far below the RBSC, and the compound was not selected as a COPC. The results of this sample are not included in the RA, since no COPCs were selected.

2.3.2 TNT Area C

Soil. Fourteen surface soil and 26 subsurface soil samples were analyzed for metals, nitroaromatics, PCBs, SVOCs and VOCs (Table 2-2). Twenty-one metals were detected in

surface soil (Table 2-13); lead was the only metal selected as a COPC. The MDC for manganese exceeded its BSC and RBSC; however, the Mann-Whitney U-test demonstrated that manganese concentrations were comparable to background (Appendix A). Nine nitroaromatics were identified in 2 to 14 surface soil samples each. The sum of the MDCs for 2,4- and 2,6-DNT (9.845 mg/kg + 10.7 mg/kg = 20.545 mg/kg) exceeded the MDC of total DNT (16.7 mg/kg) ; therefore, the analytical results for the individual DNT isomers were used instead of the result for total DNT. Six nitroaromatics were selected as COPCs. Aroclor 1260 was the only PCB identified in surface soil; it was selected as a COPC. SVOCs, identified in one to seven samples each, included two phthalate esters and 13 PAHs. Seven PAHs were selected as COPCs. Nine VOCs were identified in 1 to 14 samples each at concentrations well below their RBSCs; none were selected as COPCs.

In subsurface soil, twenty-one metals were detected (Table 2-14). Chromium and lead exceeded both their BSCs and RBSCs and were selected as COPCs; however, the it is clear that the only reason chromium was selected as a site-related chemical is because of a single hit approximately an order of magnitude above the others in Sample No. AA0446. Twelve nitroaromatics were identified in 1 to 24 samples each. The sum of the MDCs for 2,4- and 2,6-DNT (275 mg/kg + 65.5 mg/kg = 340.5 mg/kg) exceeded the MDC of total DNT (297 mg/kg); therefore, the analytical results for the individual DNT isomers were used instead of the result for total DNT. Seven nitroaromatics were selected as COPCs. Aroclor 1254 and Aroclor 1260 were the only PCBs identified in subsurface soil; both were selected as COPCs. SVOCs, identified in one to eight samples each, include two phthalate esters and 14 PAHs. Seven PAHs were selected as COPCs. Eight VOCs were identified in 2 to 16 samples each at concentrations well below their RBSCs; none were selected as COPCs for direct exposure pathways (Table 2-14) or for vapor intrusion into indoor air (Table 2-15).

COPCs for total soil for TNT Area C (Table 2-16) include all COPCs in surface soil and subsurface soil. The STC for each COPC in total soil is the larger of the values estimated for surface or subsurface soil.

Unusually high concentrations of lead were observed in TNT Area C soils, as was noted in TNT Area A soils. Concentrations of nitroaromatics were variable, but very high. No consistent pattern was observed in surface and subsurface soils; however, the highest detection of TNT, 41,261 mg/kg in surface soil, equivalent to greater than 4 percent, suggests that deposits of TNT

exist on or near the surface. Concentrations of PAHs were slightly but consistently higher in subsurface soils, which may reflect the rough grading described in Section 3.1.1.1.

Sediment. Waterways on TNT Area C are intermittent, so that the sediment is not continually covered with water and at times is indistinguishable from the surrounding soil. Therefore, in the absence of background data specific for sediment, soil background data (Table 2-3) were used to identify site-related chemicals for evaluation in the RA.

Fifteen sediment samples were taken for evaluation in the RA and were analyzed for the same parameters as soil (Table 2-2). Twenty metals were detected in the 15 sediment samples (Table 2-17); arsenic was the only metal selected as a COPC. Although lead exceeds its BSC, suggesting that a site-related contribution from surrounding soil had occurred, the MDC is well below the RBSC, and it is concluded that lead in on-site sediment does not pose a threat to human health. Eight nitroaromatics were identified in one to eight samples each. The sum of the MDCs for 2,4- and 2,6-DNT (0.276 mg/kg + 0.183 mg/kg = 0.459 mg/kg) exceeded the MDC of total DNT (0.414 mg/kg) ; therefore, the analytical results for the individual DNT isomers were used instead of the result for total DNT. Six nitroaromatics were selected as COPCs. Aroclor 1260 was the only PCB identified in on-site sediment; it was selected as a COPC. SVOCs, identified in one to three samples each, include two phthalate esters and six PAHs. One PAH, benzo(a)pyrene, was selected as a COPC. Five VOCs were identified in one to seven samples each at concentrations well below their RBSCs; none were selected as COPCs. One sample taken from Sample Location SD09 had an unusually high concentration of TNT, 1,492 mg/kg. The next highest detected concentration was 2.9 mg/kg at Sample Location SD15, which is far removed from SD09. Sample Location SD09 was dry when sampled (please see Volume I, *Report of Findings*, Part II, Table 2-1). The reason for the unusually high hit at SD09 is unclear, because it does not appear to be near any of the former process buildings.

Surface Water. Ten surface water samples collocated with the on-site sediment samples discussed above were taken and analyzed for the same parameters as soil and sediment for evaluation in the RA (Table 2-2). The other four sediment sampling locations were dry. Seventeen metals were detected in the surface water samples (Table 2-18); manganese was the only metal selected as a COPC. Eight nitroaromatics were identified in one to two samples each. The MDC of total DNT (7.92 mg/kg) exceeded the sum of the MDCs for 2,4- and 2,6-DNT (2.57 mg/kg + 2.95 mg/kg = 5.52 mg/kg); therefore, the analytical result for total DNT was used

instead of the results for the individual isomers. Total DNT was selected as a COPC. SVOCs were limited to di-n-butyl phthalate identified in one sample. VOCs were limited to acetone and carbon disulfide. The SVOC and VOCs were present at concentrations well below their RBSCs and were not selected as COPCs. The COPCs in the surface water samples are evaluated in the RA.

3.0 Exposure Assessment

Exposure is the contact of a receptor with a chemical or physical agent. An exposure assessment estimates the type and magnitude of potential exposure of a receptor to COPCs found at or migrating from a site (EPA, 1989a). An exposure assessment includes the following steps:

- Characterize the physical setting.
- Identify the contaminant sources, release mechanisms, and migration pathways.
- Identify the potentially exposed receptors.
- Identify the potential exposure pathways.
- Estimate exposure concentrations.
- Estimate chemical intakes or contact rates.

3.1 Conceptual Site Exposure Model

The conceptual site exposure model (CSEM) provides the basis for identifying and evaluating the potential risks to human health in the RA. The CSEM (Figure 3-1) includes the receptors appropriate to all plausible site-use scenarios and the potential exposure pathways. Graphically presenting all possible pathways by which a potential receptor may be exposed, including all sources, release and transport pathways, and exposure routes, facilitates consistent and comprehensive evaluation of risk to human health and helps ensure that potential pathways are not overlooked. The elements of a CSEM include:

- Source
- Source media (i.e., initially contaminated environmental media)
- Contaminant release mechanisms
- Contaminant transport pathways
- Intermediate or transport media
- Exposure media
- Receptors
- Routes of exposure.

Contaminant release mechanisms and transport pathways are not relevant for direct receptor contact with a contaminated source medium.

The receptors and pathways in Figure 3-1 reflect plausible scenarios developed from information regarding site background and history, topography, climate, and demographics as presented by the site-wide groundwater investigation (IT, 1997). Asterisks identify exposure pathways that are complete and addressed in the RA. Justification for exclusion of other pathways is provided

in the footnotes or the descriptions of the receptors in Section 3.1.3. Groundwater is potentially a medium of concern at TNT Areas A and C. However, all risk evaluation of groundwater is deferred to the site-wide groundwater delivery order, which is pending. Therefore, groundwater is not included in the CSEM. It is likely, however, that the CSEM will require revision during the groundwater evaluation.

3.1.1 Physical Setting

Details of the physical setting and historical management of TNT Areas A and C are located in Volume 1, *Report of Findings*, Part II and Part III, respectively. Sufficient detail is reiterated below to support the transport pathways and exposure scenarios presented in Figure 3-1.

3.1.1.1 TNT Area A

TNT Area A consists of approximately 114 acres located in the east central portion of PBOW (Section 1.2, Part I, Volume I). This area was used during World War II as a manufacturing site for TNT and DNT. After World War II, the site was maintained in an "as is" condition until the mid-1950s. Decommissioning and decontamination, begun in 1955, included removing soil around building catch basins, excavating and burning wooden and ceramic flume lines, and flushing and dismantling steam, flume, and drain lines. Burning was conducted in separate burning grounds rather than on TNT Area A proper. However, it is unclear where the various lines were flushed, or where or how flush water was disposed. The site, along with much of the rest of PBOW, was transferred to NASA in 1963. Additional decontamination was performed in 1966 in five stages:

1. Ground inspection and removal of obvious contamination
2. Digging up the ground at regular intervals and removing visible contamination
3. Burning old buildings and rough-grading the area
4. Decontamination of sump basins and removal of concrete
5. Further decontamination of previously decontaminated equipment for sale to outside buyers.

The decontamination was termed "substantial" (Dames & Moore, 1997); overall, more than 16,000 pounds of TNT were removed.

TNT Area A is partially wooded (less than 25 percent) and consists predominantly of large open areas of prairie grasslands. The Engineering Building is located in the central portion of TNT Area A and is occupied currently by NASA employees. The site is slightly hilly, generally increasing in elevation from the southeast to northwest.

TNT Area A is crossed by Lindsey Ditch and smaller connecting ditches. The ditches are dry during periods with little rainfall. Plum Brook is not connected to either TNT Area A or C; however, anecdotal evidence indicates that it was contaminated with nitroaromatics during World War II. An off-site location was sampled, and the sample results are considered in the TNT Area A evaluation simply because the sampling locations were closer to TNT Area A than to other areas under investigation.

3.1.1.2 TNT Area C

TNT Area C consists of approximately 119 acres located on the western side of PBOW between Campbell Street and Ransom Road (Section 1.2, Part II, Volume I). This area was used during WWII as a manufacturing site for TNT and DNT. Virtually everything stated above regarding the decontamination of TNT Area A can be restated for TNT Area C, except that decontamination of TNT Area C was not as thorough as decontamination of TNT Area A.

The site is heavily wooded with small areas of open grasslands. It is gently hilly. There are no buildings on site and the area is not currently used by NASA.

TNT Area C is crossed by small intermittent streams that flow into Pipe Creek. The ditches and streams on TNT Areas A and C are too small to support sport fishing; however, both sites provide habitat for deer and other wildlife.

3.1.2 Contaminant Sources, Release Mechanisms, and Migration Pathways

Contaminant sources, release mechanisms and migration pathways are summarized in Figure 3-1. Briefly, TNT is made by nitrating toluene in a three-step process that uses nitric and sulfuric acids (Dames and Moore, 1997). The processing lines consist of individual buildings connected by pipelines that carry the reactive materials and the reactions to completion. Contamination involved the inadvertent release of TNT, its precursors, contaminants and residues, and acids or sellite (sodium sulfite made from soda ash and sulfur) from the process lines or drying or packaging areas. Releases occurred to the surface soil and, from leaking or

damaged underground pipelines, to subsurface soil. Releases probably occurred during the decontamination and building and equipment removal processes described above. Runoff and erosion may have spread contamination over the surrounding surface soil and may have carried contaminants to nearby streams. Infiltration and leaching may have carried contaminants into the subsurface soil or groundwater. As noted above, the groundwater evaluation is deferred to a future site-wide groundwater delivery order.

3.1.3 Receptors and Exposure Pathways

Receptors, selected to represent the upper bound on exposure from all plausibly exposed groups of people at TNT Areas A and C, and the pathways by which they may be exposed to chemicals, are summarized in Figure 3-1 and Table 3-1.

The RA was based on a reasonable maximum exposure (RME) assumption. The intent of the RME assumption is to estimate the highest exposure level that could reasonably be expected to occur, but not necessarily the worst possible case (EPA, 1989a, 1991). It is interpreted as reflecting the 90 to 95th percentile on exposure. In keeping with EPA (1991) guidance, variables chosen for a baseline RME scenario for intake rate (IR), exposure frequency (EF) and exposure duration (ED) are generally upper-bounds. Other variables, e.g., body weight (BW) and exposed skin surface area (SA), are generally central or average values. In the case of contact rates consisting of multiple components, e.g., dermal contact with soil or water, which consists of a dermal absorption factor (ABS) and soil-to-skin adherence factor (AF) for soil, and permeability coefficient (PC) and exposure time (ET) for water, only one variable, ABS or PC needs to be an upper bound. The conservatism built into the individual variables ensures that the entire estimate for contact rate is more than sufficiently conservative.

The averaging time (AT) for noncancer evaluation was computed as the product of ED (years) times 365 days per year (days/year), to estimate an average daily dose over the entire exposure period (EPA, 1989a). For cancer evaluation, AT was computed as the product of 70 years, the assumed human lifetime, times 365 days/year, to estimate an average daily dose prorated over a lifetime, regardless of the frequency or duration of exposure. This methodology assumes that the risk from short-term exposure to a high dose of a given carcinogen is equivalent to long-term exposure to a correspondingly lower dose, provided that the total lifetime doses are equivalent. This approach is generally consistent with the EPA (1986) policy of carcinogen evaluation, although it introduces considerable uncertainty into the cancer RA.

A fractional term (FI) was introduced into the chemical intake equations to account for scenarios in which exposure to a potentially contaminated medium associated with the site is less than total daily exposure to that medium. For example, if either of the sites of interest were small, so that a groundskeeper may spend only one-half of his working time at the site, an FI of 0.5 would be applied to the soil ingestion and dermal intake equations. An FI was used also when a receptor's exposure is split between two comparable media. For example, the on-site resident is exposed to both soil and sediment; therefore, FIs are introduced that apportion his exposure between the two media. The default value of FI is 1.

Exposure to groundwater is plausible for several of the receptor scenarios detailed below. However, the groundwater evaluation is deferred to a future site-wide groundwater delivery order. Plausible pathways for exposure to groundwater will be developed at that time.

3.1.3.1 Groundskeeper

The groundskeeper scenario is designed to evaluate the upperbound for site worker exposure to surface soil in the current and future site-use scenario. Direct exposure pathways include incidental ingestion and dermal contact. Inhalation of dust, raised by operating lawn mowers or other equipment, is also evaluated because relatively high dust concentrations may be produced within the groundskeeper's breathing zone, with little opportunity for dilution by the large volume of ambient air.

IT's experience has been that VOC-contaminated surface soil that has been in place for extended periods is not a significant source of airborne VOCs, because infiltration and dissipation over time reduce residues at the surface (i.e., first few centimeters) from which volatilization would occur. However, as noted above, the data set for surface soil may include samples taken from up to 2 feet bgs, where dissipation has not reduced VOC concentrations (Tables 2-1 and 2-2). In other words, the surface soil data set might indicate the presence of VOCs, although volatilization to the air is unlikely to be significant. Therefore, a surface-soil-to-air volatilization model will not be used in addition to the activity-based dust emissions model to estimate airborne concentrations of VOCs. Instead, the airborne concentrations estimated by the dust emissions model will be assumed to sufficiently estimate levels of VOCs that may arise from volatilization, because the dust emissions model treats the VOCs as if they were located at the surface. It is assumed that VOC emissions from subsurface soil would be attenuated by the overlying soil, so that concentrations in ambient air would not be toxicologically significant.

It is assumed that any contact with the intermittent surface water or sediment in the streams associated with TNT Areas A and C would be infrequent and sporadic, since such contact would not be a part of the groundskeeper's regular duties or activities. Therefore, exposure to these media is not quantified.

The groundskeeper is assumed to be a 70-kilogram adult who works 8 hours per day (hours/day), approximately 5 days per week (days/week) year-round on site for a total of 250 days/year for 25 years (EPA, 1991). The respiratory rate for the groundskeeper is assumed to be 20 m^3/8-hour workday (2.5 cubic meters per hour [m^3/hour]), and the soil incidental ingestion rate is assumed to be 100 milligrams per day (mg/day), comparable to that for an agricultural worker.

Recent studies evaluating soil adherence that consider the nature of the activity performed and the different body regions were reviewed by EPA (1997a). Measurements of soil adherence to hands, arms, legs, feet, and face for 29 groundskeepers revealed AFs ranging from 8E-4 milligrams per square centimeters (mg/cm^2) (legs) to 1.5E-1 mg/cm^2 (hands). The AF weight-averaged across these body regions (i.e., adjusted to reflect the different SAs of the different body regions) for males and females is 9E-3 mg/cm^2, which is used in this evaluation. The SA of body regions evaluated for groundskeepers includes approximately 11,300 cm^2 (EPA, 1997a).

3.1.3.2 Indoor Worker

This receptor scenario is developed to evaluate exposure to indoor airborne VOCs entrapped in a building. VOCs released from subsurface soil may enter a building through joints or cracks in the foundation or slab. The indoor worker is also potentially exposed to surface soil via incidental ingestion. Dermal exposure to surface soil and inhalation of airborne dust and VOCs from surface soil, although plausible, are expected to be less significant than incidental ingestion because he spends his work time indoors. Therefore, dermal contact and inhalation of dust and airborne VOCs from surface soil are not quantified. Exposure to VOCs in ambient (outdoor) air from volatilization from subsurface soil is not quantified for the reasons given for the groundskeeper.

The indoor worker is assumed to be a 70-kilogram adult who works 8 hours/day, approximately 5 days/week year-round on the site for a total of 250 days/year for 25 years (EPA, 1991). His soil incidental ingestion rate is assumed to be 50 mg/day, and his inhalation rate is assumed to be 20 m^3/8-hour workday.

3.1.3.3 Construction Worker

The construction worker scenario is developed to evaluate short-term exposure to surface and subsurface soil (total soil) in either the current or future site-use scenario. Construction projects are expected to be infrequent. It is assumed that the construction worker participates in only one construction project on the site. Relevant exposure pathways include incidental ingestion and dermal contact, inhalation of dust raised by operating construction equipment, and inhalation of airborne VOCs released from subsurface soil during excavation and grading.

The construction worker may also be exposed to surface water and sediment during projects such as installation of underground utilities or rerouting stream flow. Dermal contact is the most significant pathway for exposure to surface water. Incidental ingestion of surface water is also possible, but is not expected to be nearly as significant as dermal contact. Inhalation of VOCs from surface water is also possible; but the large volume of outdoor air and natural air currents are expected to dilute airborne concentrations, so that this pathway is expected to be less significant than dermal contact, which is quantified. For these reasons incidental ingestion and inhalation of VOCs from surface water are not quantified. Dermal contact and incidental ingestion may be important pathways for exposure to sediment, and both are evaluated.

The construction worker is assumed to be a 70-kilogram adult who works 8 hours/day, approximately 5 days/week, year-round on site at the rate of 250 days/year (EPA, 1991). Construction projects are assumed to last 6 months. The respiratory rate for the construction worker is assumed to be 20 m^3/8-hour workday (2.5 m^3/hour). Excavation and soil grading activities, which result in intensive soil contact, are assumed to last for 3 months; for the remaining 3 months, construction activities are assumed to result in less intensive soil contact. Soil ingestion rates of 480 mg/day (EPA, 1993) and 100 mg/day, similar for the agricultural worker (EPA, 1991), are assumed for the intensive and less intensive soil contact periods, respectively, resulting in a time-weighted average rounded to 290 mg/day.

As noted above, the construction worker may be exposed to surface water and sediment during the 6-month construction period. Dermal exposure to surface water and sediment is assumed to occur for 4 hours/day, or one-half the normal work day. The incidental ingestion rate for sediment is assumed to be 290 mg/day, the same as assumed for soil. It is assumed that the arms, forearms and hands, an SA of approximately 3,100 cm^2 (EPA, 1997a), are exposed to surface water and sediment. An AF for sediment of 0.24 mg/cm^2 (EPA, 1997a) is estimated for the

hands and arms, using the same method described for the groundskeeper exposure to soil, and using data for construction workers, utility workers, and equipment operators.

An AF for soil for the construction worker of 8E-2 mg/cm^2 is estimated using the same method as previously described for the groundskeeper, combining EPA (1997a) data for construction workers, utility workers, and equipment operators to capture the full range of activities likely to be performed by this receptor. The body regions evaluated for construction workers total approximately 11,300 cm^2.

The construction worker scenario described above provides for several different kinds of construction projects, such as upland excavation and building projects (exposure primarily to soil), and stream re-routing (exposure primarily to surface water and sediment). It is unlikely, however, that a single construction worker would participate in all these activities during a given project. Therefore, the evaluation described above is probably overly conservative and may represent some double-counting. For example, it is unlikely that the construction worker would be dermally exposed simultaneously to soil, sediment and surface water. Similarly, the air in his breathing zone is not likely to contain the reasonable maximum concentrations of COPCs estimated from soil and surface water simultaneously. Dermal and inhalation exposure, however, are not expected to be risk drivers in the construction worker scenario. Therefore, the potential for double-counting is not expected to contribute significantly to total risk estimates summed across chemicals, pathways and media. Should construction worker risk estimates exceed acceptable limits, alternative RA(s) may be performed using refined exposure assumptions based on the physical characteristics of the site. For example, an upland excavation and building project may be assumed for one or more areas of the site, and a stream re-routing project may be assumed for another. This approach will more precisely reflect plausible exposure scenarios, reduce the likelihood of double-counting, and more accurately identify risk-driving media and chemicals.

3.1.3.4 On-Site Resident

The on-site resident scenario is developed to evaluate the upper bound for long term exposure to site soil, surface water and sediment under the future site-use scenario. The resident is assumed to be exposed to total soil because residential development would involve excavation and grading, which would mix surface and subsurface soil. Relevant pathways for total soil exposure include incidental ingestion, dermal contact, and inhalation of dust and VOCs.

Evaluation of VOCs from total soil is addressed during evaluation of airborne dust as described for the groundskeeper. It is assumed that 80 percent of the soil surface is covered with pavement or vegetation for evaluating inhalation to airborne dust. Inhalation of VOCs released from subsurface soil and entrapped in indoor air is also evaluated.

The resident could have access to the streams and creeks associated with TNT Areas A and C and could be exposed to surface water and sediment. It is assumed that the resident would visit the streams for 8 hours/day, 2 days/week during the warmer half of the year. The resident is assumed to wade for 3 hours/day on 52 days/year. Plausible exposure pathways include dermal contact with surface water, and incidental ingestion and dermal contact with sediment. Incidental ingestion of surface water in a wading scenario is considered to be less significant than dermal contact and is not quantified. Inhalation of VOC emissions from surface water is also possible; but the large volume of outdoor air and natural air currents are expected to dilute airborne concentrations, so that this pathway is expected to less significant than dermal contact, which is quantified. For these reasons, inhalation of VOC emissions from surface water is not quantified.

As noted in Section 2.3.1, COPCs were identified in off-site sediment downgradient from TNT Area A. The assumptions for on-site residential exposure to sediment will be used to evaluate the risk from exposure to off-site sediment.

Inhalation of VOCs released from subsurface soil and trapped in indoor air is also evaluated.

The on-site residential scenario is evaluated using both an adult and a child. Cancer risk is estimated as the sum of the risks calculated for the adult and the child. Only the child is used for the noncancer evaluation. This approach captures the greater conservatism of the larger incidental soil and sediment ingestion rates and inhalation rate for the child when expressed on a BW basis.

The adult resident is assumed to be a 70-kilogram person with an incidental soil ingestion rate of 100 mg/day, an inhalation rate of 20 m^3/day (0.83 m^3/hour) (EPA, 1991). Approximately 25 percent of his body SA, or 4,500 cm^2, is available for exposure to soil or sediment (EPA, 1992b). Approximately 30 percent of his total body SA, 5,450 cm^2, is available for exposure to surface water. It is assumed that dermal uptake of organic chemicals from water does not reach steady

state. The adult resident is assumed to be exposed 350 days/year for 24 years (EPA, 2000). The mechanisms of exposure to soil and sediment are likely to be similar; therefore, the incidental soil ingestion rate of 100 mg/day is also applied to sediment.

The child resident is assumed to be a 1 through 6 year-old with an average BW of 15 kilograms, a soil ingestion rate of 200 mg/day, and an inhalation rate of 10 m^3/day (EPA, 2000). Approximately 25 percent of his body SA, or 1,750 cm^2, is available for exposure to soil or sediment (EPA, 1992b). Approximately 30 percent of his total body SA, 2,100 cm^2, is available for exposure to surface water. The child resident is exposed for 350 days/year for 6 years (EPA, 1991, 2000). The mechanisms of exposure to soil and sediment are likely to be similar; therefore, the incidental soil ingestion rate of 200 mg/day is also applied to sediment.

An average soil and sediment AF of 0.2 mg/cm^2 is adopted for the on-site resident (EPA, 1992b).

EPA (1989a) permits the development of a fraction to reflect the proportion of total daily exposure that a receptor obtains from a potentially-contaminated medium. In this scenario, the FI is used to apportion the resident's time of exposure between site soil and sediment. It is assumed that the resident spends 16 hours/day awake and potentially exposed to soil or sediment. As previously noted, 350 days/year are available for contact with soil; 52 of those days are also available for contact with sediment. It is assumed that contact with soil and sediment does not occur simultaneously; i.e., on those days when the resident spends time at the streams, 8 hours would be spent in contact with soil and 8 hours would be spent in contact with sediment. The fraction of exposure to soil, therefore, is 16 hours/16 hours = 1 on the 298 days without time spent at the streams, and 8 hours/16 hours = 0.5 on the 52 days with some time spent at the streams. A weighted fraction of 0.93 (rounded to 0.9) is estimated for exposure to soil over the entire 350 days/year EF. A weighted fraction of 0.07 (rounded to 0.1) is estimated for exposure to sediment over the entire 350 days/year EF.

Inhalation of VOCs released from subsurface soil and entrapped in indoor air is evaluated by assuming that the resident spends 16.4 hours/day indoors (EPA, 1997a). The inhalation rate of the adult resident, 20 m^3/day, is multiplied by 16.4 hours/24 hours per day to estimate a daily indoor inhalation rate of 13.7 m^3/day. An indoor inhalation rate of 6.8 m^3/day is estimated in the same manner for the child resident.

3.1.3.5 Hunter

This scenario is developed to evaluate the potential for contaminants in soil to affect food-chain pathways. Both TNT Areas A and C provide habitat for deer and other wildlife, and deer hunting is permitted on the PBOW facility. Therefore, a hunter who consumes his game is a plausible scenario requiring evaluation. Many kinds of game animals may be hunted and consumed (e.g., squirrel, pheasant and other upland birds, turkey, deer); however, the deer is the species most likely to contribute meaningfully to the diet. Therefore, this evaluation is limited to a deer hunter. Potential exposure pathways include incidental soil ingestion, dermal contact with soil, and ingestion of venison from deer that browse plants growing on contaminated surface soil, all of which are evaluated quantitatively. Inhalation of airborne dust from wind currents is a potentially complete exposure pathway; however, vegetation reduces dust emissions to insignificant levels (EPA, 1996a), and it is assumed that the deer hunter would spend virtually all of his time on vegetated rather than bare soil. Therefore, it is assumed that inhalation exposure would contribute much less than incidental ingestion, and the inhalation exposure pathway is not quantified.

Inhalation exposure to airborne VOCs from subsurface soil and surface water is not evaluated for the reasons previously explained for other receptors.

The deer hunter is assumed to be a 70-kilogram adult nearby resident (exposure duration of 30 years) (EPA, 1991) who harvests deer and consumes venison. It is assumed that he spends his entire 2-week vacation hunting on PBOW; i.e., his EF for incidental soil ingestion and dermal contact is 14 days/year. His incidental soil ingestion rate is assumed to be 100 mg/day (EPA, 1991). It is assumed that approximately 25 percent of his body SA, or 4,550 cm^2, is available for exposure to soil (EPA, 1992b). A soil AF of 0.2 mg/cm^2 is assumed.

Data were not located regarding the rate of venison ingestion; therefore, a hypothetical scenario is adapted from the assumptions applied to a similar site in West Virginia (IT, 2000c). A highly conservative but plausible scenario consists of a hunter who kills a deer each year. It is assumed that the hunter eats 10 pounds (4.5 kilograms) of venison per year (Sharp, 1995). This consumption rate corresponds to 0.013 kg/day (0.186 g/kg-day) of venison for each of the 350 days per year (EPA, 1991) that the hunter spends at home.

It is likely that the successful hunter would share his venison with the rest of the family, which may include small children. Small children, however, would be unlikely to accompany the hunter afield. Therefore, the direct exposure pathways evaluated for the hunter (incidental ingestion and dermal contact with soil) will not be evaluated for the small child. The hunter's child is called a child venison consumer for the purposes of this evaluation.

Data regarding the rate of venison ingestion by small children were not located. However, if it is assumed that venison may replace beef in the diet, the differences in beef consumption between adults and children can be used to estimate a venison ingestion rate for children. EPA (1997a) provides per capita beef intake data for less than 1- to 5-year-old children ranging from 0.941 to 1.46 g/kg-day (time-weighted average of 1.296 g/kg-day). EPA (1997a) provides per capita beef intake data for 12- to 70+-year-old adults ranging from 0.568 to 0.83 g/kg-day (time-weighted average of 0.727 g/kg-day). From these data it can be estimated that the beef consumption of small children, expressed on a BW basis, is approximately 1.8 times that of an adult. Therefore, a venison ingestion rate of 0.335 g/kg-day is estimated for the young child from the venison ingestion rate of 0.186 g/kg-day for the adult. Assuming that the child is 0 to 6 years old with an average BW of 15 kilograms (EPA, 2000), the child venison ingestion rate may be expressed as 0.005 kg/day.

3.1.3.6 Other Receptors Not Considered

Another plausible receptor group is delivery personnel. These receptors, however, would be less intensively exposed to soil than the groundskeeper; therefore, their exposures are not evaluated. TNT Areas A or C could become part of the area used for National Guard training activities. National Guard trainees, however, may be less exposed to any of the potentially contaminated media than the receptors identified above. Since they may not represent upper bound for non-residential exposure, these receptors are not evaluated. Parts of PBOW are used for fishing and hunting. The streams on TNT Areas A and C, however, are too small to support fish and are not used for fishing. Therefore, fish ingestion as an indirect pathway for exposure to surface water and sediment is not evaluated.

The exposure variable values used in the contaminant intake models are compiled in Table 3-2.

3.2 Quantification of Exposure-Point Concentrations

The EPC is defined as the concentration of COPC in an environmental medium to which a receptor is exposed. It is computed as a conservative estimate of average and is used to calculate COPC intake rates (Section 3.3). EPCs of COPCs in soil, surface water, and sediment to which receptors are directly exposed are mathematically equivalent to the STCs, which were also computed as conservative estimates of average (Section 2.2). EPCs are calculated for indirect exposure media (e.g., air) by using STCs for the concentration terms in the equations that follow. The EPCs thus calculated for the indirect exposure media are considered to be conservative estimates of average.

Chemical-specific variable values used to estimate EPCs and to quantify intake rates are compiled in Table 3-3. The values are documented in the toxicity profiles for the chemicals selected as COPCs (please see Section 4.5).

3.2.1 Exposure-Point Concentrations in Air

3.2.1.1 COPC Concentrations from Dust

Inhalation exposure to particulate (dust) emissions from soils for the groundskeeper and construction worker evaluations arises from activities that raise dust. Therefore, the most appropriate approach to estimating chemical concentrations in ambient air is the use an activity-based dust-loading equation (U.S. Department of Energy [DOE], 1989):

$$C_a = (D)(C_{so})(CF_1) \qquad \text{Eq. 3.1}$$

where:

C_a = contaminant concentration in air (mg/m^3, calculated)
D = dust-loading factor (g of soil/m^3 of air)
C_{so} = contaminant concentration in soil (mg/kg)
CF_1 = conversion factor (1E-3 kg/g).

Plausible values for D include 2E-4 g/m^3 for agricultural activity (DOE, 1989), 6E-4 g/m^3 for construction work (DOE, 1983), and 1E-4 g/m^3 for other activity (National Council on Radiation Protection and Measurements [NCRP], 1984). The value for D of 1E-4 g/m^3 for other activity is used for the groundskeeper. It is assumed that construction activities requiring intimate contact with soil, for which D = 6E-4 g/m^3 is appropriate, may last for one-half of a construction period.

The remaining one-half of the time is more realistically characterized by D = 1E-4 g/m^3. Therefore, a time-weighted average dust-loading factor for construction work of 3.5E-4 g/m^3 is estimated for the construction worker.

Airborne concentrations of VOCs estimated by the dust-loading model are assumed to sufficiently estimate levels of VOCs that may arise from volatilization, because the dust-loading model treats the VOCs as if they were located at the surface.

The resident is more likely to be exposed to dust arising from wind erosion rather than from dust-raising activities on the site. EPA (1996a) derived a model for estimating a dust particulate emission factor based on an "unlimited reservoir" model and the assumption that the source area is square:

$$PEF = Q/C \cdot \frac{3600}{0.036 \cdot (1 - V) \cdot (U_m/U_t)^3 \cdot F(x)} \qquad \text{Eq. 3.2}$$

where:

PEF	=	particulate emission factor (m^3/kg, calculated)
Q/C	=	inverse of the mean concentration at center of square source (43.08 g/m^2-second per kg/m^3, site-specific value from Table 3 in EPA [1996a] [Zone 7, Cleveland, 30-acre site])
3600	=	seconds/hour
V	=	fraction of surface covered with vegetation (0.8, unitless, assumed)
U_m	=	mean annual wind speed (default, 4.69 m/second)
U_t	=	equivalent threshold value of wind speed at 7 m (default, 11.32 m/second)
F(x)	=	function dependent on U_m/U_t (default, 0.194).

The concentration of COPC in air is calculated as follows:

$$C_a = \frac{C_{so}}{PEF} \qquad \text{Eq. 3.3}$$

where:

C_a	=	contaminant concentration in air (mg/m^3)
C_{so}	=	contaminant concentration in soil (mg/kg)
PEF	=	particulate emission factor (m^3/kg).

Airborne concentrations of VOCs estimated by the wind erosion model are assumed to sufficiently estimate levels of VOCs that may arise from volatilization, because the wind erosion model treats the VOCs as if they were located at the surface.

3.2.1.2 COPC Concentrations in Indoor Air

An EPA (1997b) modification of the Johnson and Ettinger model is used to estimate airborne concentrations of VOCs in indoor air from subsurface soil for the indoor worker and resident.

Estimating indoor airborne concentrations from subsurface soil can be considered to consist of three separate steps:

- Estimating VOC concentration in soil gas at source of contamination (C_{source})
- Estimating an attenuation coefficient that captures the decline in VOC concentration between soil gas at the source and indoor air (α)
- Combining C_{source} and α to estimate VOC concentration in indoor air in the building ($C_{building}$).

An "infinite source" assumption is selected to maintain consistency with the EPA (1996a) methodology for PEF, and to impart a conservative bias to the evaluation. It is assumed that both the source of VOC contamination in subsurface soil and the foundation of the building are located above the groundwater saturation zone. It is also assumed that VOC contamination in soil does not exist in a nonaqueous phase. Because of the strongly conservative bias imparted by the infinite source assumption, average values are selected for model variables, when possible, if site-specific data are not available. Default values are taken preferentially from EPA (1996a) to maintain consistency with the other models described in Section 3.2.1, then from EPA (1997b).

The first step in estimating indoor air concentrations is to relate the concentration of VOC in soil gas at the source of contamination to the concentration of VOC in soil, as follows:

$$C_{source} = \frac{(H')(C_{so})(\rho_b)(CF_2)}{\theta_w + (K_d)(\rho_b) + (H')(\theta_a)} \qquad \text{Eq. 3.4}$$

where:

C_{source}	=	VOC concentration in soil gas at source of contamination (g/cm^3)
H'	=	dimensionless Henry's law constant (chemical-specific, may be estimated as H · 41 [EPA, 1996a])
H	=	Henry's law constant (atmosphere-m^3/mole, chemical-specific)
C_{so}	=	contaminant concentration in soil (mg/kg)
ρ_b	=	dry soil bulk density (1.5 g/cm^3, default [EPA, 1996a])
CF_2	=	conversion factor (10^{-6} kg/mg)
θ_w	=	water-filled soil porosity (0.15 L_{water}/L_{soil}, default [EPA, 1996a])
K_d	=	soil-water partition coefficient (cm^3/g, chemical-specific, may be estimated as $K_{oc} \cdot f_{oc}$)
K_{oc}	=	soil organic carbon-water partition coefficient (cm^3/g, chemical-specific)
f_{oc}	=	organic carbon content of soil (0.006 g/g, default [EPA, 1996a])
θ_a	=	air-filled soil porosity (0.28 unitless, default [EPA, 1996a])
n	=	total soil porosity (0.43 unitless, default [EPA, 1996a]).

The next step in calculating indoor air concentrations is the estimation of an attenuation coefficient that reflects the phenomena that reduce concentration in air between the source and the interior of the building. Because of the many phenomena involved, it is helpful to break this step into several smaller segments.

Diffusion is probably the most important phenomenon involved in the transport of VOC vapors from source to building. The EPA (1997b) modification of the Johnson and Ettinger model provides for multiple layers, i.e., different soil types, each of which would have its own physical properties that affect diffusion, between the contaminant source and the foundation of the building. For the purposes of this evaluation, it is simplistically assumed that only one soil type – the predominant soil type in the area – intervenes between source and building foundation. The equation for effective diffusivity through the soil between the source and the building foundation is given as:

$$D^{eff} = D_a(\theta_a^{3.33} / n^2) + (D_w / H')(\theta_w^{3.33} / n^2) \qquad \text{Eq. 3.5}$$

where:

D^{eff}	=	effective diffusion coefficient across soil (cm^2/second, calculated)
D_a	=	diffusivity in air (cm^2/second, chemical specific)
θ_a	=	air-filled soil porosity (0.28 unitless, default [EPA, 1996a])
n	=	total soil porosity (0.43 unitless, default [EPA, 1996a])
D_w	=	diffusivity in water (cm^2/second, chemical specific)

H' = dimensionless Henry's law constant (chemical-specific, may be estimated as H · 41 [EPA, 1996a])
θ_w = water-filled soil porosity (0.15 L_{water}/L_{soil}, default [EPA, 1996a]).

The equation for the attenuation coefficient is given as:

$$\alpha = \frac{\left(\left(\frac{D^{eff} A_B}{Q_{building} L_T}\right) \text{x} \exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right)\right)}{\left(\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) + \left(\frac{D^{eff} A_B}{Q_{building} L_T}\right) + \left(\frac{D^{eff} A_B}{Q_{soil} L_T}\right)\left(\exp\left(\frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right) - 1\right)\right)} \quad \text{Eq. 3.6}$$

where:

α = attenuation coefficient (unitless, calculated)
D^{eff} = effective diffusion coefficient across soil (cm^2/second)
A_B = area of enclosed space below grade (1.51E+6 cm^2, see below)
$Q_{building}$ = building ventilation rate (4.61E+4 cm^3/second, see below)
L_T = distance from source to building (150 cm, as previously estimated for TNT Area B)
Q_{soil} = flow rate of soil gas into enclosed space (cm^2/second, see below)
L_{crack} = foundation or slab thickness (15 cm, default [EPA, 1997b])
D^{crack} = effective diffusion coefficient through cracks (cm^2/second, assumed to be equivalent to D^{eff} [EPA, 1997b])
A_{crack} = total area of cracks (492 cm^2, see below).

The Engineering Building is located in the central portion of TNT Area A. This building could serve as the source of the building characteristics required for Equation 3.6. However, it is generally very difficult to measure the required building characteristics. Furthermore, there is no assurance that the characteristics of the Engineering Building would reflect the characteristics of future buildings. Therefore, the building characteristics are obtained from other sources. EPA (1997a) reviewed several studies of the volumes of houses and recommends 369 cubic meters as a central estimate of the volume of a house. Assuming the house has 8 foot (2.44 meters) ceilings and exists on one level, an area of 151.3 square meters, equivalent to 1.51E+6 cm^2, can be estimated as an upper bound on the area below grade.

An average building ventilation rate of 3,984 m^3/day was estimated for a home (EPA, 1997a), which is equivalent to 4.61E+4 cm^3/second.

EPA (1997b) assumes that the only crack available for the entry of soil gas is a 0.1-centimeter-wide gap at the interface of the floor and foundation. As noted above, it is assumed that the area of the basement floor is 151.3 square meters. Assuming that the house is square, the length of one side would be 12.3 meters, and the total length of the wall would be 49.2 meters (4,920 centimeters). Therefore, the area of the crack would be 492 cm^2.

The equation for the flow rate of soil gas into enclosed space is:

$$Q_{soil} = \frac{2\,\pi\,\Delta P\,k_v\,X_{crack}}{\mu\,\ln(2\,Z_{crack}\,/\,r_{crack})} \qquad \text{Eq. 3.7}$$

where:

Q_{soil} = flow rate of soil gas into enclosed space (cm^2/second, calculated)
ΔP = pressure differential between soil surface and enclosed space (20 g/cm-second^2)
k_v = soil vapor permeability (cm^2, see below)
X_{crack} = floor-wall seam perimeter (4,920 cm, see above)
μ = viscosity of air (1.83E+5 g/cm-second [EPA, 1992e])
Z_{crack} = crack depth below grade (108 cm, see below)
r_{crack} = equivalent crack radius (0.1 cm, see below).

Data were not located from which to estimate the crack depth below grade. Presumably, however, houses or other buildings may be built on slabs or on full foundations. EPA (1997b) provides default depths of 15 centmeters for buildings on slabs and 200 centimeters for buildings on foundations. The average, 108 centimeters, is chosen for this evaluation.

Equation 3.7 assumes that vapor transport occurs solely by pressure-driven air flow to an idealized cylinder buried some distance (Z_{crack}) below grade. The length of the cylinder is assumed to be equal to X_{crack}. Therefore, the equivalent crack radius can be estimated as follows:

$$r_{crack} = \eta\left(\frac{A_B}{X_{crack}}\right) \qquad \text{Eq. 3.8}$$

where:

r_{crack} = equivalent crack radius (cm, calculated)
η = A_{crack}/A_B
A_{crack} = area of total cracks (492 cm^2, see above)
A_B = area of enclosed space below grade (1.51E+6 cm^2, see above)
X_{crack} = floor-wall seam perimeter (4920 cm, see above).

From the foregoing, a value of 0.1 cm is estimated for r_{crack}.

Soil vapor permeability is a very sensitive parameter associated with convective transport of vapors within the zone of influence of a building (EPA, 1997b). It can be estimated as the product of soil intrinsic permeability and the relative air permeability at the estimated water-filled soil porosity (θ_w). Soil intrinsic permeability is estimated as follows:

$$k_i = \frac{K_s \mu_w}{\rho_w g} \qquad \text{Eq. 3.9}$$

where:

k_i	=	soil intrinsic permeability (cm^2, calculated)
K_s	=	soil saturation hydraulic conductivity (cm/second, see below)
μ_w	=	dynamic viscosity of water (0.01307 g/cm-second [EPA, 1997b])
ρ_w	=	density of water (0.999 g/cm^2, [EPA, 1997b])
g	=	acceleration due to gravity (980.665 cm/$second^2$ [EPA, 1997b]).

Soil saturation hydraulic conductivity is related to soil texture. Site-specific data were used in conjunction with Table 4 of EPA (1997b) to estimate an approximate value for K_s.

Relative air permeability is estimated as follows:

$$k_{rg} = \left(1 - S_{te}\right)^{0.5}\left(1 - S_{te}^{1/M}\right)^{2M} \qquad \text{Eq. 3.10}$$

where:

k_{rg}	=	relative air permeability (positive unitless value, calculated)
S_{te}	=	effective total fluid saturation (unitless, see below)
M	=	van Genuchten shape parameter (unitless, see below).

Site-specific data regarding the nature of the soil were used in conjunction with Table 2 of EPA (1997b) to estimate an appropriate van Genuchten shape parameter.

S_{te} is calculated as follows:

$$S_{te} = \frac{\theta_w - \theta_r}{n - \theta_r} \qquad \text{Eq. 3.11}$$

where:

S_{te} = effective total fluid saturation (unitless, calculated)
θ_w = water-filled soil porosity (0.15 L_{water}/L_{soil}, default [EPA, 1996a])
θ_r = soil water content (cm^3/cm^3, taken from Table 2 of EPA [1997b])
n = total soil porosity (0.43 unitless, default [EPA, 1996a]).

Soil vapor permeability is estimated as follows:

$$k_v = (k_i)(k_{rg}) \qquad \text{Eq. 3.12}$$

where:

k_v = soil vapor permeability (cm^2, calculated)
k_i = soil intrinsic permeability (cm^2)
k_{rg} = relative air permeability (unitless).

The foregoing permit calculation of the attenuation coefficient, which, in turn permits calculation of the concentration of the VOC in indoor air in the building, as follows:

$$C_{building} = \alpha\ CF_3\ C_{source} \qquad \text{Eq. 3.13}$$

where:

$C_{building}$ = VOC concentration in indoor air in the building (mg/m^3, calculated)
α = attenuation coefficient (unitless)
CF_3 = conversion factor (1E+9 mg-cm^3/g-m^3)
C_{source} = VOC concentration in soil gas at source of contamination (g/cm^3).

3.2.1.3 VOC Concentrations from Subsurface Soil in Ambient Air

The construction worker may be exposed to VOCs released from subsurface soil by volatilization. Exposure-point concentrations of VOCs in ambient air due to volatilization are estimated with a chemical-specific soil volatilization factor calculated from the following equations and defaults provided by EPA (1996a):

$$VF_s = Q/C \cdot CF_4 \cdot \left(\frac{[3.14 \cdot D_A \cdot T]^{1/2}}{2 \cdot \rho_b \cdot D_A} \right) \qquad \text{Eq. 3.14}$$

and

$$D_A = \frac{(\theta_a^{10/3} \cdot D_i \cdot H' + \theta_w^{10/3} \cdot D_W)/n^2}{\rho_b \cdot K_d + \theta_w + \theta_a \cdot H'} \qquad \text{Eq. 3.15}$$

where:

VF_s	=	chemical-from-soil volatilization factor (m^3/kg, chemical-specific, calculated)
Q/C	=	inverse of the mean concentration at center of square source (43.08 g/m^2-second per kg/m^3, site-specific value from Table 3 of EPA [1996a] [Zone 7, Cleveland, 30-acre site])
CF_4	=	conversion factor (1E-4 m^2/cm^2)
D_A	=	apparent diffusivity (cm^2/second, calculated)
T	=	exposure interval (seconds, estimated as ED · 3.15E7 seconds/year)
ED	=	exposure duration (years, receptor-specific)
ρ_b	=	dry soil bulk density (1.5 g/cm^3, default)
θ_a	=	air-filled soil porosity (0.28 unitless, default)
n	=	total soil porosity (0.43 unitless, default)
ρ_s	=	true soil or particle density (2.65 g/cm^3)
θ_w	=	water-filled soil porosity (0.15 L_{water}/L_{soil}, default)
D_i	=	diffusivity in air (cm^2/second, chemical specific)
H'	=	dimensionless Henry's law constant (chemical-specific, may be estimated as H · 41)
H	=	Henry's law constant (atmosphere-m^3/mole, chemical-specific)
D_W	=	diffusivity in water (cm^2/second, chemical-specific)
K_d	=	soil-water partition coefficient (cm^3/g, chemical-specific, may be estimated as $K_{oc} \cdot f_{oc}$)
K_{oc}	=	soil organic carbon-water partition coefficient (cm^3/g, chemical-specific)
f_{oc}	=	organic carbon content of soil (6E-3 g/g, default, or site-specific).

The concentration of COPC in ambient air is estimated as follows:

$$C_a = \frac{C_{so}}{VF_s} \qquad \text{Eq. 3.16}$$

where:

C_a = contaminant concentration in air (mg/m^3, calculated)
C_{so} = contaminant concentration in soil (mg/kg)
VF_s = chemical-from-soil volatilization factor (m^3/kg, chemical-specific, calculated).

3.2.2 Exposure-Point Concentrations of COPCs in Venison

The hunter is assumed to harvest and consume game, and share it with his family, including small children. The game is assumed to be venison, because deer is the species hunted most widely and most likely to provide a regular contribution to the diet. Data do not exist to reliably estimate contaminant concentrations in venison, but the following simplifying assumptions permit estimates sufficient for an RA.

- Deer are small ruminants and as such are not unlike cattle; thus, it is reasonable to assume they may have similar physiological processes that could yield similar biotransfer factors. Unlike beef, however, deer meat does not undergo marbling with fat, and deer fat is quite unpalatable and is likely to be trimmed rather than consumed. Therefore, the biotransfer factors for edible venison are derived by adjusting biotransfer factors for beef to account for differences in the fat content of table-ready beef (cooked choice retail cuts trimmed to 0 inches of fat: average 14.4 percent fat) and venison (cooked boneless muscle meats: average 2.9 percent fat) (Nutrient Database, 1997).

- Deer are expected to browse a much larger area than that encompassed in either of the TNT Areas A or C; therefore the fraction of total browse consumed from the contaminated site is expected to be small.

- Indirect food-chain pathways may be significant for metals and for those SVOCs that persist in the environment and have the tendency to bioaccumulate. VOCs are generally mobile in the environment and labile in biological systems and do not tend to bioaccumulate.

To reflect the assumptions previously noted, venison biotransfer factors are estimated by multiplying beef biotransfer factors by 2.9/14.4 (or 0.20), and by a fraction, FI_e. FI_e reflects the areal portion of the site compared to a deer's home range area. These assumptions are captured in the following equation:

$$B_v = 0.20\ (FI_e)\ (B_b) \qquad \text{Eq. 3.17}$$

where:

B_v	=	biotransfer factor for venison
0.20	=	factor to reflect differences in fat content between beef and venison (0.20, unitless, see above)
FI_e	=	areal portion of site compared to a deer's home range (1, unitless, see below)
B_b	=	biotransfer factor for beef.

Values for B_b for metals are compiled in Table 3-3.

The TNT Area A and C sites are fairly large (greater than 100 acres each). Although a deer may naturally roam several hundred acres, the sites are very suitable habitat and it is plausible that either site could provide sufficient browse to support several deer. Therefore, FI_e is conservatively set equal to 1.

Deer are assumed to be exposed to contaminants by ingesting browse growing on contaminated soil. It is estimated that deer consume approximately 1.74 kilogram of browse per day (Sample, et al., 1996), which is approximately 50 percent dry matter (DM), or 0.87 kilogram browse DM per day (Mautz, et al., 1976). The contaminant concentration in browse is estimated from the following equation, which was originally developed for estimating the contaminant concentration in forage to which cattle may be exposed (EPA, 1994a):

$$C_p = (CF_7)\ (C_{so})\ (B_p) \qquad \text{Eq. 3.18}$$

where:

C_p	=	concentration of contaminant in (plant) forage DM (mg/kg, calculated)
CF_7	=	conversion factor to adjust for soil containing 20 percent moisture (1.25 unitless)
C_{so}	=	concentration of contaminant in soil (mg/kg)
B_p	=	soil-to-forage biotransfer factor (mg of chemical per kg of dry plant/mg of chemical per kg of dry soil).

Values for B_p are compiled in Table 3-3. B_p values for the vegetative parts of plants, rather than the reproductive parts of plants, were selected, when possible, because deer browse year-round, and the vegetative parts are more available for the greater part of the year.

The concentration of COPC in venison can be estimated from the following equation (adapted from EPA, 1994a):

$$C_v = (Q_p)\ (C_p)\ (B_v) \qquad \text{Eq. 3.19}$$

where:

C_v = contaminant concentration in venison (mg/kg)
Q_p = browse ingestion rate (0.87 kg DM/day)
C_p = contaminant concentration in browse DM (mg/kg)
B_v = biotransfer factor for venison (days/kg).

3.3 Quantification of Chemical Intake

This section describes the models used to quantify doses or intakes of the COPCs by the exposure pathways identified above. Models were taken or modified from EPA (1989a) unless otherwise indicated.

3.3.1 Inhalation of COPCs in Air

The following equation is used to estimate the inhaled dose of COPC in air (groundskeeper, construction worker, on-site resident: inhalation of dust and VOCs in ambient air from surface or total soil; construction worker: inhalation of VOCs in ambient air from subsurface soil; indoor worker and on-site resident: inhalation of VOCs in indoor air from subsurface soil):

$$I_a = \frac{(C_a)(FI_a)(IR_a)(EF)(ED)}{(BW)(AT)} \qquad \text{Eq. 3.20}$$

where:

I_a = inhaled dose of COPC (mg/kg-day, calculated)
C_a = concentration of COPC in air (mg/m^3)
FI_a = fraction of exposure attributed to site media (unitless)
IR_a = inhalation rate (m^3/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days).

3.3.2 Incidental Ingestion of COPCs in Soil

The ingested dose of COPC in soil (groundskeeper, construction worker, on-site resident, indoor worker, hunter) is estimated from the equation:

$$I_{so} = \frac{(C_{so})(FI_{so})(IR_{so})(EF)(ED)(CF_2)}{(BW)(AT)} \qquad \text{Eq. 3.21}$$

where:

I_{so} = ingested dose of COPC in soil (mg/kg-day, calculated)
C_{so} = concentration of COPC in soil (mg/kg)
FI_{so} = fraction of exposure attributed to site soil or sediment (unitless)
IR_{so} = ingestion rate of soil or sediment (mg/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
CF_2 = conversion factor (1E-6 kg/mg)
BW = body weight (kg)
AT = averaging time (days).

3.3.3 Incidental Ingestion of COPCs in Sediment

The ingested dose of COPC in sediment (construction worker, on-site resident) is estimated from the equation:

$$I_{sd} = \frac{(C_{sd})(FI_{sd})(IR_{sd})(EF)(ED)(CF_2)}{(BW)(AT)} \qquad \text{Eq. 3.22}$$

where:

I_{sd} = ingested dose of COPC in sediment (mg/kg-day, calculated)
C_{sd} = concentration of COPC in sediment (mg/kg)
FI_{sd} = fraction of exposure attributed to site sediment (unitless)
IR_{sd} = ingestion rate of sediment (mg/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
CF_2 = conversion factor (1E-6 kg/mg)
BW = body weight (kg)
AT = averaging time (days).

3.3.4 Dermal Contact with COPCs in Soil, Sediment, or Water

Unlike the methodologies for estimating inhaled or ingested dose of COPC, which quantify the dose presented to the barrier membrane (the pulmonary or gastrointestinal mucosa, respectively), dermal dose is estimated as the dose that crosses the skin and is systemically absorbed. For this reason, dermal toxicity values are also based on absorbed dose. The absorbed dose of COPC is estimated from the equation (EPA, 1992b):

$$DAD = \frac{(DA)(SA)(EF)(ED)}{(BW)(AT)} \qquad \text{Eq. 3.23}$$

where:

DAD = average dermally absorbed dose of COPC (mg/kg-day, calculated)
DA = dose absorbed per unit body surface area per day (mg/cm^2-day)
SA = SA_{so} for soil, SA_{sd} for sediment, SA_{sw} for surface water, = surface area of the skin exposed (cm^2)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days).

DA is calculated differently for dermal uptake from soil or sediment than from water. Dermal uptake of constituents from soil (groundskeeper, construction worker, on-site resident, hunter) or sediment (construction worker, on-site resident) assumes that absorption is a function of the fraction of a dermally applied dose that is absorbed. It is calculated from the equation (EPA, 1992b):

$$DA = (C)(FI)(CF_2)(AF)(ABS) \qquad \text{Eq. 3.24}$$

where:

DA = dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C = C_{so} for soil, C_{sd} for sediment, = concentration of COPC in medium (mg/kg)
FI = FI_{so} for soil, FI_{sd} for sediment, = fraction of exposure attributed to site medium (unitless)
CF_2 = conversion factor (1E-6 kg/mg)
AF = AF_{so} for soil, AF_{sd} for sediment, = soil- or sediment-to-skin adherence factor (mg/cm^2-day)
ABS = absorption fraction (unitless, chemical-specific).

ABS values are compiled in Table 3-3. The ABS values identified for soil are also used for sediment.

Quantification of dermal uptake of constituents from surface water (construction worker, on-site resident) depends on a PC, which describes the rate of movement of a constituent from water across the dermal barrier to the systemic circulation (EPA, 1992b). The equation for dermal uptake of chemicals from water is the same as the equation for dermal uptake of chemicals from soil. DA for dermal uptake from water was calculated from the following equation:

$$DA = (C)(PC)(FI)(ET)(CF_6) \qquad \text{Eq. 3.25}$$

where:

DA = dose absorbed per unit body surface area per day (mg/cm^2-day, calculated)
C = C_{sw} for surface water, = concentration of COPC in water (mg/L)
PC = permeability coefficient (cm/hour)
FI = FI_{sw} for surface water, = fraction of exposure attributed to site medium (unitless)
ET = ET_{sw} for surface water, = time of exposure (hours/day)
CF_6 = conversion factor (1E-3 L/cm^3).

PC values are compiled in Table 3-3.

3.3.5 Consumption of Venison

Consumption of venison by the hunter or his child is evaluated by the following equation:

$$I_v = \frac{(C_v)(IR_v)(EF)(ED)}{(BW)(AT)} \qquad \text{Eq. 3.26}$$

where:

I_v = ingested dose of COPC in venison (mg/kg-day, calculated)
C_v = concentration of COPC in venison (mg/kg)
IR_v = venison ingestion rate (kg/day)
EF = exposure frequency (days/year)
ED = exposure duration (years)
BW = body weight (kg)
AT = averaging time (days).

The output of the exposure assessment is an estimate of intake rate for each COPC in each medium for each exposure pathway for each receptor, generally expressed as milligrams, per kilogram of body weight per day (mg/kg-day). These estimates have little value or provide little perspective except when mathematically combined with toxicity values to estimate risk. Therefore, the intake rates are not compiled separately in tables and presented at this point in the evaluation. Instead, they are included in the risk characterization compiled in Appendix B.

4.0 Toxicity Evaluation

Toxicity is defined as the ability of a chemical to induce adverse effects in biological systems. The purpose of the toxicity assessment is two-fold:

- To identify the cancer and noncancer effects that may arise from exposure of humans to the COPCs (hazard assessment)
- To provide an estimate of the quantitative relationship between the magnitude and duration of exposure and the probability or severity of adverse effects (dose-response assessment).

The latter is accomplished by the derivation of cancer and noncancer toxicity values, as described below.

4.1 Cancer Evaluation

A few chemicals are known, and many more are suspected, to be human carcinogens. The evaluation of the potential carcinogenicity of a chemical includes both a qualitative and a quantitative aspect (EPA, 1986). The qualitative aspect is a weight-of-evidence evaluation of the likelihood that a chemical might induce cancer in humans. The EPA (1986) recognizes six weight-of-evidence group classifications for carcinogenicity:

- Group A - Human Carcinogen: human data are sufficient to identify the chemical as a human carcinogen.
- Group B1 - Probable Human Carcinogen: human data indicate that a causal association is credible, but alternative explanations cannot be dismissed.
- Group B2 - Probable Human Carcinogen: human data are insufficient to support a causal association, but testing data in animals support a causal association.
- Group C - Possible Human Carcinogen: human data are inadequate or lacking, but animal data suggest a causal association, although the studies have deficiencies that limit interpretation.
- Group D - Not Classifiable as to Human Carcinogenicity: human and animal data are lacking or inadequate.
- Group E - Evidence of Non-Carcinogenicity to Humans: human data are negative or lacking, and adequate animal data indicate no association with cancer.

The toxicity value for carcinogenicity, called a cancer slope factor (SF), is an estimate of potency. Potency estimates are developed only for chemicals in Groups A, B1, B2 and C, and only if the data are sufficient. The potency estimates are statistically derived from the dose-response curve from the best human or animal study or studies of the chemical. Although human data are often considered to be more reliable than animal data because there is no need to extrapolate the results obtained in one species to another, most human studies have one or more of the following limitations:

- The duration of exposure is usually considerably less than lifetime.
- The concentration or dose of chemical to which the humans were exposed can be approximated only crudely, usually from historical data.
- Concurrent exposure to other chemicals frequently confounds interpretation.
- Data regarding other factors (tobacco, alcohol, illicit or medicinal drug use, nutritional factors and dietary habits, heredity) are usually insufficient to eliminate confounding or quantify its effect on the results.
- Most epidemiologic studies are occupational investigations of workers, which may not accurately reflect the range of sensitivities of the general population.
- Most epidemiologic studies lack the statistical power (i.e., sample size) to detect a low, but chemical-related, increased incidence of tumors.

Most potency estimates are derived from animal data, which present different limitations:

- It is necessary to extrapolate from results in animals to predict results in humans, usually done by estimating an equivalent human dose from the animal dose.
- The range of sensitivities arising from genotypic and phenotypic diversity in the human population is not reflected in the animal models ordinarily used in cancer studies.
- Usually very high doses of chemical are used, which may alter normal biology, creating a physiologically artificial state and introducing substantial uncertainty regarding the extrapolation to the low-dose range expected with environmental exposure.

- Individual studies vary in quality (e.g., duration of exposure, group size, scope of evaluation, adequacy of control groups, appropriateness of dose range, absence of concurrent disease, sufficient long-term survival to detect tumors with long induction or latency periods).

The SF is usually expressed as "extra risk" per unit dose; that is, the additional risk above background in a population corrected for background incidence. It is calculated by the expression:

$$SF=(p_{(d)}-p_{(0)})/(1-p_{(0)})$$

Eq. 4.1

where:

SF = cancer slope factor (risk per mg/kg-day)
$p_{(d)}$ = the probability of cancer associated with dose = 1 mg/kg-day
$p_{(0)}$ = the background probability of developing cancer at dose = 0 mg/kg-day.

The SF is expressed as risk per milligrams per kilogram per day (mg/kg-day). In order to be appropriately conservative, the SF is usually the 95 percent upper bound on the slope of the dose-response curve extrapolated from high (experimental) doses to the low-dose range expected in environmental exposure scenarios. EPA (1986) assumes that there are no thresholds for carcinogenic expression; therefore, any exposure represents some quantifiable risk.

The oral SF is usually derived directly from the experimental dose data, because oral dose is usually expressed as mg/kg-day. When the test chemical was administered in the diet or drinking water, oral dose first must be estimated from data for the concentration of the test chemical in the food or water, food or water intake data, and body weight data.

The EPA (2001a) Integrated Risk Information System (IRIS) expresses inhalation cancer potency as a unit risk factor (URF) based on concentration, or risk per microgram (μg) of chemical/m^3 of ambient air. Because cancer risk characterization requires a potency expressed as risk per mg/kg-day, the URF must be converted to the mathematical equivalent of an inhalation cancer SF, or risk per unit dose. Since the inhalation unit risk is based on continuous lifetime exposure of an adult human (assumed to inhale 20 cubic meters of air/day and to weigh 70

kilograms) the mathematical conversion consists of multiplying the unit risk (per $\mu g/m^3$) by 70 kilograms and by 1,000 micrograms per milligram ($\mu g/mg$), and dividing the result by 20 m^3/day (EPA, 1997c).

4.2 Evaluation of Noncancer Effects

Many chemicals, whether or not associated with carcinogenicity, are associated with noncarcinogenic effects. The evaluation of noncancer effects (EPA, 1989c) involves:

- Qualitative identification of the adverse effect(s) associated with the chemical; these may differ depending on the duration (e.g., acute or chronic) or route (e.g., oral or inhalation) of exposure
- Identification of the critical effect for each duration of exposure (i.e., the first adverse effect that occurs as dose is increased)
- Estimation of the threshold dose for the critical effect for each duration of exposure
- Development of an uncertainty factor; i.e., quantification of the uncertainty associated with interspecies extrapolation, intraspecies variation in sensitivity, severity of the critical effect, slope of the dose-response curve, and deficiencies in the data base, in regard to developing a reference dose (RfD) for human exposure
- Identification of the target organ for the critical effect for each route of exposure.

These information points are used to derive an exposure route- and duration-specific toxicity value called an RfD, expressed as mg/kg-day, which is considered to be the dose for humans, with uncertainty of an order of magnitude or greater, at which adverse effects are not expected to occur. Mathematically, it is estimated as the ratio of the threshold dose to the uncertainty factor.

EPA (2001a) and the Health Effects Assessment Summary Tables (HEAST) (EPA, 1997c) express the inhalation noncancer reference value as a reference concentration (RfC) in units of mg/m^3. Because noncancer risk characterization requires a reference value expressed as mg/kg-day, the RfC must be converted to an inhalation RfD. Since the inhalation RfC is based on continuous exposure of an adult human (assumed to inhale 20 m^3 of air/day and to weigh 70 kilograms), the mathematical conversion consists of multiplying the RfC (mg/m^3) by 20 m^3/day and dividing the result by 70 kilograms.

Lead. The noncancer effects of lead are not evaluated in the same manner as other chemicals. EPA (1990a, 2001a) considers the use of an RfD for lead inappropriate because the effect level is so low as to be practically without a threshold. Also, lead is ubiquitous in the environment, and natural or background exposure occurs continually from multiple sources. Therefore, it is felt that an exposure route-specific threshold value such as an oral RfD may not be sufficiently protective.

4.3 Target Organ Toxicity

As a matter of science policy, the EPA (1989a) assumes dose- and effect-additivity for noncarcinogenic effects. This assumption provides the justification for adding the hazard quotients (HQ) or HI in the risk characterization for noncancer effects resulting from exposure to multiple chemicals, pathways or media. The EPA (1989a), however, acknowledges that adding all HQ or HI values may overestimate hazard, because the assumption of additivity is probably appropriate only for those chemicals that exert their toxicity by the same mechanism.

Mechanism of toxicity data sufficient for predicting additivity with a high level of confidence are available for very few chemicals. In the absence of such data, EPA (1989a) assumes that chemicals that act on the same target organ may do so by the same mechanism of toxicity, unless the data clearly indicate otherwise. That is, target organ serves as a surrogate for mechanism of toxicity. When total HI for all media for a receptor exceeds 1 due to the contributions of several chemicals, it is appropriate to segregate the chemicals by route of exposure and mechanism of toxicity (i.e., target organ) and estimate separate HI values for each.

As a practical matter, since human environmental exposures are likely to involve near- or sub-threshold doses, the target organ chosen for a given chemical is the one associated with the critical effect. If more than one organ is affected at the threshold, all are chosen. Target organ is also selected on the basis of duration of exposure (i.e., the target organ for chronic or subchronic exposure to low or moderate doses is selected rather than the target organ for acute exposure to high doses) and route of exposure. Because dermal RfD values are derived from oral RfD values, the oral target organ is adopted as the dermal target organ. For some chemicals, no target organ is identified. This occurs when no adverse effects are observed or when adverse effects such as reduced longevity or growth rate are not accompanied by recognized organ- or system-specific functional or morphologic alteration.

4.4 Dermal Toxicity Values

Dermal RfDs and SFs are derived from the corresponding oral values, provided there is no evidence to suggest that dermal exposure induces exposure route-specific effects that are not appropriately modeled by oral exposure data. In the derivation of a dermal RfD, the oral RfD is multiplied by the gastrointestinal absorption factor (GAF), expressed as a decimal fraction. The resulting dermal RfD, therefore, is based on absorbed dose. The RfD based on absorbed dose is the appropriate value with which to compare a dermal dose, because dermal doses are expressed as absorbed rather than exposure doses. The dermal SF is derived by dividing the oral SF by the GAF. The oral SF is divided, rather than multiplied, by the GAF because SFs are expressed as reciprocal dose.

4.5 Sources of Toxicity Information Used in the Risk Assessment

Toxicity values are chosen using the following hierarchy:

- The EPA (2001a) on-line IRIS data base containing toxicity values that have undergone the most rigorous Agency review
- The latest version of the annual HEAST, including all supplements (EPA, 1997c)
- Other EPA documents, memoranda, former Environmental Criteria and Assessment Office (ECAO), or National Center for Environmental Assessment (NCEA) derivations for the Superfund Technical Support Center.

Some of the more recent NCEA memoranda update values in the HEAST or in the IRIS data base, in which case the NCEA evaluation will take precedence over the other sources. All toxicity values, regardless of their source, are evaluated for appropriateness for use in the RA.

When toxicity values are not located, the primary literature may be surveyed to determine whether sufficient data exist that would permit derivation of a toxicity value. The use of surrogate chemicals is also considered, if the chemical structure, adverse effects, and toxic potency of the surrogate and chemical of interest are judged to be sufficiently similar.

GAFs, used to derive dermal RfDs and SFs from the corresponding oral toxicity values, are obtained from the following sources:

- Oral absorption efficiency data compiled by the NCEA for the Superfund Health Risk Technical Support Center of the EPA

- Federal agency reviews of the empirical data, such as Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles and various EPA criteria documents
- Other published reviews of the empirical data
- The primary literature.

GAFs obtained from reviews are compared to empirical (especially more recent) data, when possible, and are evaluated for suitability for use in deriving dermal toxicity values from oral toxicity values. The suitability of the GAF increases when the following similarities are present in the oral toxicokinetic study from which the GAF is derived and in the key toxicity study from which the oral toxicity value is derived:

- The same strain, sex, age and species of test animal was used.
- The same chemical form (e.g., the same salt or complex of an inorganic element or organic compound) was used.
- The same mode of administration (e.g., diet, drinking water or gavage vehicle) was used.
- Similar dose rates were used.

The most defensible GAF for each chemical is used in the RA.

Individual toxicity profiles are presented in Appendix C for all of the COPCs evaluated in the RA. A toxicity profile briefly describes the uses of the chemical, its physical properties, behavior in environmental media, biotransfer capability, and toxicity evaluation. Summary information sufficient to support the risk calculations is provided in Table 4-1.

4.6 Dinitrotoluenes

As noted in Section 2.1.2, two different analytical methods return analytical values for the DNTs. Method 8330 returns a value for total DNT, and Method 8270B returns values for the 2,4- and 2,6-DNT isomers separately. Data from the method yielding the larger DNT concentration were used for COPC selection and STC estimation. The oral SF for the 2,4-/2,6-DNT mixture was used for either isomer and total DNT. The oral RfD for 2,6-DNT is one-half that for 2,4-DNT, suggesting that the 2,4-isomer is less toxic. However, a two-fold difference in RfD values is not

large, as RfD values go, and is well within the range of uncertainty associated with RfDs in general. Therefore, the oral RfD for 2,6-DNT was applied to total DNT values to ensure adequate protectiveness of the RA.

5.0 Risk Characterization

Risk characterization is the combination of the results of the exposure assessment and toxicity assessment to yield a quantitative expression of risk. Quantitative estimates are developed for individual chemicals, exposure pathways and exposure media for each receptor. The risk characterization is used to guide risk management decisions.

Generally, the risk characterization follows the methodology prescribed by the EPA (1989a), as modified by more recent information and guidance. The EPA methods are, appropriately, designed to be health-protective and tend to overestimate, rather than underestimate, risk. The risk results are generally conservative, because risk characterization involves multiplication of the conservatisms built into the estimation of source-term and exposure-point concentrations, the exposure (intake) estimates, and the toxicity dose-response assessments.

Risk characterization is limited to those site-related chemicals selected as COPCs, i.e., present at concentrations that exceed RBSCs (Section 2.1.5).

Up to this point, the term risk has been used generically to mean the potential for the occurrence of adverse effects, either cancer or noncancer, to arise from exposure to chemicals. However, at this point in the discussion, it is helpful to define terms more precisely. Therefore, in this section of the document, the term risk is used to describe the likelihood or probability of the occurrence of cancer. The potential for the occurrence of noncancer effects is termed noncancer hazard.

5.1 Cancer Risk

The risk from exposure to potential chemical carcinogens is estimated as the probability of an individual developing cancer over a lifetime, and is called the ILCR. In the low-dose range, which would be expected for most environmental exposures, cancer risk is estimated from the following linear equation (EPA, 1989a):

$$ILCR = (CDI)(SF) \qquad \text{Eq. 5.1}$$

where:

ILCR = incremental lifetime cancer risk, a unitless expression of the probability of developing cancer, adjusted for background incidence, calculated

CDI = chronic daily intake, averaged over 70 years (mg/kg-day)
SF = cancer slope factor (risk per mg/kg-day).

The chronic daily intake (CDI) term in Equation 5.1 is equivalent to the "I" or "DAD" terms (intake or dose) in Equations 3.20 through 3.26 when these equations are evaluated for cancer intakes.

The use of Equation 5.1 assumes that chemical carcinogenesis does not exhibit a threshold and that the dose-response relationship is linear in the low-dose range. Because this equation could generate theoretical cancer risks greater than 1 for high-dose levels, it is considered to be inaccurate at cancer risks greater than 1E-2. In these cases, cancer risk may be the one-hit model (EPA, 1989a):

$$ILCR = 1 - e^{[(CDI)(SF)]} \qquad \text{Eq. 5.2}$$

where:

ILCR = incremental lifetime cancer risk, a unitless expression of the probability of developing cancer, adjusted for background incidence, calculated
$-e^{(CDI)(SF)}$ = the exponential of the negative of the risk calculated using Equation 5.1

As a matter of policy, the EPA (1986) considers the carcinogenic potency of simultaneous exposure to low doses of carcinogenic chemicals to be additive, regardless of the chemicals' mechanisms of toxicity or sites (organs of the body) of action. Cancer risk arising from exposure to a given chemical in a given medium by multiple pathways is estimated from the following equation:

$$ILCR_{chem} = ILCR_{(path\,1)} + ILCR_{(path\,2)} + \ldots ILCR_{(path\,i)} \qquad \text{Eq. 5.3}$$

where:

$ILCR_{chem}$ = total cancer risk for a given chemical in a given medium summed across pathways, calculated
$ILCR_{(path\ i)}$ = cancer risk for a given chemical in a given medium by a given exposure pathway.

Cancer risk for a given receptor across chemicals and across media is summed in the same manner.

For risk management purposes, OEPA considers a total ILCR of 1E-6 to be a point of departure below which cancer risks are considered to be insignificant. ILCR estimates between 1E-6 and 1E-4 are considered to fall within a risk management range. ILCR estimates above 1E-4 are considered to be clearly unacceptable. The OEPA policy is consistent with the EPA (1990b) policy of risk management.

5.2 Noncancer Effects of Chemicals

The hazards associated with noncancer effects of chemicals are evaluated by comparing an exposure level or intake with an RfD. The HQ, defined as the ratio of intake to RfD, is estimated as (EPA, 1989a):

$$HQ = I/RfD \qquad \text{Eq. 5.4}$$

where:

HQ = hazard quotient (unitless, calculated)
I = intake of chemical averaged over subchronic or chronic exposure period (mg/kg-day)
RfD = reference dose (mg/kg-day).

The I term in Equation 5.4 is equivalent to the "I" or "DAD" terms (intake or dose) in Equations 3.20 through 3.26, when these equations are evaluated for noncancer intakes.

Chemical noncancer hazards are evaluated using chronic RfD values. This approach is different from the probabilistic approach used to evaluate cancer risks. An HQ of 0.01 does not imply a 1 in 100 chance of an adverse effect, but indicates that the estimated intake is 100 times lower than the RfD. An HQ of unity indicates that the estimated intake equals the RfD. If the HQ is greater than unity, there may be concern for potential adverse health effects.

In the case of simultaneous exposure of a receptor to multiple chemicals, or to a given chemical by multiple pathways, an HI is calculated as the sum of the HQs by:

$$HI = HQ_1 + HQ_2 + ...HQ_i \qquad \text{Eq. 5.5}$$

where:

HI = hazard index (unitless, calculated)
HQ_i = hazard quotient for the ith chemical, or for the ith pathway.

An HI may be calculated across all exposure pathways for a given chemical, across all chemicals for a given exposure pathway, across all chemicals and exposure pathways for a given exposure medium, or across all media to yield the total HI for a given receptor.

HQ or HI values below or equal to the threshold value of 1 are interpreted to mean that adverse noncancer effects are unlikely. HQ or HI values greater than 1 are interpreted to mean that there is a likelihood of adverse noncancer effects.

Calculating a total HI as the sum of HQ values is based on the assumption that the potential for noncancer effects is additive. EPA (1989a), however, acknowledges that the assumption of additivity is probably appropriate only for chemicals that induce adverse effects by the same mechanism (please see Section 4.3). Therefore, if the total HI for a receptor exceeds 1, individual HI values may be calculated for each target organ.

Lead. As mentioned in Section 4.2, toxicity values are not available for the evaluation of lead. Risk assessment of lead generally consists of estimating blood lead levels in children associated with exposure to the environmental media at the site in question, and comparing the estimate with the cutoff level of 10 µg/dL. Two common exposure scenarios are routinely evaluated. The first is residential, which involves direct exposure of a young child. The EPA (1994b) integrated exposure-uptake biokinetic blood lead model for young children (IEUBK) is used to predict blood lead levels for children hypothetically exposed at the site. The IEUBK is a self-contained DOS-based computer program. Average lead concentrations in the various media are input in the model; default values provided by the IEUBK are used when site-specific data are not available. Arithmetic mean values, rather than conservative estimates of average, are used because the IEUBK contains a statistical module that addresses individual variation in exposure and physiological parameters. The output is a probability density histogram of predicted blood lead levels. The risk assessment is considered to "pass" if the IEUBK predicts that not more than 5

percent of young children exposed in this manner would experience a mean blood lead level above the 10 μg/dL cutoff.

An alternative risk assessment for lead in soil for residential site use may consist of comparing the average concentration with the RBRC of 400 mg/kg. The risk assessment is considered to pass if the average concentration of lead in soil does not exceed 400 mg/kg. Development of the RBRC of 400 mg/kg is described in the next section.

The second common exposure scenario addresses adult exposures to lead in soil in nonresidential exposure scenarios (U.S. EPA 1996b). The method focuses on the estimation of blood lead concentrations in fetuses carried by women exposed to average concentrations of lead in soil (U.S. EPA 1999). The method is based on a probability model for blood lead levels in adult women exposed to lead in soil, coupled with an estimated constant of proportionality between fetal and maternal blood lead levels, a geometric mean fetal blood lead concentration and empirically determined geometric standard deviation (U.S. EPA 1999). The statistical terms used in the method permit an equation to be used to establish an average adult blood lead concentration such that a fetus has not more than a 5 percent probability of blood lead concentrations exceeding 10 ug/dL (U.S. EPA 1996). The risk assessment is considered to pass if the average adult blood lead level does not predict an excess of 5 percent probability that fetal blood lead levels exceed 10 ug/dL, as interpreted by the TRW for the established cleanup goal to limit childhood risk of exceeding 10 ug/dL to 5% (U.S. EPA 1994c, 1996b).

An alternative risk assessment for lead in soil for industrial site use may consist of comparing the average concentration with the RBRC of 750 mg/kg. The risk assessment is considered to pass if the average concentration of lead in soil does not exceed 750 mg/kg. Development of the RBRC of 750 mg/kg is described in the next section.

5.3 Risk-Based Remediation Criteria Development

RBRC development performed as part of the RA provides support for risk management decisions. RBRCs are site-specific risk-based concentrations that reflect the exposure and toxicity assumptions applied in the baseline RA. Consequently the RBRCs are source medium-, receptor-, and chemical-specific.

The first step in RBRC development is selection of COCs. Either of two conditions result in designation of a COPC as a COC:

- The concentration of the COPC exceeds its medium-specific ARAR, provided one is available.
- The COPC contributes significantly to cancer risk or hazard as described below.

As a practical matter, ARARs are not available for soil, surface water or sediment; therefore, comparison to ARARs is not considered herein. COCs based on cancer are selected for any medium for which the total ILCR (summed across chemicals and exposure pathways) exceeds 1E-6; COCs based on noncancer are selected for any medium for which the total HI (summed across chemicals and exposure routes) exceeds 1. An individual COPC in that medium must have an ILCR (summed across exposure pathways) exceeding 1E-6 to be selected as a cancer-based COC. An individual COPC in that medium must have an HI (summed across exposure pathways) exceeding 0.1 to be selected as a noncancer-based COC.

RBRCs are risk- or hazard-specific concentrations of chemicals developed only for the COCs in media selected by the criteria described above. RBRCs for cancer COCs are estimated for a given medium from the following equation:

$$RBRC_{coc} = \frac{ST_{coc}\,TR}{ILCR_{coc}} \qquad \text{Eq. 5.6}$$

where:

$RBRC_{coc}$	=	risk-based remediation criterion for a given COC, receptor and source medium (calculated)
ST_{coc}	=	source-term concentration of the COC in the given medium
TR	=	target risk level (1E-6, 1E-5)
$ILCR_{coc}$	=	total incremental lifetime cancer risk for a given COC, receptor and source medium.

RBRCs for noncancer COCs are estimated as follows:

$$RBRC_{coc} = \frac{ST_{coc}\,THI}{HI_{coc}} \qquad \text{Eq. 5.7}$$

where:

$RBRC_{coc}$	=	risk-based remediation criterion for a given COC, receptor and source medium (calculated)
ST_{coc}	=	source-term concentration of the COC in the given medium
THI	=	target hazard index (0.1, 1)
HI_{coc}	=	total hazard index for a given COC, receptor and source medium.

Concentration units are not provided in Equations 5.6 or 5.7; the RBRC units will be the same as the concentration units of the source-term concentration.

Lead. The procedure described above is not suitable for developing an RBRC for lead. EPA (1994c,d, 1998, 2001b) has considerable experience using the IEUBK to develop screening levels for lead in soil. The concentration of 400 mg/kg in soil has stood the test of time as a screening level. EPA (1998) recommends applying site-specific data to the IEUBK to develop site-specific cleanup levels or RBRCs. In IT's considerable experience, cleanup levels developed with the IEUBK do not exceed the screening level of 400 mg/kg unless site-specific exposure parameters are available that differ substantially from the defaults provided by the model. The residential scenario developed herein (Section 3.1.3.4) is based on standard exposure assumptions. Site-specific information is not available that would permit refinement of these assumptions. Therefore, the IEUBK is not used to develop a site-specific RBRC for lead in soil for residential use. Instead, the 400 mg/kg screening level confirmed by EPA (1998) is adopted as the RBRC.

EPA (2000) provides a PRG of 750 mg/kg for lead in soil for industrial sites, based on the recommendations of the Technical Review Workgroup (TRW) for Lead. Details were not available. The PRG is appropriately considered a screening value for lead for industrial site use. Plausible receptor scenarios for industrial site use include the groundskeeper, the indoor worker and the construction worker. Theoretically, the EPA (1996b) adult blood lead model could be used to develop RBRCs for lead in soil for these exposure scenarios. However, central tendency or mid-range exposure variable values, including estimates for incidental soil ingestion rate, are not available for these receptors. Therefore, any attempt to refine the screening level or develop a site-specific RBRC would introduce an inordinate amount of uncertainty. Largely for this reason, the EPA (2000) PRG of 750 mg/kg for lead in industrial soil is adopted as the RBRC for the groundskeeper, indoor worker, and construction worker.

5.4 Risk Characterization Results and Discussion

ILCR and HQ estimates for each receptor, medium and COPC, including sums across exposure routes for each COPC, are compiled in tables in Appendix B1 for TNT Area A and Appendix B2 for TNT Area C.

ILCR, HQ and HI estimates are surrounded by considerable uncertainty; therefore, EPA (1989a) recommends that they be rounded to one significant figure for presentation in an RA. However, to facilitate review and to more accurately compare the contribution of individual chemicals and exposure pathways to the totals, these estimates are presented in the risk tables in scientific notation rounded to two places to the right of the decimal. Discussions in the text, however, follow the EPA (1989a) guidance and round the estimates to one significant figure or the nearest whole integer. In other words, an HI of 1.49E+0 will be rounded to 1 and interpreted to mean that the HI does not exceed the threshold level of 1 and that occurrence of adverse noncancer effects is unlikely. An HI of 1.49E+1 will be rounded to 15.

COCs are defined as the chemicals that contribute significantly to an unacceptable ILCR or HI. For this discussion, a significant contribution to cancer risk by a given chemical in a given medium is defined as an ILCR summed across all exposure routes exceeding 1E-6. A significant contribution to noncancer hazard by a given chemical in a given medium is defined as an HI summed across all exposure routes exceeding 0.1. The COCs that contribute most significantly to unacceptable ILCR or HI estimates are often called risk-drivers.

The discussion that follows will refer to classes of chemicals, e.g., metals, nitroaromatics, PAHs, etc. It should be noted that 2,4- and 2,6-DNT are listed in some tables as nitroaromatics and in others as SVOCs, to reflect the analytical method under which they were analyzed. However, they will be discussed with the chemical class nitroaromatic compounds, because morphologically and toxicologically they belong to this chemical class.

When total HI summed across chemicals and/or media exceeds the threshold limit of 1, consideration is given to possible benefit of segregating HI values by target organ, as suggested by EPA (1989a) (please see Sections 4.3 and 5.2). However, it will be shown below that all noncancer risk-drivers are nitroaromatic compounds. Examination of the toxicity profiles in Appendix C reveals that all the nitroaromatics have at least one target organ, the erythrocyte, in common. The nitrate moiety induces oxidation of hemoglobin to methemoglobin, which is incapable of releasing oxygen to the tissues, and which shortens the life of the erythrocyte.

Given the chemical class of COPCs involved and the commonality of target organ and mechanism of toxicity, there appears to be little point in segregating and re-summing HI by target organ.

5.4.1 TNT Area A

Total HI and ILCR estimates for each receptor and each source medium for TNT Area A are summarized in Table 5-1. Documentation is provided in Appendix B1, Tables B.1-1 through B.1-13. The groundskeeper, indoor worker, hunter, and child venison consumer are evaluated for exposure only to surface soil. Total HI estimates for these receptors are below the threshold limit of 1. Total ILCR estimates for these receptors are below or near the low end of the risk management range. It is concluded that exposure to surface soil poses no unacceptable noncancer hazard or cancer risk for the groundskeeper, indoor worker, adult hunter or child venison consumer.

The construction worker and on-site resident are evaluated for exposure to total soil, surface water and sediment. Total HI estimates summed across all media for these receptors exceed the threshold level of 1 (Table 5-1). Also, total ILCR estimates summed across all media for these receptors exceed the risk management range and are clearly unacceptable. However, HI sums for surface water and sediment are below 0.1, defined as the point of significant contribution to noncancer hazard. Also, ILCR sums for surface water and sediment are below 1E-6, defined as the point of departure for significant contribution to cancer risk. Therefore, it is concluded that only contaminants in total soil contribute significantly to cancer risk and noncancer hazard for the construction worker and on-site resident.

COCs in total soil for the construction worker and on-site resident are identified in Tables 5-2 and 5-3, respectively. Cancer risk-drivers, the COCs that contribute most to unacceptable ILCR totals, include 2,4- and 2,6-DNT for the construction worker, and 2,4- and 2,6-DNT and Aroclor 1260 for the on-site resident. Noncancer COCs are limited to the nitroaromatics but include several compounds for both receptors. No attempt was made to segregate and re-sum HI values by target organ, as explained above.

RBRCs for total soil for cancer risk and noncancer effects for the construction worker and on-site resident are compiled in Tables 5-2 and 5-3, respectively. It is suggested that the RBRCs developed for the on-site resident be adopted as the basis for the proposed cleanup levels for TNT Area A, because the on-site resident is the most highly exposed of all plausible receptors for the site. RBRCs based on a target ILCR of 1E-5 are suggested as being sufficiently protective to account for the additivity of cancer risk. In other words, the total ILCR with all cancer-based COCs present at concentrations equivalent to a cancer risk of 1E-5 would fall below 1E-4. RBRCs based on a target HI of 0.1 are suggested to account for the potential additivity of hazard from several chemicals (nitroaromatics) with a common mechanism of toxicity. Some chemicals (TNT, 2,4-DNT, 2,6-DNT) were selected as COCs for both cancer risk and noncancer hazard. The proposed cleanup levels for these chemicals should be the concentration associated with an ILCR of 1E-5 (2,4-DNT) or an HI of 0.1 (TNT and 2,6-DNT), whichever is smaller.

The proposed cleanup levels are slightly over-protective, at least for chemicals evaluated for noncancer effects, which includes all seven nitroaromatics. Basing cleanup levels on a target HI of 1 for each COC would not be sufficiently protective, because the total HI for the nitroaromatics would exceed the threshold limit of 1. On the other hand, setting the target HI at 0.1 yields cleanup levels that are slightly overly-protective. Theoretically, a cleanup level could be established for each of the nitroaromatics based on an HI of 0.14 (i.e., 1 divided by 7). In fact, there are an infinite number of combinations that would yield a total HI for all the nitroaromatics that meets but does not exceed the threshold limit of 1. To further complicate matters, EU-specific cleanup levels could be estimated (please see below), because fewer than seven nitroaromatics were selected as COCs for most of the EUs. However derived, the proposed cleanup levels should be considered as average concentrations, rather than not-to-exceed concentrations, for the COCs in soil.

As discussed in Section 2.1.1, an EU analysis is justified if unacceptable cancer risk or hazard levels are estimated for the construction worker or on-site resident. A reasonable EU for a construction worker and on-site resident would be much smaller than the whole of TNT Area A, and, to be practical for this evaluation, is assumed to include the area associated with each former process building. Therefore, the soil data were grouped by former building number and the risk

estimates were re-run. Grouping by building was accomplished by relating each soil sample to its appropriate building location as presented in Volume I, *Report of Findings*, Part I, Table 2-1. Only those buildings with chemical concentrations sufficiently high to qualify as COPCs were included in the evaluation. An insufficient number of samples was associated with each building to allow a statistical approach to STC estimation; therefore, the MDC of each COPC was selected as the STC.

The risk and hazard estimates for the construction worker and on-site resident for each former building on TNT Area A are summarized in Table 5-4. Documentation is provided in Appendix B, Tables B.1-14 through B.1-85. Several buildings passed the EU analysis; i.e., the ILCR did not exceed 1E-4 and the HI did not exceed 1. The buildings that failed are discussed separately below.

Building 112. The Building 112 evaluation failed because the total HI for the on-site resident slightly exceeded the threshold level of 1. Three nitroaromatics (2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, TNT) were identified as noncancer-based COCs (Table B.1-21). Building 112 could be brought into compliance by a 50 percent reduction in concentration of the noncancer COCs. Alternatively, the proposed cleanup levels described above could be applied.

Building 119. The Building 119 evaluation failed because the total ILCR for the on-site resident exceeded the risk management range, and the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.1-23 through B.1-25). Aroclor 1260 and three nitroaromatics (TNT, and 2,4- and 2-6-DNT) were identified as the cancer-based COCs; seven nitroaromatics were identified as the noncancer-based COCs. The proposed cleanup levels described above should be applied.

Building 126. The Building 126 evaluation failed because the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.1-31, B.1-33). Three nitroaromatics (2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, TNT) were identified as noncancer COCs; however, TNT accounts for nearly all of the HI. Adopting the RBRC for TNT based on an HI of 1 as the cleanup level would yield a total HI (when rounded to one significant figure) of 1, at which point Building 126 would be in compliance.

Building 131. The Building 131 evaluation failed because the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.1-39, B.1-41). Six nitroaromatics were identified as noncancer COCs. The proposed cleanup levels described above should be applied.

Building 139. The Building 139 evaluation failed because the total ILCR value for the on-site resident exceeded the risk management range, due largely to Aroclor 1260 with significant contributions from TNT, and 2,4- and 2,6-DNT (Table B.1-48). The proposed cleanup levels described above should be applied.

Building 141. The Building 141 evaluation failed because the total HI value for the on-site resident exceeded the threshold value of 1 due to three nitroaromatics (2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, TNT) (Table B.1-53). The proposed cleanup levels described above should be applied.

Building 142. The Building 142 evaluation appeared to fail because the unrounded total HI value for the on-site resident slightly exceeded the threshold value of 1 (Table B.1-57). However, the total HI rounded to one significant figure is equivalent to 1, suggesting that the likelihood of noncancer effects is low, and it appears unnecessary to consider Building 142 for further investigation or action.

Building 146. The Building 146 evaluation failed because the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.1-63, B.1-65). Three nitroaromatics (2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, TNT) were identified as noncancer COCs. The proposed cleanup levels described above should be applied.

Building 192. The Building 192 evaluation failed because the total ILCR for the on-site resident exceeded the risk management range, and the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.1-79 through B.1-81). Cancer-based COCs were limited to 2,4- and 2,6-DNT, both of which have ILCR estimates exceeding the risk management range. 2,4- and 2,6-DNT were also identified as the noncancer-based COCs. The proposed cleanup levels described above should be applied.

Building 195. The Building 195 evaluation failed because the total ILCR values for the construction worker and on-site resident exceeded the risk management range, and the total HI values for both receptors exceeded the threshold level of 1 (Tables B.1-83 through B.1-85). Cancer-based COCs included Aroclor 1260, TNT, and 2,4- and 2,6-DNT. Noncancer-based COCs included 4-amino-2,6-DNT, and 2,4- and 2,6-DNT. The proposed cleanup levels described above should be applied.

Lead. Unusually high concentrations of lead were observed in soil, particularly in subsurface soil, probably associated with lead flashing released during former process building demolition and burning. The average concentration of lead in surface soil fell below the RBSC of 400 mg/kg for residential exposure. A residential exposure unit, however, is likely to be far less than the 114 acres associated with TNT Area A. A review of the raw data showed that only one surface soil sample, associated with former Building 142, had a lead concentration exceeding the RBRC. The average concentration of lead in subsurface soil of 487 mg/kg slightly exceeded the residential RBSC, although it did not exceed the RBSC of 750 mg/kg for the construction worker. Two subsurface soil samples, one associated with former Building 119 and one with former Building 139, had lead concentrations exceeding the residential RBSC. Lead was not identified as a COPC in sediment or surface water associated with TNT Area A.

5.4.2 TNT Area C

Total HI and ILCR estimates for each receptor and each source medium for TNT Area C are summarized in Table 5-5. Documentation is provided in Appendix B2, Tables B.2-1 through B.2-13. The groundskeeper, indoor worker, hunter, and child venison consumer were evaluated for exposure only to surface soil. Total ILCR estimates for the hunter and child venison consumer were within or below the risk management range. Total ILCR estimates for the groundskeeper and indoor worker exceeded the risk management range and are clearly unacceptable. Total HI estimates were below the threshold limit of 1 only for the child venison consumer. Total HI estimates for the groundskeeper, indoor worker, and hunter exceeded the threshold value of 1. Examination of Table B.2-3 reveals that the unacceptable HI estimated for the hunter arises entirely from direct exposure routes, predominantly incidental ingestion of TNT and its degradation products in soil. Exposure to surface soil poses no unacceptable cancer risk or noncancer hazard for indirect (food-chain) exposure.

COCs in surface soil for the groundskeeper, indoor worker, and hunter were identified in Tables 5-6, 5-7, and 5-8, respectively. No cancer-based COCs were selected for the hunter. Cancer-based COCs for the groundskeeper and indoor worker included TNT, PAHs and Aroclor 1260; however, TNT was the most important cancer risk-driver for the groundskeeper and indoor worker. Noncancer-based COCs were limited to TNT for the hunter, but include other nitroaromatic compounds for the groundskeeper and indoor worker. However, TNT was the most important noncancer risk driver in surface soil for these three receptors.

RBRCs for surface soil for cancer risk and noncancer effects for the groundskeeper, indoor worker, and hunter are compiled in Tables 5-6, 5-7, and 5-8. It is suggested that the RBRCs developed for the on-site resident be adopted as the basis for the proposed cleanup levels for TNT Area C, because the on-site resident provides the more conservative evaluation. RBRCs based on a target ILCR of 1E-5 are suggested as being sufficiently protective to account for the additivity of cancer risk. RBRCs based on a target HI of 0.1 are suggested to account for the potential additivity of hazard from several nitroaromatics with a common mechanism of toxicity. The proposed cleanup levels are slightly overly-protective, at least for chemicals evaluated for noncancer effects, as described for the proposed cleanup levels for total soil at TNT Area A.

The construction worker and on-site resident are evaluated for exposure to total soil, surface water and sediment. The total ILCR summed across all media for the construction worker fell within the risk management range (Table 5-5). The total ILCR summed across all media for the on-site resident slightly exceeded the risk management range and is unacceptable. Total HI estimates summed across all media for the construction worker and on-site resident exceeded the threshold level of 1. However, it is clear from Table 5-5 that unacceptable risk and hazards arise almost entirely from exposure to total soil, with an additional significant contribution from sediment. Examination of the raw data shows that the contribution from sediment is due almost entirely to an unusually high concentration of TNT (1492 mg/kg) at Sample Location SD09. (The next highest detected concentration was 2.9 mg/kg at a sample location far removed from SD09.)

Surface water is clearly not implicated as a significant contributor to cancer risk for either receptor. The HI of 0.2 from manganese for construction worker exposure to surface water

(Table B.2-8) is practically insignificant, because manganese does not share a target organ or mechanism of toxicity with the nitroaromatics that are COCs in total soil and sediment (see below). Therefore, exposure to surface water at TNT Area C is considered unlikely to yield unacceptable cancer risk or noncancer hazard and is not evaluated further.

COCs in total soil for the construction worker are identified in Table 5-9. No cancer-based COCs were selected for the construction worker. Noncancer-based COCs for the construction worker included chromium and several nitroaromatic compounds. The HI for chromium of 0.5 arises almost entirely from inhalation of dust (Table B.2-5). However, chromium does not share a target organ or mechanism of toxicity with the nitroaromatics, which are the other COCs in total soil and sediment. Therefore, chromium is considered to be practically insignificant and is not considered further.

COCs in total soil for the on-site resident are identified in Table 5-10. Cancer-based COCs for the on-site resident include TNT, Aroclors 1254 and 1260, and several PAHs. The cancer risk-drivers are TNT, 2,4-DNT and benzo(a)pyrene. Noncancer-based COCs include Aroclor 1254 and several nitroaromatic compounds.

RBRCs for total soil for cancer risk and noncancer effects for the construction worker and on-site resident are compiled in Tables 5-9 and 5-10. It is suggested that the RBRCs developed for the on-site resident be adopted as the basis for the proposed cleanup levels for TNT Area C because the on-site resident is the most highly exposed of all plausible receptors for the site. RBRCs based on a target ILCR of 1E-5 are suggested as being sufficiently protective to account for the additivity of cancer risk. RBRCs based on a target HI of 0.1 are suggested to account for the potential additivity of hazard from several nitroaromatics with a common mechanism of toxicity. The proposed cleanup levels are slightly over protective as described above.

The construction worker and on-site resident are also exposed to sediment, which contributed significantly to noncancer hazard for both receptors (Table 5-5). COCs in sediment for the construction worker and on-site resident, based on noncancer, were limited to several nitroaromatic compounds (Tables 5-11, 5-12). It is suggested that the RBRCs developed for the on-site resident be adopted as the basis for the proposed cleanup levels for TNT Area C as

described above. RBRCs based on a target HI of 0.1 are suggested to account for the potential additivity of hazard from several nitroaromatics with a common mechanism of toxicity. The proposed cleanup levels are overly-protective, as described above. The proposed cleanup levels should be considered as average concentrations, rather than not-to-exceed concentrations, for the COCs in the media discussed above. In fact, it appears that characterization and removal of TNT in the area of Sample Location SD09 would remove all significant threat from exposure to sediment.

As discussed in Section 2.1.1, an EU analysis is justified if unacceptable cancer risk or hazard levels are estimated for the construction worker or on-site resident. A reasonable EU for a construction worker and on-site resident would be much smaller than the whole of TNT Area C, and, to be practical for this evaluation, is assumed to include the area associated with each former process building. Therefore, the soil data were grouped by former building number and the risk estimates were re-run. Grouping by building was accomplished by relating each soil sample to its appropriate building location as presented in Volume I, *Report of Findings*, Part II, Table 2-1. Only those buildings with chemical concentrations sufficiently high to qualify as COPCs were included in the evaluation. An insufficient number of samples was associated with each building to allow a statistical approach to STC estimation; therefore, the MDC of each COPC was selected as the STC.

The risk and hazard estimates for the construction worker and on-site resident for each building on TNT Area C are summarized in Table 5-13. Documentation is provided in Appendix B2, Tables B.2-14 through B.2-77. A few buildings passed the EU analysis, i.e., the ILCR did not exceed 1E-4 and the HI did not exceed 1. Most buildings did not pass and are discussed separately.

Building 603. The Building 603 evaluation failed because the total HI for the on-site resident exceeded the threshold level of 1. Three nitroaromatics (2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, TNT) were identified as noncancer-based COCs (Table B.2-21). The proposed cleanup levels described above should be applied.

Building 606. The Building 606 evaluation failed because the total HI value for the on-site resident exceeded the threshold level of 1 (Tables B.2-25). The two aminodinitrotoluenes are largely responsible for the unacceptable HI. A 50 percent reduction in the concentration of the aminodinitrotoluenes would bring the soil at Building 606 into compliance.

Building 616. The Building 616 evaluation failed because the total ILCR for the on-site resident exceeded the risk management range, and the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.2-31 through B.2-33). Cancer-based COCs included TNT (the major risk driver), with significant contributions from Aroclor 1260 and a few PAHs. Three nitroaromatics (2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, TNT) were identified as noncancer COCs; however, TNT accounts for nearly all of the HI. The proposed cleanup levels described above should be applied.

Building 629. The Building 629 evaluation failed because the total ILCR for the on-site resident exceeded the risk management range, and the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.2-39 through B.2-41). Cancer-based COCs included three nitroaromatics and two Aroclors. Three nitroaromatics are identified as noncancer COCs. The proposed cleanup levels described above should be applied.

Building 682. The Building 682 evaluation failed because the total ILCR for the on-site resident exceeded the risk management range, and the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.2-51 through B.2-53). Cancer-based COCs included three nitroaromatics and Aroclor 1260, with TNT contributing almost all the cancer risk. Three nitroaromatics were identified as noncancer COCs, with TNT contributing most of the HI. The proposed cleanup levels described above should be applied.

Building 683. The Building 683 evaluation failed because the total ILCR for the on-site resident exceeded the risk management range, and the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.2-55 through B.2-57). Cancer-based COCs included three nitroaromatics. Five nitroaromatics were identified as noncancer COCs. 2,4-DNT is the major cancer and noncancer risk driver. The proposed cleanup levels described above should be applied.

Building 686. The Building 686 evaluation failed because the total ILCR for the on-site resident exceeded the risk management range, and the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.2-59 through B.2-61). Cancer-based COCs included TNT, Aroclor 1260 and several PAHs. TNT and benzo(a)pyrene contribute most of the cancer risk. Three nitroaromatics were identified as noncancer COCs. The proposed cleanup levels described above should be applied.

Building 689. The Building 689 evaluation failed because the total ILCR for the on-site resident exceeded the risk management range, and the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.2-63 through B.2-65). Cancer-based COCs included two nitroaromatics, Aroclor 1260, and several PAHs. Three nitroaromatics were identified as noncancer COCs. The proposed cleanup levels described above should be applied.

Building 692. The Building 692 evaluation failed because the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.2-67, B.2-69). Noncancer-based COCs included four nitroaromatics, with the majority of the HI contributed by TNT. The proposed cleanup levels described above should be applied.

Building 693. The Building 693 evaluation appeared to fail because the total HI value for the on-site resident slightly exceeded the threshold value of 1 (Table B.2-73). However, the total HI rounded to one significant figure is equivalent to 1, suggesting that the likelihood of noncancer effects is low, and it appears unnecessary to consider Building 693 for further investigation or action.

Building 696. The Building 696 evaluation failed because the total ILCR for the on-site resident exceeded the risk management range, and the total HI values for the construction worker and on-site resident exceeded the threshold level of 1 (Tables B.2-75 through B.2-77). Cancer-based COCs included TNT, Aroclor 1260, and several PAHs. Noncancer-based COCs included four nitroaromatics. The proposed cleanup levels described above should be applied.

Lead. Unexpectedly high concentrations of lead were observed in surface and subsurface soil, probably associated with lead flashing released during former process building demolition, as mentioned for TNT Area A. The average concentration of lead in surface soil fell below the RBSC of 400 mg/kg for residential exposure. A residential exposure unit, however, is likely to be far less than the 119 acres associated with TNT Area C. A review of the raw data showed that two surface soil samples, sample AB0438 associated with former Building 686 and sample AB0455 associated with former Building 682, had lead concentrations exceeding the RBRC. The average concentration of lead in subsurface soil of 89 mg/kg also fell below the residential RBSC. Only one subsurface soil sample, associated with former Building 629, had lead concentrations exceeding the residential RBSC. Lead was not identified as a COPC in sediment or surface water associated with TNT Area C.

6.0 Uncertainty Analysis

This section explores the uncertainties inherent in the RA process. Uncertainty is a factor in each step of the data evaluation and exposure and toxicity assessments presented in the preceding sections. Uncertainties associated with early stages of the RA become magnified when they are concatenated with other uncertainties in the latter stages. It is not possible to eliminate all uncertainty, sometimes not even to reduce it; however, a recognition of the uncertainties is fundamental to the understanding and reasonable use of the RA results.

Generally, risk assessments carry two types of uncertainty. Measurement uncertainty refers to the usual variance that accompanies scientific measurements, e.g., instrument uncertainty (accuracy and precision) associated with contaminant concentrations. The results of the RA incorporate the accumulated variances of the individual measured values. A different kind of uncertainty stems from data gaps, i.e., additional information needed to complete the database for the assessment. Often, the data gap is significant, such as imprecision regarding the number of days that a hunter might visit the site, or the absence of information on the effects of human exposure to a chemical (EPA, 1992c).

EPA (1992c) guidance urges risk assessors to address or provide descriptions of individual risk to include the "high end" portions and "central tendency" of the risk distribution. One way of fulfilling this request, if either cancer or noncancer risk exceeds generally acceptable limits (cancer risk greater than 1E-4 or target organ-specific HI greater than 1) is to re-calculate the ILCRs or HIs using central tendency (CT) values for as many intake model variables as possible. In contrast to the RME evaluation, which prevails in RAs and uses upper-end values for intake or contact rates, exposure frequency and exposure duration, the CT evaluation uses average or mid-range values for these variables (EPA, 1991). The intent is to present a quantified risk/hazard estimate more typical for the receptor of interest.

CT evaluations generally fall short of their stated intent for several reasons. First, the UCL on the mean, which is adopted as the source-term concentration for the RME evaluation is also used for the CT evaluation. Since the UCL on the mean is generally considered as a conservative estimate of average (EPA, 1989a), its use defeats the purpose of the CT. Second, there is little information available as to what constitutes a reliable CT estimate for most exposure variables (EPA, 1993), with the possible exception of a simple on-site residential scenario. Hence, RME

values are still used. Third, the procedures for developing cancer and noncancer toxicity values are intended to be protective even for unusually sensitive members of the population. Furthermore, the procedures do not readily accommodate the development of CT values; i.e., toxicity values geared to those with average or typical sensitivity. Consequently, the toxicity values are likely to be overly conservative for the average or typical receptor, resulting in overestimation of risk for these individuals. The exception is the cancer evaluation for PCBs, for which CT toxicity values have been developed (EPA, 2001a). A CT evaluation, therefore, usually provides little additional perspective, compared with the RME, particularly for exposure scenarios such as the construction worker and hunter, for which no reliable estimation of most exposure variable values can be made. It should be stated that management decisions are generally based on RME rather than CT evaluations.

Another method of quantifying uncertainty, called Monte Carlo simulation, provides a more graphic illustration of the uncertainty about a risk/hazard estimate, because it presents the risk as a range with probability densities. To be meaningful, however, Monte Carlo simulation requires that the nature of the distributions of the variables that drive the risk assessment should be well characterized. However, well characterized distributions are available for few exposure or toxicological variables, in which case the Monte Carlo simulation provides an incomplete or potentially misleading illustration of the magnitude or the distribution of the uncertainty.

Because of the limitations of the CT and Monte Carlo procedures, the uncertainty analysis consists of a qualitative discussion of the sources of uncertainty and their impact on the estimated risk results and their interpretation, as follows.

Sampling and Analytical Limitations. It is not possible to completely characterize the nature and extent of contamination on any site. Uncertainties arise from limits on the number of locations that can be sampled to characterize the site. The sampling protocol used at TNT Areas A and C, however, was designed to optimize efficiency of the sampling effort and reduce uncertainty by focusing on areas around former buildings where TNT was made or processed. Furthermore, the sampling appears to be sufficient to show that the contamination is largely limited to the soil, with the exception of some nitroaromatic compounds in sediment at TNT Area C (please see next paragraph). Specifically, the data show that surface water is not a medium of concern. There appears to be little uncertainty regarding the media affected by chemical releases at TNT Areas A and C.

Two different methods were used to analyze DNTs in soil. Method 8330 returned results for total DNTs. Method 8270C returned results for the 2,4- and 2,6-DNT isomers separately. Neither method appeared to consistently give the "best" results; therefore, results from the method returning the more conservative (larger) concentrations were used. Generally, the difference between the methods was less than a factor of 2, which is within the range of normal laboratory variation. One subsurface soil sample at TNT Area A, however, yielded a 7-fold difference in results. The uncertainty about this sample could be significant because the results from this sample determined the STCs of the DNTs, which were risk drivers in total soil. Evaluation of the data package showed that the discrepancy was probably due to sample heterogeneity, exacerbated by matrix effects and the requirement for sample dilution, and that the results should be considered as estimated, reflecting greater uncertainty in their accuracy. The uncertainty about this sample would not significantly alter the conclusions of the RA.

As noted in Section 2.3.2, one sediment sample at TNT Area C had an unusually high concentration of TNT, approximately 500-fold higher than the next highest detection. Furthermore, the sample location did not appear to be near any of the former process buildings, and no explanation is immediately apparent for the high concentration of TNT. Its occurrence, however, raises concern that there could be other local pockets of contamination not directly related to any of the process buildings that may have been overlooked.

The sampling and analytical data are sufficient to identify nitroaromatic compounds as the major contaminants in soil. Lead, PCBs and PAHs were also identified. Analyses were not performed for pesticides and herbicides, or dioxins/dibenzofurans. Pesticides and herbicides may have been used to control insects and discourage overgrowth of weeds. These classes of compounds, however, are commonly identified in agricultural and formerly agricultural areas, and lack of analysis for these chemicals is not considered to impart significant uncertainty to the assessment. Dioxins/dibenzofurans are commonly associated with incineration, but their formation generally requires a source of chlorine, such as chlorinated solvents. There is no record or other reason to believe that chlorinated organics were present when the former buildings were demolished and burned; therefore, lack of analysis for the dioxins/dibenzofurans is not viewed as a significant source of uncertainty.

The major uncertainty to arise from the number of soil samples becomes apparent when risks are re-calculated for EUs consisting of the area around each of the former process buildings.

Examination of Table 2-1 in Volume I, *Report of Findings*, Part I (TNT Area A), and Table 2-1 in Volume I, *Report of Findings*, Part II (TNT Area C) shows that the number of soil samples associated with each building ranges from 1 to 8, with most buildings at the lower end of the range. The number of samples associated with each of the buildings for which an evaluation was performed (i.e., the buildings with one or more chemicals present at concentrations sufficiently high to be selected as COPCs) ranged from 1 to 5 for TNT Area A and 1 to 6 for TNT Area C.

The MDC was selected as the STC to attempt to compensate for the uncertainty associated with the small number of samples for each building. Generally, this may be considered to impart a conservative bias to the RA, but in this case uncertainty remains regarding how well the soil around each building was characterized. It is possible that the building demolition and rough grading may have obscured or covered substantial pockets of contamination, particularly at TNT Area C, where previous decontamination was less thorough (Dames & Moore, 1997). Overall, the direction of bias imparted by the small number of samples for each building is unclear.

It should be noted that all groundwater is deferred to a future site-wide groundwater delivery order. Groundwater is known to be contaminated, its lack of inclusion herein represents a data gap in the RA.

Selection and Quantification of Chemicals of Potential Concern. Uncertainty associated with the processes used to identify COPCs and estimate STCs arises from the following:

1. Identifying background chemicals. Metals are judged to be present at concentrations comparable to background if the MDC does not exceed the BSC, or if statistical testing demonstrates that the site data and background data are drawn from the same population. Lead was the only metal selected as a COPC in soil at TNT Area A. Lead and chromium were selected as COPCs in soil at TNT Area C. The source of lead is fairly well understood, and it seems clear that its presence is site related at both TNT Areas A and C. The situation with chromium is not as clear. Selection of chromium as a COPC results from only one sample concentration exceeding background. The uncertainty about the status of chromium, however, is not important, because the metal contributed insignificantly to cancer risk and noncancer hazard.

   Some organic chemicals, such as PAHs, may be considered to be anthropogenic background. PAHs were identified in soil at both TNT Areas A and C, probably as a result of burning the former process buildings during earlier decontamination

procedures. There are no site-specific background data for the PAHs, and several were selected as COPCs. PAH concentrations at TNT Area A all fall within global background levels for urban areas compiled by Agency for Toxic Substances and Disease Registry (ATSDR) (1997). Some PAH concentrations at TNT Area C exceed the ATSDR background levels. Given the rational explanation for their presence, it is best to conclude that the PAHs are site-related compounds in soil. The PAHs are significant risk drivers at TNT Area C but not at TNT Area A.

2. Estimated STCs are uncertain. For statistical purposes, if a constituent is positively identified at a site and has at least a single positive hit, all the samples with nondetects are assumed to have a value equal to half the reporting limit and are included in the data set. These procedures may introduce a conservative bias into the risk assessment.

3. A limited number of samples may not completely characterize the site, because they provide less information about the population from which they are drawn than do larger sample sets. Accordingly, small sets tend to have a greater variability, which results in the calculation of wide confidence intervals on the mean concentration and high STCs. In some cases, the 95 percent UCL was greater than the maximum value; thus, the maximum value was chosen as the STC. High confidence limits may introduce a conservative bias into the risk assessment; however, please see discussion regarding the number of samples for each former process building in the previous section.

4. Laboratory analytical techniques have a degree of uncertainty associated with them. These uncertainties are documented by using data qualifiers to reflect the degree of certainty of measurement. For example, some data were estimated (e.g., J-qualified), while other data were rejected (i.e., R-qualified). The direction of bias is unclear.

5. According to EPA (1992a), 95 percent UCLs are used for STCs. Therefore, the exposure assessment is likely to underestimate the STCs in 5 percent of the cases, and overestimate exposures in 95 percent of cases, imparting an overall conservative bias to the risk assessment.

Selection of Hypothetical Receptors and Potential Exposure Pathways. The exposure scenarios chosen for evaluation address plausible receptors for the current and projected future site uses previously described. Although the specific uses to which the sites may be put are not entirely certain, the general categories (industrial, recreational, residential) are comprehensive and fairly standard. The receptor scenarios selected for evaluation include the most intensely exposed for each general site-use category; therefore, uncertainty regarding the

specific uses has no meaningful effect on interpretation of the RA. For example, the groundskeeper represents the upper bound on exposure for any industrial application. The indoor worker represents the upper bound on any worker indoor exposure, particularly relevant for VOCs that may gain entrance to a building from subsurface soil. The construction worker represents the upper bound on short-term exposure to soil, regardless of the nature or final product of a construction project. The hunter represents a plausible scenario for recreational site use and indirect (food-chain) exposure. Finally, the on-site resident represents the upper bound for residential site use. In fact, the resident is generally considered to represent the upper bound for any standard site use.

Another source of uncertainty in the receptor scenarios is the decision not to quantify intake or uptake from certain exposure routes. For example, inhalation of VOCs in outdoor air that volatilized from subsurface soil by the groundskeeper, indoor worker and hunter is not quantified. It is assumed that overlying soil would attenuate emissions and that the large volume of outdoor air and natural air currents would dilute concentrations in the breathing zone to toxicologically insignificant levels. This assumption is based on considerable experience with volatilization models, and is consistent with the assumption applied by EPA (2000) in developing PRGs for soil. Although VOCs were identified in subsurface soil at TNT Areas A and C, their concentrations were below RBSCs, further reducing concern that a potentially significant exposure pathway was not evaluated.

As another example, the groundskeeper and hunter are not evaluated for exposure to surface water or sediment, even though these receptors spend most of their time outdoors. Since contact with surface water would not be part of their normal activities, it is assumed that any exposure would be sporadic and would not readily lend itself to quantification. Also, such exposures should be viewed as repeated acute rather than chronic, which does not fit the EPA (1989) paradigm or the toxicity values developed for an RA. Finally, exposure to surface water is evaluated for the construction worker and on-site resident, who are expected to be more regularly exposed. Therefore, the decision not to evaluate surface water exposure for the groundskeeper and hunter is not seen as a significant source of uncertainty affecting the results or interpretation of the RA.

The indoor worker is not evaluated for inhalation of airborne dust or VOCs from surface soil, or for dermal contact with surface soil, because these exposure routes are expected to be less

significant than incidental ingestion, which is quantified. The decision not to quantify inhalation and dermal exposure imparts a non-conservative bias to the RA. However, inhalation and dermal contact are quantified for the groundskeeper, who is more intensely exposed by these routes. Risk estimates for the groundskeeper from inhalation exposure were negligible (Tables B.1-1, B.2-1). Therefore, it is assumed that inhalation exposure would be negligible for the indoor worker as well, and that the decision not to quantify this route had no meaningful effect on the outcome of the RA or its interpretation.

The situation with dermal exposure is not so clear. Dermal risk estimates for the groundskeeper were significant at TNT Area C (Table B.2-1), although more than five-fold less than risk estimates for incidental ingestion. Although it is expected that the intensity of dermal exposure to soil would be much less for an indoor worker than an outdoor worker, dermal exposure parameters have not been developed for the indoor worker with which to test this assumption. Therefore, the decision not to evaluate dermal exposure represents a source of uncertainty that cannot be quantified.

The construction worker and on-site resident are not evaluated for inhalation of VOCs from surface water or incidental ingestion of surface water, because these exposure routes are expected to be less significant than dermal exposure, which is quantified. The decision not to quantify inhalation and incidental ingestion imparts a non-conservative bias to the RA. However, concentrations of VOCs are less than EPA (2000) PRGs for tap water, which address inhalation in an indoor setting. Therefore, it is assumed that the decision not to quantify inhalation of VOCs for the construction worker and on-site resident had no meaningful effect on the outcome of the RA or its interpretation. The situation with incidental ingestion is not so clear. Although it is expected that the potential for incidental ingestion would be very low in a wading scenario, and far less significant than dermal uptake, exposure parameters for incidental ingestion have not been developed with which to test this assumption. Therefore, the decision not to evaluate incidental ingestion represents a source of uncertainty that cannot be quantified.

The hunter is not evaluated for inhalation of dust from surface soil because this receptor is expected to spend most of his time on vegetated soil, and because inhalation exposure is expected to be far less than incidental ingestion of soil, which is quantified. However, inhalation is quantified for the groundskeeper, who is more intensely exposed. Risk estimates for the groundskeeper from inhalation exposure were negligible (Tables B.1-1, B.2-1). Therefore, it is

assumed that inhalation exposure would be negligible for the hunter as well, and that the decision not to quantify this route had no meaningful effect on the outcome of the RA or its interpretation.

Quantification of Intakes. Ingestion rates, inhalation rates, EDs, and EFs are based on upper-bound values (EPA, 1989a, 1991), even though it is likely that serial multiplication of conservative variable values leads to gross overestimation of COPC intakes (Cogliano, 1997).

Toxicity Assessment. Considerable uncertainty is associated with the qualitative (hazard assessment) and quantitative (dose-response) evaluations of a toxicity assessment. Hazard assessment of carcinogenicity is evaluated as a weight-of-evidence determination (EPA, 1986). Positive animal cancer test data suggest that humans also contain tissue(s) that may manifest a carcinogenic response; however, the animal data cannot necessarily be used to predict the target tissue in humans. In the hazard assessment of noncancer effects, positive animal data suggest the nature of the effects (i.e., the target tissues and type of effects) anticipated in humans (EPA, 1989c).

Uncertainty in hazard assessment arises from the nature and quality (sensitivity and selectivity) of the animal and human data. Uncertainty is decreased when similar effects are observed across species, strain, sex, and exposure route; when the magnitude of the response is clearly dose-related; when pharmacokinetic data indicate a similar fate in animals and humans; when postulated mechanisms of toxicity are similar for humans and animals; and when the COPC is structurally similar to other chemicals for which the toxicity is more completely characterized. This potential source of uncertainty is unlikely to be significant for TNT Areas A and C, because the adverse effects of the nitroaromatics and the carcinogenicity of the PAHs are relatively well understood and appear to be consistent across species. The carcinogenicity of the PCBs to humans, however, is less well established.

There are many sources of uncertainty in the dose-response evaluation for cancer (i.e., computation of an SF or unit risk) and noncancer effects (i.e., computation of an RfD). First, there is uncertainty regarding interspecies (animal-to-human) extrapolation, which, in the absence of quantitative pharmacokinetic, dosimetric, or mechanistic data, is usually based on consideration of interspecies differences in basal metabolic rate. Second, there is uncertainty regarding intra-species, or individual, variation. Most toxicity experiments are performed with animals that are very similar in age and genotype, so that intragroup biological variation is minimal, but the

human population of concern may reflect wide heterogeneity including unusual sensitivity to the COPC. Even toxicity data from human occupational exposure reflect a bias, because only those individuals sufficiently healthy to attend work regularly and those not unusually sensitive to the COPC are likely to be occupationally exposed. Third, uncertainty arises from expansion from short-term to lifetime exposure, e.g., the construction worker and child on-site resident. Additional uncertainty arises from the potential for children to be more sensitive than adults, which has been shown for at least one chemical (vinyl chloride, which is not an issue at TNT Areas A or C). Finally, the quality of the key study (from which the quantitative estimate is derived) and the database contributes to uncertainty. For cancer studies, the uncertainty associated with some quality factors (e.g., study group size) is expressed within the 95 percent upper-bound of the SF. For noncancer effects, additional uncertainty factors may be applied in the derivation of the RfD to reflect poor quality of the key study or gaps in the database.

Another source of uncertainty regarding quantitative risk estimation for carcinogenicity is the method by which data from high doses in animal studies are extrapolated to the dose range expected for environmentally exposed humans. The linearized multistage model, which is used in most quantitative estimates of human cancer risk from animal data (TNT, PAHs, PCBs), is based on a nonthreshold assumption of carcinogenesis. An impressive body of evidence, however, suggests that epigenetic carcinogens, as well as many genotoxic carcinogens, have a threshold below which they are noncarcinogenic (Gold, et al., 1992); therefore, the use of the linearized multistage model is ultraconservative for chemicals that exhibit a threshold for carcinogenicity.

A further source of uncertainty for noncancer effects arises from use of an effect level in the estimation of an RfD or RfC, because this estimation is predicated on the assumption of a threshold below which adverse effects are not expected. Therefore, an additional uncertainty factor is usually applied to estimate a no-effect level. Additional uncertainty arises from estimating RfD values for chronic exposure from less-than-chronic data. Unless empirical data indicate that effects do not worsen with increasing duration of exposure, an additional uncertainty factor is applied to the no-effect level in the less-than-chronic study. Uncertainty also arises from the presence of chemicals (e.g., lead) for which there are no EPA-approved toxicity values, and for which quantitative risk characterization is not possible. However, the adult blood-lead model and the IEUBK are supported by a considerable body of empirical data, and are considered to be among the best validated of the various models used in risk assessment.

In summary, the EPA methodology for both cancer and noncancer toxicity evaluation is intentionally designed to be protective. However, the extent to which toxicity values may overestimate toxic potency is not clear, and it is possible that the toxicity values for some compounds may not be adequately protective.

Uncertainty regarding the cancer and noncancer toxicity values for the DNTs deserves special mention. The oral SF of 6.8E-1 per mg/kg-day for the 2,4-/2,6- mixture was applied to either isomer and total DNT. The SF was developed from a study with a mixture containing approximately 98 percent 2,4-DNT and 2 percent 2,6-DNT (EPA, 2001a). Other studies, however, suggest that the 2,6-isomer is the more potent carcinogen, and 2,4-DNT alone was placed in cancer weight-of-evidence Group D – not classifiable as to carcinogenicity to humans. Application of the SF to 2,6-DNT alone seems to be a reasonable extension of the empirical data. Application of the SF to 2,4-DNT alone, however, may impart an unnecessarily conservative bias to the RA. On the other hand, it seems the prudent thing to do, especially considering that the 2,4-isomer constituted 98 percent of the mixture on which the SF is based. Application of the SF to the 2,4-isomer had a significant effect on the numerical results of the RA, because 2,4-DNT was a cancer risk driver for construction worker and on-site resident exposure to total soil at TNT Area A, and on-site resident exposure to total soil at TNT Area C. It had no effect on the interpretation of the RA because other chemicals (PCBs, 2,6-DNT, benzo[a]pyrene) were also identified as cancer risk drivers.

The oral RfD for 2,4-DNT is 2E-3 mg/kg-day and the oral RfD for 2,6-DNT is 1E-3 mg/kg-day. Casual comparison of the oral RfD values suggests that the 2,6-isomer is slightly more toxic than the 2,4-isomer. The empirical data, however, suggest the opposite. This apparent discrepancy is an artifact of the lesser quality of the overall data base for the 2,6-isomer, necessitating the use of a 30-fold larger uncertainty factor in derivation of the RfD. Obviously, application of the oral RfD for 2,6-DNT to total DNT imparts a slightly conservative bias to the RA. However, the 2-fold difference between the oral RfD values for the two isomers is well within the level of uncertainty generally associated with RfDs. Furthermore, total DNT was not a noncancer risk driver for any receptor/medium combination. Therefore, application of the oral RfD for 2,6-DNT to total DNTs had no significant effect on the outcome or interpretation of the RA.

Risk Characterization. Risk characterization is the process of quantifying the risk of cancer due to exposure to carcinogens, as well as quantitatively evaluating hazards potentially posed by

exposure to noncarcinogenic toxicants. Cancer risk is assumed to be additive for all carcinogens. Noncancer risk is assumed to be additive for chemicals with similar sites of toxicological action. In the event that any combination of these chemicals results in synergistic effects, risk might be underestimated. Conversely, the assumption of additivity would overestimate risk if a combination of these chemicals acted antagonistically or had no combined toxic effect at all. As noted above, the predominant risk drivers are various nitroaromatic compounds. These compounds have at least one mechanism of toxicity in common – the oxidation of hemoglobin to methemoglobin, which is incapable of releasing oxygen to the tissues and shortens the life of the erythrocyte, leading to hemolytic anemia. The assumption of additivity seems particularly appropriate for these compounds and is deemed to contribute little to the uncertainty of the risk characterization.

The purpose of this discussion is not to disparage the results of the risk assessment, but to show how measures were taken to reduce or compensate for variation and uncertainty, and to highlight areas where uncertainty remains that may cast doubt or raise questions that must be considered by risk managers.

7.0 Summary and Conclusions

This section briefly summarizes the RA protocol and results and interprets the results, in light of the uncertainty about their estimation, to draw realistic conclusions regarding risk to human health. TNT Areas A and C were formerly occupied by several process buildings used to produce large quantities of the explosive TNT. Earlier decontamination efforts included removal of gross contamination, dismantling the equipment and burning the former process buildings, and rough grading of the areas around the buildings. TNT Area A was reported to be more thoroughly decontaminated than TNT Area C.

PBOW is currently classified for industrial use, but future residential use is considered in the risk assessment to support evaluation of all plausible receptor scenarios. Groundskeeper, construction worker and hunter scenarios were evaluated under the current site-use assumption; groundskeeper, construction worker, indoor worker, hunter (including a child venison consumer) and on-site residential scenarios were evaluated as plausible future exposure scenarios. The groundskeeper was evaluated for exposure to surface soil. The construction worker was evaluated for exposure to surface and subsurface soil (the mixture was termed "total soil"), surface water and sediment. The adult hunter was evaluated for exposure to surface soil by direct contact and indirectly by ingestion of venison (deer graze vegetation growing on contaminated soil). The on-site resident was evaluated as the upper bound on exposure to total soil, surface water and sediment.

The results of the sampling, analysis and risk evaluations are summarized separately for each area.

7.1 TNT Area A

7.1.1 Sampling and Analysis

Surface and subsurface soil samples were taken from the areas around each of the former process buildings where contamination was thought to have been possible. It appears, however, that the previous decontamination and rough grading activities may have covered areas of contamination formerly on the surface and obscured the distinction between surface and subsurface soil. Surface water and sediment samples were taken mostly from Lindsey Ditch. It was anecdotally reported that Plum Brook ran red during the time that PBOW was in operation, indicating gross

contamination with nitroaromatics. Therefore, additional surface water and sediment samples were taken from Plum Brook to ascertain whether contamination with nitroaromatics was a current concern in this body of water that flows off-site to Lake Erie. One additional surface water sample was taken from a shallow excavation (<1 ft) in a low area on TNT Area A near former Building 146 in which the water appeared to be pink.

The analytical results revealed that the soil was contaminated with substantial levels of nitroaromatics, many of which were selected as COPCs. A mixture of PCBs (Aroclor 1260) also was selected as a COPC. PCBs may have been released from transformers or other electrical equipment when the process buildings were demolished and burned. Three PAHs were also selected as COPCs. The PAHs probably formed during the burning of the buildings. Also, high levels of lead were observed in the soil in areas associated with three of the buildings. Relatively large pieces of lead were observed during sampling. Lead flashing possibly was used in the buildings and may have been used to seal pipe joints; its appearance in soil probably reflects its release during building demolition.

Aroclor 1260 and benzo(a)pyrene were selected as COPCs in sediment taken from Lindsey Ditch. Low levels of nitroaromatics were identified in on-site sediment, but not at levels sufficient to cause their selection as COPCs. Levels of nitroaromatics in sediment from Plum Brook were even lower, suggesting that off-site contamination from explosives manufacture is minimal. The sediment samples from Plum Brook, however, had levels of PAHs substantially higher than those observed on site. The PAHs were attributed to erosion and runoff from a nearby highway, and sediment from Plum Brook was not evaluated in the risk assessment.

Two metals and one TNT degradation product were selected as COPCs in surface water taken from Lindsey Ditch. No COPCs were identified in surface water from Plum Brook. The pink water from the tire track was contaminated with TNT and its degradation products. This sample is considered to reflect the contamination of the underlying shallow groundwater and was not included in the risk assessment. Groundwater will be evaluated in a site-wide investigation in the future.

7.1.2 Risk Assessment Results

The initial RA combined all surface soil and all total soil as single data sets for all of TNT Area A. This approach reflects the reasonable expectation that a groundskeeper and hunter would be

randomly and uniformly exposed over the entire area. All ILCR estimates were below or within the risk management range, and all HI estimates fell below the threshold value of 1 for the groundskeeper, hunter and indoor worker. The total ILCR exceeded the risk management range and the total HI exceeded the threshold level of 1 for the construction worker and on-site resident, due entirely to contamination in total soil. COCs contributing significantly to risk included several nitroaromatics, Aroclor 1260, and benzo(a)pyrene (minimal contribution to risk). RBRCs were developed, based on an ILCR of 1E-5 or an HI of 0.1, to provide sufficient protection for the additivity of risk.

Because the risk results for the construction worker and resident exceeded acceptable levels, the total soil data were re-combined to form EUs based on each of the former building locations. This approach reflects the assumption that a construction project or a residential lot may involve an area much smaller than the whole of TNT Area A. ILCR and HI estimates for the construction worker and on-site resident were re-run for each of the building areas. Several building areas passed the re-evaluation, i.e., the total ILCR fell within the risk management range and the total HI (rounded to one significant figure) did not exceed the threshold level of 1. Several building areas (112, 119, 126, 131, 139, 141, 146, 192, 195) did not pass, meaning that the total ILCR exceeded the risk management range or the HI exceeded the threshold level of 1 for either or both receptor scenarios.

Lead was identified as a COPC in total soil. Its average concentration is below levels of concern for industrial site use, but above levels of concern for residential site use. Examination of the raw data revealed that lead in soil exceeds levels of concern for residential use only at former Buildings 142, 119 and 139.

7.2 TNT Area C

7.2.1 Sampling and Analysis

Surface and subsurface soil samples were taken from the areas around each of the former process buildings where contamination was thought to have been possible. Previous decontamination and rough grading activities, however, probably covered areas of contamination formerly on the surface and obscured the distinction between surface and subsurface soil. Surface water and sediment samples were taken from several intermittent waterways (ditches) on TNT Area C.

The analytical results revealed that the soil was contaminated with substantial levels of nitroaromatics and PAHs, many of which were selected as COPCs. Aroclor 1254 and Aroclor 1260 also were selected as COPCs. Also, high levels of lead were observed in the soil in areas associated with three of the buildings.

Several nitroaromatics and PAHs were selected as COPCs in sediment taken on site at TNT Area C. Manganese and DNT were selected as COPCs in surface water. Groundwater was not sampled; it will be evaluated in a site-wide investigation in the future.

7.2.2 Risk Assessment Results

The initial RA combined all surface soil and all total soil as single data sets for all of TNT Area C, as described for TNT Area A. The ILCR fell below the risk management range for the child venison consumer for indirect exposure to soil; no HI was evaluated for the child venison consumer. The ILCR estimates exceeded the risk management range and the HI estimates exceeded the threshold value of 1 for the groundskeeper, indoor worker and adult hunter, due to direct exposure to surface soil. The total ILCR exceeded the risk management range and the total HI exceeded the threshold level of 1 for the construction worker and on-site resident, due largely to contamination in total soil, but with a significant contribution from sediment. COCs in soil contributing significantly to risk included several nitroaromatics, Aroclors 1254 and 1260, and several PAHs. RBRCs were developed, based on an ILCR or 1E-5 or an HI of 0.1, to provide sufficient protection for the additivity of risk. COCs in sediment included 3 nitroaromatics, with TNT by far the dominant contributor to risk. The risk from exposure to sediment is due almost entirely to an exceptionally high detection of TNT at one of 15 sample locations. The cancer risk and noncancer hazard associated with exposure to surface water were negligible.

Because the risk results for the construction worker and resident exceeded acceptable levels, the total soil data were re-combined to form EUs based on each of the former building locations, as described above for TNT Area A. Some building areas passed the re-evaluation, but many more did not, including building areas 603, 606, 616, 629, 682, 683, 686, 689, 692 and 696.

Lead was identified as a COPC in total soil. Its average concentration was below levels of concern for industrial or residential site use. Examination of the raw data revealed that lead concentrations in soil exceed levels of concern for residential use only at former Buildings 629, 682 and 686.

7.3 Conclusions

Significant contamination at TNT Area A is limited to soil. Contamination in soil poses no unacceptable risk for a groundskeeper or hunter, including a child who consumes venison from deer harvested on site, and adverse effects from exposure are unlikely. Similarly, the areas around several former buildings pose no unacceptable risk for a construction worker or on-site resident, and adverse effects from exposure are unlikely. The areas around other buildings, however, pose unacceptable cancer risk and/or noncancer hazard for a construction worker or on-site resident, raising concern for the occurrence of adverse effects.

Significant contamination at TNT Area C is limited to soil, and sediment at only one sample location. Contamination in surface soil poses unacceptable risk for a groundskeeper, indoor worker and adult hunter, raising concern for the occurrence of adverse effects, but not for a child who consumes venison from deer harvested on site. Contamination in total soil poses unacceptable risk for a construction worker and on-site resident. The areas around several former buildings pose no unacceptable risk for a construction worker or on-site resident, and adverse effects from exposure are unlikely. The areas around several other buildings, however, pose unacceptable cancer risk and/or noncancer hazard for a construction worker or on-site resident, raising concern for the occurrence of adverse effects.

It should be noted that exposure to groundwater, which is plausible for several receptor scenarios at TNT Areas A and C, was not evaluated, which represents a major data gap in this RA. Groundwater will be evaluated in a site-wide investigation in the future.

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TABLES

Table 2-1

Summary of Samples Evaluated in the Baseline Human Health Risk Assessment
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Surface Soil				
TNTA-SO016	AA0427	25-Sep-00	0 - 1	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO409	AA0481	11-Oct-00	0.5 - 1.5	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO077	AA0433	25-Sep-00	0.7 - 1.7	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO081	AA0434	25-Sep-00	0.8 - 1.8	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO081	AA0435-FD	25-Sep-00	0.8 - 1.8	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO111	AA0441	22-Sep-00	1 - 2	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO196	AA0446	25-Sep-00	1 - 2	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO297	AA0451	25-Sep-00	1 - 2	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO334	AA0453	25-Sep-00	1 - 2	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
Subsurface Soil				
TNTA-SO035	AA0431	25-Sep-00	1.5 - 2.5	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO128	AA0445	25-Sep-00	1.5 - 2.5	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO261	AA0447	25-Sep-00	1.5 - 2.5	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO276	AA0449	25-Sep-00	1.5 - 2.5	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO094	AA0437	22-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO094	AA0438-FD	22-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO123	AA0442	22-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO123	AA0443-FD	22-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO012	AA0426	25-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO016	AA0428	25-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO016	AA0429-FD	25-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO040	AA0432	25-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO105	AA0440	25-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO263	AA0448	25-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO279	AA0450	25-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO303	AA0452	26-Sep-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO225	AA0480	11-Oct-00	2 - 3	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO201	AA0472	26-Sep-00	4 - 6	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO261	AA0474	26-Sep-00	4 - 6	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO399	AA0478	26-Sep-00	4 - 6	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO105	AA0466	28-Sep-00	4 - 6	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO111	AA0468	28-Sep-00	4 - 6	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO128	AA0470	28-Sep-00	4 - 6	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO012	AA0460	29-Sep-00	4 - 6	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO062	AA0461	29-Sep-00	4 - 6	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO080	AA0463	29-Sep-00	4 - 6	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO094	AA0465	29-Sep-00	5 - 7	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO062	AA0462	29-Sep-00	6 - 8	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO399	AA0479	26-Sep-00	8 - 9	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO201	AA0473	26-Sep-00	8 - 10	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO261	AA0475	26-Sep-00	8 - 10	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO111	AA0469	28-Sep-00	8 - 10	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO128	AA0471	28-Sep-00	8 - 10	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO080	AA0464	29-Sep-00	8 - 10	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
Sediment Samples				
TNTA-SD01	AA1001	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD02	AA1002	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD03	AA1003	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD04	AA1004	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD04	AA1011-FD	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD05	AA1005	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD06	AA1006	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD07	AA1007	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD08	AA1008	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD09	AA1009	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD10	AA1010	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD11[a]	AA1013	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD12[a]	AA1014	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD13[a]	AA1015	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD14[a]	AA1016	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SD15[a]	AA1017	20-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC

Table 2-1

Summary of Samples Evaluated in the Baseline Human Health Risk Assessment
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Surface Water Samples				
TNTA-SW02	AA2002	20-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SW03	AA2003	20-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SW04	AA2004	20-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SW05	AA2005	20-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SW06	AA2006	20-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SW06	AA2011-FD	20-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SW07	AA2007	20-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SW09	AA2009	20-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SW10	AA2010	20-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SW14[a]	AA2016	18-Oct-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTA-SO080[b]	AA2018	17-Jul-00	NA	Nitroaromatics

FD = Field duplicate.
PCB = Polychlorinated biphenyls.
SVOC = Semivolatile organic compounds.
VOC = Volatile organic compounds.
TPH = Total petroleum hydrocarbons.
General chemistry limited to percent solids.
[a] Off-site location; please see Sections 2.3.1 and 3.1.1.1.
[b] Taken from a tire track; please see Section 2.3.1.

Table 2-2

Summary of Samples Evaluated in the Baseline Human Health Risk Assessment
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Surface Soil				
TNTC-SO001	AB0426	12-Oct-00	0 - 1	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO066	AB0427-FD	27-Sep-00	0 - 1	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO066	AB0429	27-Sep-00	0 - 1	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO107	AB0432	10-Oct-00	0 - 1	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO151	AB0438	10-Oct-00	0 - 1	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO192	AB0445	11-Oct-00	0 - 1	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO280	AB0452-FD	27-Sep-00	0.25 - 1.25	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO280	AB0454	27-Sep-00	0.25 - 1.25	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO150	AB0437	10-Oct-00	0.33 - 1	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO252	AB0449-FD	27-Sep-00	0.5 - 1.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO252	AB0451	27-Sep-00	0.5 - 1.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO311	AB0455	27-Sep-00	0.5 - 1.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO173	AB0443	11-Oct-00	1 - 2	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO190	AB0444	11-Oct-00	1 - 2	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO206	AB0447	12-Oct-00	1 - 2	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO241	AB0448	11-Oct-00	1 - 2	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO325	AB0478	12-Oct-00	1 - 2	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
Subsurface Soil				
TNTC-SO151	AB0439	10-Oct-00	1.3 - 2.3	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO165	AB0442	27-Sep-00	1.5 - 2.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO320	AB0477	12-Oct-00	1.5 - 2.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO192	AB0446	11-Oct-00	2 - 2.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO100	AB0476	12-Oct-00	2 - 3	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO327	AB0479	12-Oct-00	2 - 3	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO134	AB0434-FD	26-Sep-00	2.5 - 3.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO134	AB0436	26-Sep-00	2.5 - 3.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO065	AB0475	12-Oct-00	2.5 - 3.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO066	AB0430	12-Oct-00	2.5 - 3.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO074	AB0431	12-Oct-00	2.5 - 3.5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO222	AB0468	28-Sep-00	3 - 5	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO107	AB0433	10-Oct-00	3 - 4	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO241	AB0469	27-Sep-00	4 - 6	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO383	AB0470	27-Sep-00	4 - 6	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO001	AB0460	28-Sep-00	4 - 6	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO171	AB0466	28-Sep-00	4 - 6	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO397	AB0471	28-Sep-00	4 - 6	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO252	AB0473	29-Sep-00	4 - 6	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO123	AB0463	27-Sep-00	5 - 7	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO134	AB0465	27-Sep-00	5 - 7	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO066	AB0461	28-Sep-00	5 - 7	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO123	AB0464	27-Sep-00	8 - 10	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO066	AB0462	28-Sep-00	8 - 10	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO171	AB0467	28-Sep-00	8 - 10	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO407	AB0472	28-Sep-00	8 - 10	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
TNTC-SO252	AB0474	29-Sep-00	8 - 10	General Chemistry, Metals, Niroaromatics, PCB, SVOC, VOC
Sediment Samples				
TNTC-SD01	AB1001	18-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD01	AB1016-FD	18-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD02	AB1002	18-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD03	AB1003	18-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD04	AB1004	18-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD05	AB1005	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD06	AB1006	18-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD07	AB1007	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD08	AB1008	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD08	AB1018-FD	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD09	AB1009	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD10	AB1010	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD11	AB1011	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD12	AB1012	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC

Table 2-2

Summary of Samples Evaluated in the Baseline Human Health Risk Assessment
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Location	Sample Number	Sample Date	Depth (ft)	Analyses
TNTC-SD13	AB1013	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD14	AB1014	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SD15	AB1015	19-Sep-00	NA	General Chemistry, Metals, Nitroaromatics, PCB, SVOC, VOC
Surface Water Samples				
TNTC-SW01	AB2001	18-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW01	AB2016-FD	18-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW02	AB2002	18-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW03	AB2003	18-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW04	AB2004	18-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW05	AB2005	19-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW06	AB2006	18-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW07	AB2007	19-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW08	AB2008	19-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW08	AB2018-FD	19-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW10	AB2010	19-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC
TNTC-SW11	AB2011	19-Sep-00	NA	Metals, Nitroaromatics, PCB, SVOC, VOC

FD = Field duplicate
Pest = Organochlorine Pesticides
PCB = Polychlorinated biphenyls
SVOC = Semivolatile organic compounds
VOC = Volatile organic compounds
General chemistry limited to percent solids.

Table 2-3

Background Concentrations of Metals in Soil[a]
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UTL [b]	Background Screening Criterion [c]
Aluminum	12 / 12	3520 - 15500	NA	L	8.43E+03	2.69E+04	1.55E+04
Antimony	9 / 25	5.9 - 9.3	5.4 - 74	NP	4.68E+00	NA	9.30E+00
Arsenic	23 / 26	2.1 - 36.5	1.2 - 3.7	L	1.08E+01	7.10E+01	3.65E+01
Barium	9 / 12	35.6 - 826	23.2 - 24.7	L	1.16E+02	1.30E+03	8.26E+02
Beryllium	6 / 25	0.57 - 1	0.57 - 1.2	L	5.65E-01	1.17E+00	1.00E+00
Cadmium	0 / 25	NA	0.57 1.2	L	4.49E-01	NA	NA
Calcium	12 / 12	735 - 52300	NA	L	1.13E+04	2.18E+05	5.23E+04
Chromium	25 / 26	4.4 - 29	12.3 - 12.3	NP	1.34E+01	NA	2.90E+01
Cobalt	9 / 12	9.6 - 116	5.8 - 6.2	L	2.26E+01	2.48E+02	1.16E+02
Copper	23 / 26	2.3 - 56.2	2.2 - 2.9	L	1.70E+01	1.47E+02	5.62E+01
Iron	12 / 12	5880 - 234000	NA	L	4.01E+04	3.58E+05	2.34E+05
Lead	26 / 26	1.9 - 48.6	NA	L	1.28E+01	5.13E+01	4.86E+01
Magnesium	12 / 12	629 - 10400	NA	L	3.26E+03	3.08E+04	1.04E+04
Manganese	26 / 26	21 - 13300	NA	L	7.29E+02	3.51E+03	3.51E+03
Mercury	2 / 26	0.085 - 0.085	0.037 - 0.3	L	9.06E-02	5.60E-01	8.50E-02
Nickel	26 / 26	5.4 - 55.1	NA	L	2.28E+01	7.79E+01	5.51E+01
Potassium	11 / 12	579 - 3390	617 - 617	L	1.24E+03	6.08E+03	3.39E+03
Selenium	5 / 25	0.61 - 2	0.57 - 4.9	NP	1.55E+00	NA	2.00E+00
Silver	2 / 26	1.1 - 11.1	1.1 - 1.3	NP	1.00E+00	NA	1.11E+01
Sodium	0 / 12	NA	566 - 663	L	3.03E+02	NA	NA
Thallium	2 / 25	1.2 - 1.3	1.1 - 6.1	NP	1.91E+00	NA	1.30E+00
Vanadium	11 / 12	9 - 40.9	61.7 - 61.7	L	2.48E+01	8.31E+01	4.09E+01
Zinc	26 / 26	6.6 - 655	NA	L	7.30E+01	3.22E+02	3.22E+02

mg/kg = milligrams per kilogram
NA = Not applicable; not available.

[a] Data used to determine soil background are based on sampling from IT, 1998, ***Site Investigation of Acid Areas, Plum Brook Ordnance Works, Sandusky, Ohio.***

[b] 95% UTL = 95% upper tolerance limit calculated as described in Section 2.1.4 and rounded to 3 significant figures.

[c] The maximum detected concentration is used as the background screening criterion for nonparametric data sets; for normal or lognormal data sets, the 95% UTL or the maximum detected concentration, whichever is less, is used.

Note: Detection limits from sample 6990 were deleted when calculating results for antimony, beryllium, cadmium, selenium and thallium. The detection limits were elevated by dilution factors which greatly exceed any detected concentration and would bias results unrealistically high.

Table 2-4

Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil[a]
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]		COPC? [e,f]	Source Term Concentration [g]
Metals											
Aluminum	8 / 8	3520 - 6820	43.7 - 53.4	N	5.40E+03		1.55E+04	7.60E+03		N (a)	---
Antimony	2 / 5	2.24 - 3.69	1.34 - 1.6	L	1.62E+00		9.30E+00	3.10E+00		N (b)	---
Arsenic	8 / 8	2.76 - 8.59	1.09 - 1.34	L	4.25E+00		3.65E+01	3.90E-02		N (b)	---
Barium	8 / 8	20.5 - 124	1.09 - 1.34	NP	3.88E+01		8.26E+02	5.40E+02		N (a)	---
Beryllium	8 / 8	0.226 - 0.45	0.218 - 0.267	N	3.40E-01		1.00E+00	1.50E+01		N (a)	---
Cadmium	7 / 7	0.131 - 1.59	0.655 - 0.802	L	5.88E-01			3.70E+00		N (a)	---
Calcium	8 / 8	4080 - 125000	109 - 275	L	2.90E+04			Nutrient		N (c)	---
Chromium	8 / 8	8.09 - 19.9	1.09 - 1.34	L	1.19E+01		2.90E+01	2.10E+01	h	N (a)	---
Cobalt	8 / 8	2.82 - 9.1	1.09 - 1.34	NP	4.23E+00		1.16E+02	4.70E+02		N (a)	---
Copper	8 / 8	7.86 - 88.4	1.09 - 1.34	L	3.35E+01		5.62E+01	2.90E+02		N (a)	---
Iron	8 / 8	8290 - 21900	21.8 - 26.7	NP	1.21E+04			Nutrient		N (c)	---
Lead	8 / 8	7.24 - 588	0.655 - 0.802	L	1.55E+02	1.86E+03	4.86E+01	4.00E+02		Y	5.88E+02
Magnesium	8 / 8	1090 - 10400	54.6 - 66.8	L	3.12E+03			Nutrient		N (c)	---
Manganese	8 / 8	93.3 - 515	1.09 - 1.34	L	2.55E+02		3.51E+03	1.80E+02		N (b)	---
Mercury	6 / 8	0.022 - 0.134	0.034 - 0.04	L	5.36E-02		8.50E-02	2.30E+00		N (a)	---
Nickel	8 / 8	7.42 - 18.3	1.09 - 1.34	L	1.19E+01		5.51E+01	1.60E+02		N (a)	---
Potassium	8 / 8	393 - 939	54.6 - 66.8	L	6.18E+02			Nutrient		N (c)	---
Sodium	2 / 2	180 - 181	218 - 248.5	N	1.81E+02			Nutrient		N (c)	---
Vanadium	8 / 8	10.6 - 19.9	1.09 - 1.34	N	1.53E+01			5.50E+01		N (a)	---
Zinc	8 / 8	50.3 - 751	3.28 - 4.01	L	2.50E+02			2.30E+03		N (a)	---
Nitroaromatics											
2-Amino-4,6-dinitrotoluene	4 / 8	0.59 - 9.23	0.0952 - 0.1	NP	1.99E+00	9.23E+00		3.70E-01	i	Y	9.23E+00
4-Amino-2,6-dinitrotoluene	5 / 8	0.132 - 5.975	0.0952 - 0.1	L	1.44E+00	2.03E+02		3.70E-01	i	Y	5.98E+00
2-Nitrotoluene	1 / 8	0.374 - 0.374	0.19 - 0.2	NP	1.33E-01			3.70E+01		N (a)	---
1,3,5-Trinitrobenzene	1 / 8	0.373 - 0.373	0.0952 - 0.1	NP	8.98E-02			1.80E+02		N (a)	---
2,4,6-Trinitrotoluene	5 / 8	0.704 - 151.5	0.0952 - 0.1	L	2.07E+01	6.41E+05		1.60E+00		Y	1.52E+02
Dinitrotoluene, total	4 / 8	0.188 - 7.36	0.0952 - 0.1	L	1.24E+00	1.16E+02		7.20E-02		Y	7.36E+00
PCB											
Aroclor 1260	8 / 8	0.00862 - 2.48	0.0745 - 0.368	L	5.62E-01	9.77E+01		2.20E-02		Y	2.48E+00
Semivolatile Organic Compounds											
2,4-Dinitrotoluene	4 / 8	0.0761 - 2.03	0.366 - 0.459	NP	4.03E-01	2.03E+00		7.20E-02	j	N (d)	---
2,6-Dinitrotoluene	1 / 8	0.694 - 0.694	0.366 - 0.459	NP	2.62E-01	6.94E-01		7.20E-02	j	N (d)	---
2-Methylnaphthalene	1 / 8	0.0999 - 0.0999	0.366 - 0.459	NP	1.87E-01			1.20E+02	i	N (a)	---
Benzo(a)anthracene	2 / 8	0.0496 - 0.117	0.366 - 0.459	NP	1.67E-01	1.89E-01		6.20E-02		Y	1.17E-01
Benzo(a)pyrene	3 / 8	0.0424 - 0.107	0.366 - 0.459	NP	1.45E-01	1.88E-01		6.20E-03		Y	1.07E-01
Benzo(b)fluoranthene	2 / 8	0.127 - 0.162	0.366 - 0.459	N	1.82E-01	2.01E-01		6.20E-02		Y	1.62E-01
Bis(2-ethylhexyl)phthalate	1 / 8	0.0355 - 0.0355	0.366 - 0.459	NP	1.80E-01			3.50E+00		N (a)	---
Chrysene	2 / 8	0.107 - 0.109	0.366 - 0.459	NP	1.73E-01			6.20E+00		N (a)	---
Di-n-butyl phthalate	1 / 8	0.0729 - 0.0729	0.366 - 0.459	NP	1.79E-01			6.10E+02		N (a)	---
Fluoranthene	1 / 8	0.176 - 0.176	0.366 - 0.459	L	1.92E-01			2.30E+02		N (a)	---
Phenanthrene	2 / 8	0.0633 - 0.0807	0.366 - 0.459	NP	1.64E-01			2.30E+02	i	N (a)	---
Pyrene	1 / 8	0.153 - 0.153	0.366 - 0.459	N	1.89E-01			2.30E+02		N (a)	---
Volatile Organic Compounds											
2-Butanone	1 / 8	0.0098 - 0.0098	0.00957 - 0.01425	L	6.41E-03			7.30E+02		N (a)	---

Table 2-4

Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil[a]
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration [g]
Acetone	8 / 8	0.0134 - 0.194	0.00957 - 0.01425	L	7.39E-02			1.60E+02	N (a)	---
Benzene	1 / 8	0.00244 - 0.00244	0.00479 - 0.007115	N	2.97E-03			6.50E-02	N (a)	---
Carbon disulfide	1 / 8	0.00324 - 0.00324	0.00479 - 0.007115	N	3.02E-03			3.60E+01	N (a)	---
Methylene chloride	2 / 2	0.0795 - 0.0805	0.00572 - 0.00586	N	8.00E-02			8.90E-01	N (a)	---
Toluene	1 / 8	0.00339 - 0.00339	0.00479 - 0.007115	N	3.09E-03			5.90E+01	N (a)	---

COPC - Chemical of Potential Concern; UCL - Upper Confidence Limit.
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparametric; data are found to be neither normally nor lognormally distributed.
mg/kg - milligrams per kilogram.
PCB - Polychlorinated biphenyl.
[a] Surface soil is defined by samples taken from 0 to 2 feet below ground surface.
[b] Method of estimation based on statistical distribution (please see Section 2.2.1).
[c] Please see Table 2-3.
[d] Please see section 2.1.5.
[e] N = Chemical is not chosen as a COPC:
(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).
(b) = maximum detected concentration is less than the background screening concentration.
(c) = essential nutrient.
(d) = please see section 2.3.1.
[f] Y = Chemical is chosen as COPC.
[g] 95% UCL or maximum detected concentration, whichever is lower, is chosen as the source term concentration.
[h] Based on PRG for total chromium.
[i] Calculated; reference Appendix B.
[j] Based on PRG for mixed dinitrotoluene.

Table 2-5

Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil [a]
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]		COPC? [e,f]	Source Term Concentration [g]
Metals											
Aluminum	31 / 31	1090 - 13200	40.2 - 54.3	L	6.20E+03		1.55E+04	7.60E+03		N (b)	---
Antimony	5 / 29	0.669 - 3.14	1.205 - 1.63	NP	9.51E-01		9.30E+00	3.10E+00		N (b)	---
Arsenic	30 / 31	2.21 - 23.2	1.005 - 1.36	L	6.74E+00		3.65E+01	3.90E-02		N (b)	---
Barium	31 / 31	9.08 - 109	1.005 - 1.36	L	3.24E+01		8.26E+02	5.40E+02		N (a)	---
Beryllium	31 / 31	0.16 - 0.796	0.2015 - 0.271	L	4.26E-01		1.00E+00	1.50E+01		N (a)	---
Cadmium	11 / 30	0.103 - 1.175	0.6035 - 0.814	NP	3.50E-01			3.70E+00		N (a)	---
Calcium	31 / 31	1180 - 97600	100.5 - 136	NP	2.14E+04			Nutrient		N (c)	---
Chromium	31 / 31	3.09 - 40.3	1.005 - 1.36	L	1.19E+01	1.46E+01	2.90E+01	2.10E+01	h	N (d)	---
Cobalt	31 / 31	0.803 - 19	1.005 - 1.36	L	6.42E+00		1.16E+02	4.70E+02		N (a)	---
Copper	31 / 31	2.06 - 93.8	1.005 - 1.36	L	1.50E+01		5.62E+01	2.90E+02		N (a)	---
Iron	31 / 31	3910 - 44800	20.15 - 27.1	L	1.54E+04			Nutrient		N (c)	---
Lead	30 / 30	3.15 - 11900	0.6035 - 0.814	NP	4.87E+02	1.19E+04	4.86E+01	4.00E+02		Y	1.19E+04
Magnesium	31 / 31	235 - 19100	50.3 - 67.9	L	3.89E+03			Nutrient		N (c)	---
Manganese	31 / 31	26.7 - 1370	1.005 - 1.36	L	3.32E+02		3.51E+03	1.80E+02		N (b)	---
Mercury	14 / 29	0.021 - 0.084	0.033 - 0.044	NP	3.19E-02		8.50E-02	2.30E+00		N (a)	---
Nickel	31 / 31	3.26 - 50.7	1.005 - 1.36	L	1.89E+01		5.51E+01	1.60E+02		N (a)	---
Potassium	31 / 31	245 - 3660	50.3 - 67.9	NP	1.18E+03			Nutrient		N (c)	---
Selenium	5 / 30	0.97 - 2.05	1.005 - 1.25	NP	7.20E-01		2.00E+00	3.90E+01		N (a)	---
Silver	1 / 31	0.704 - 0.704	0.6035 - 0.814	NP	3.58E-01		1.11E+01	3.90E+01		N (a)	---
Sodium	10 / 10	92.1 - 454	209 - 271	L	2.62E+02			Nutrient		N (c)	---
Thallium	2 / 31	1.34 - 2.38	2.045 - 2.71	NP	1.21E+00	1.25E+00	1.30E+00	5.20E-01		N (d)	---
Vanadium	31 / 31	6.54 - 26.2	1.005 - 1.36	N	1.56E+01		4.09E+01	5.50E+01		N (a)	---
Zinc	31 / 31	12.8 - 239.5	3.015 - 4.07	L	6.43E+01		3.22E+02	2.30E+03		N (a)	---
Nitroaromatics											
2-Amino-4,6-dinitrotoluene	14 / 31	0.358 - 33.6	0.087 - 10	NP	3.54E+00	3.36E+01		3.70E-01	i	Y	3.36E+01
4-Amino-2,6-dinitrotoluene	17 / 31	0.0915 - 16	0.087 - 0.1	NP	2.26E+00	9.77E+00		3.70E-01	i	Y	9.77E+00
2-Nitrotoluene	10 / 31	0.235 - 582	0.174 - 20	NP	2.47E+01	5.82E+02		3.70E+01		Y	5.82E+02
3-Nitrotoluene	9 / 31	0.13 - 59	0.174 - 20	NP	2.77E+00	5.90E+01		3.70E+01		Y	5.90E+01
4-Nitrotoluene	10 / 31	0.249 - 484	0.174 - 20	NP	1.91E+01	4.84E+02		3.70E+01		Y	4.84E+02
1,3,5-Trinitrobenzene	6 / 31	0.0761 - 0.902	0.087 - 0.1	NP	1.15E-01			1.80E+02		N (a)	---
2,4,6-Trinitrotoluene	23 / 31	0.0875 - 530	0.087 - 10	NP	5.12E+01	2.59E+02		1.60E+00		Y	2.59E+02
Dinitrotoluene, total	20 / 31	0.114 - 2708	0.087 - 10	NP	1.27E+02	1.59E+03		7.20E-02		N (e)	---
Nitrobenzene	5 / 31	0.0713 - 0.205	0.087 - 0.1	NP	6.02E-02			2.00E+00		N (a)	---
PCBs											
Aroclor 1260	19 / 31	0.0125 - 69.8	0.0709 - 8.06	NP	2.52E+00	6.98E+01		2.20E-02		Y	6.98E+01
Semivolatile Organic Compounds											
2,4-Dinitrotoluene	18 / 29	0.165 - 8912	0.352 - 1579	NP	3.14E+02	8.91E+03		7.20E-02	j	Y	8.91E+03
2,6-Dinitrotoluene	18 / 31	0.0529 - 10274	0.352 - 1579	NP	4.41E+02	1.03E+04		7.20E-02	j	Y	1.03E+04
2-Methylnaphthalene	3 / 31	0.0907 - 1.15	0.352 - 78.9	NP	2.37E+00			1.20E+02	i	N (a)	---
Benzo(a)anthracene	2 / 31	0.0386 - 0.295	0.352 - 78.9	NP	2.38E+00	2.95E-01		6.20E-02		Y	2.95E-01
Benzo(a)pyrene	1 / 31	0.218 - 0.218	0.352 - 78.9	NP	2.38E+00	2.18E-01		6.20E-03		Y	2.18E-01
Benzo(b)fluoranthene	1 / 31	0.305 - 0.305	0.352 - 78.9	NP	2.39E+00	3.05E-01		6.20E-02		Y	3.05E-01
Benzo(ghi)perylene	1 / 31	0.0981 - 0.0981	0.352 - 78.9	NP	2.38E+00			2.30E+02	i	N (a)	---
Benzo(k)fluoranthene	1 / 31	0.158 - 0.158	0.352 - 78.9	NP	2.38E+00			6.20E-01		N (a)	---

Table 2-5

Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil [a]
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration [g]
Bis(2-ethylhexyl)phthalate	4 / 31	0.0231 - 0.0595	0.352 - 78.9	NP	2.36E+00			3.50E+00	N (a)	---
Chrysene	2 / 31	0.0733 - 0.202	0.352 - 78.9	NP	2.38E+00			6.20E+00	N (a)	---
Di-n-butyl phthalate	2 / 31	0.0568 - 0.216	0.352 - 78.9	NP	2.38E+00			6.10E+02	N (a)	---
Fluoranthene	1 / 31	0.193 - 0.193	0.352 - 78.9	NP	2.38E+00			2.30E+02	N (a)	---
Indeno(1,2,3-cd)pyrene	1 / 31	0.0996 - 0.0996	0.352 - 78.9	NP	2.38E+00	9.96E-02		6.20E-02	Y	9.96E-02
Naphthalene	1 / 31	0.652 - 0.652	0.352 - 78.9	NP	2.37E+00			5.60E+00	N (a)	---
Phenanthrene	3 / 31	0.0516 - 0.45	0.352 - 78.9	NP	2.36E+00			2.30E+02 [i]	N (a)	---
Pyrene	1 / 31	0.175 - 0.175	0.352 - 78.9	NP	2.38E+00			2.30E+02	N (a)	---
Volatile Organic Compounds										
2-Butanone	1 / 31	0.00475 - 0.00475	0.00937 - 0.0164	L	5.78E-03			7.30E+02	N (a)	---
Acetone	26 / 29	0.00713 - 0.188	0.00937 - 0.0164	L	4.40E-02			1.60E+02	N (a)	---
Benzene	1 / 31	0.0026 - 0.0026	0.00468 - 0.0082	L	2.90E-03			6.50E-02	N (a)	---
Carbon disulfide	9 / 31	0.00185 - 0.00917	0.00468 - 0.0082	NP	3.29E-03			3.60E+01	N (a)	---
Methylene chloride	6 / 6	0.05355 - 0.0957	0.005815 - 0.0257	L	7.23E-02			8.90E-01	N (a)	---
Toluene	12 / 31	0.00196 - 0.013	0.00468 - 0.0082	NP	3.50E-03			5.90E+01	N (a)	---
Xylene, o-	1 / 31	0.0027 - 0.0027	0.00468 - 0.0082	L	2.87E-03			1.40E+02	N (a)	---
Xylenes, m,p-	1 / 31	0.00787 - 0.00787	0.00468 - 0.0082	NP	3.04E-03			1.40E+02	N (a)	---

COPC - Chemical of Potential Concern.
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparametric; data are found to be neither normally nor lognormally distributed.
UCL - Upper Confidence Limit.
mg/kg - milligrams per kilogram.

[a] Subsurface soil is defined by samples taken from 1.5 to 10 feet below ground surface.
[b] Method of estimation based on statistical distribution (please see Section 2.2.1).
[c] Please see Table 2-3.
[d] Please see Section 2.1.5.
[e] N = Chemical is not chosen as a COPC:
(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).
(b) = maximum detected concentration is less than the background screening concentration.
(c) = essential nutrient.
(d) = Mann-Whitney U test demonstrated site data set is equivalent to background data set (please see Appendix A).
(e) = please see Section 2.3.1.
[f] Y = Chemical is chosen as COPC.
[g] 95% UCL or maximum detected concentration, whichever is lower, is chosen as the source term concentration.
[h] Based on PRG for total chromium.
[i] Calculated; reference Appendix B.
[j] Based on PRG for mixed dinitrotoluene.

Table 2-6

Screening of VOCs from Subsurface Soil in Indoor Air
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Chemical Concentration In Soil (mg/kg)	VOC Concentration In Soil Gas C_{source} (g/cm^3)	Effective Diffusion Coefficient D^{eff} (cm^2/sec)	Attenuation Coefficient α (unitless)	VOC Concentration in Indoor Air In the Building (mg/m^3)	Risk-Based Screening Criterion [a] (mg/m^3)	COPC?
Volatile Organic Compounds							
2-Butanone	4.75E-03	3.19E-11	6.36E-03	4.51E-06	1.44E-07	1.00E-01	No
Acetone	1.88E-01	2.88E-09	9.74E-03	6.91E-06	1.99E-05	3.70E-02	No
Benzene	2.60E-03	1.20E-09	6.86E-03	4.87E-06	5.82E-06	2.50E-04	No
Carbon disulfide	9.17E-03	1.88E-08	8.11E-03	5.75E-06	1.08E-04	7.30E-02	No
Methylene chloride	9.57E-02	4.59E-08	7.88E-03	5.59E-06	2.56E-04	4.10E-03	No
Toluene	1.30E-02	2.84E-09	6.79E-03	4.81E-06	1.37E-05	4.00E-02	No
Xylene, o-	2.70E-03	3.12E-10	5.46E-03	3.87E-06	1.21E-06	7.30E-02	No
Xylenes, m,p-	7.87E-03	9.11E-10	5.46E-03	3.87E-06	3.53E-06	7.30E-02	No

[a] Please see Section 2.1.5.
cm^2/sec = Square centimeters per second.
COPC = chemical of potential concern
g/cm^3 = grams per cubic centimeter.
mg/kg = Milligrams per kilogram.
mg/m^3 = Milligrams per cubic meter.
VOC = volatile organic compounds

Table 2-7

COPC Selection for Total Soil[a]
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name	STC Surface Soil [b] (mg/kg)	STC Subsurface Soil [c] (mg/kg)	Source Term Concentration (mg/kg)
Metals			
Lead	5.88E+02	1.19E+04	1.19E+04
Nitroaromatics			
2-Amino-4,6-dinitrotoluene	9.23E+00	3.36E+01	3.36E+01
4-Amino-2,6-dinitrotoluene	5.98E+00	9.77E+00	9.77E+00
2-Nitrotoluene	--	5.82E+02	5.82E+02
3-Nitrotoluene	--	5.90E+01	5.90E+01
4-Nitrotoluene	--	4.84E+02	4.84E+02
2,4,6-Trinitrotoluene	1.52E+02	2.59E+02	2.59E+02
PCB			
Aroclor 1260	2.48E+00	6.98E+01	6.98E+01
Semivolatile Organic Compounds			
2,4-Dinitrotoluene	--	8.91E+03	8.91E+03
2,6-Dinitrotoluene	--	1.03E+04	1.03E+04
Benzo(a)anthracene	1.17E-01	2.95E-01	2.95E-01
Benzo(a)pyrene	1.07E-01	2.18E-01	2.18E-01
Benzo(b)fluoranthene	1.62E-01	3.05E-01	3.05E-01
Indeno(1,2,3-cd)pyrene	--	9.96E-02	9.96E-02

[a] Total soil is defined in Section 2.1.1 of the text.
[b] Please see Table 2-4.
[c] Please see Table 2-5.
COPC = Chemical of potential concern.
STC = Source term concentration.
mg/kg = Milligram per killogram.
PCB = Polychlorinated biphenyl.
-- = Chemical was either not selected as a COPC, or not detected.

Table 2-8

Statistical Summary and COPC Selection for Chemicals Detected in Sediment at On-Site Locations
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [a]	Background Screening Criterion [b]	Risk-Based Screening Criterion [c]	COPC? [d,e]	Source Term Concentration [f]
Metals										
Aluminum	10 / 10	3020 - 14300	48.9 - 59.9	N	1.01E+04		1.55E+04	7.60E+04	N (a)	---
Arsenic	10 / 10	2.735 - 25	1.22 - 1.5	L	8.79E+00		3.65E+01	3.90E-01	N (b)	---
Barium	10 / 10	18.95 - 177	1.22 - 1.5	L	5.79E+01		8.26E+02	5.40E+03	N (a)	---
Beryllium	7 / 7	0.172 - 1.56	0.248 - 0.3	N	8.54E-01		1.00E+00	1.50E+02	N (a)	---
Cadmium	3 / 8	0.164 - 1.16	0.733 - 0.899	L	4.36E-01			3.70E+01	N (a)	---
Calcium	10 / 10	2730 - 68700	122 - 150	L	2.99E+04			Nutrient	N (c)	---
Chromium	10 / 10	8.08 - 24.2	1.22 - 1.5	N	1.73E+01		2.90E+01	2.10E+02 g	N (a)	---
Cobalt	10 / 10	2.9 - 84.9	1.22 - 1.5	L	2.23E+01		1.16E+02	4.70E+03	N (a)	---
Copper	8 / 8	5.375 - 26.5	1.22 - 1.5	N	1.59E+01		5.62E+01	2.90E+03	N (a)	---
Iron	10 / 10	13000 - 58300	24.4 - 30	L	2.46E+04			Nutrient	N (c)	---
Lead	10 / 10	5.645 - 59	0.733 - 0.899	L	2.27E+01		4.86E+01	4.00E+02	N (a)	---
Magnesium	10 / 10	1650 - 9510	61.1 - 74.9	N	5.06E+03			Nutrient	N (c)	---
Manganese	10 / 10	133.75 - 2770	1.22 - 1.5	L	8.01E+02		3.51E+03	1.80E+03	N (b)	---
Mercury	5 / 10	0.0235 - 0.207	0.041 - 0.047	NP	4.58E-02		8.50E-02	2.30E+01	N (a)	---
Nickel	9 / 9	13.2 - 117	1.22 - 1.5	L	4.62E+01		5.51E+01	1.60E+03	N (a)	---
Potassium	10 / 10	524 - 3030	61.1 - 74.9	N	1.79E+03			Nutrient	N (c)	---
Selenium	1 / 9	0.851 - 0.851	1.22 - 1.5	NP	6.74E-01		2.00E+00	3.90E+02	N (a)	---
Silver	1 / 10	0.557 - 0.557	0.733 - 0.899	NP	4.06E-01		1.11E+01	3.90E+02	N (a)	---
Sodium	8 / 10	71.6 - 252	244 - 300	L	1.39E+02			Nutrient	N (c)	---
Vanadium	10 / 10	15.3 - 29.4	1.22 - 1.5	L	2.11E+01		4.09E+01	5.50E+02	N (a)	---
Zinc	10 / 10	18.4 - 201	3.67 - 4.49	L	7.83E+01		3.22E+02	2.30E+04	N (a)	---
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	6 / 10	0.0707 - 1.19	0.087 - 0.1	NP	2.75E-01			3.70E+00 h	N (a)	---
2-Amino-4,6-dinitrotoluene	5 / 10	0.063 - 2.92	0.087 - 0.1	NP	6.70E-01			3.70E+00 h	N (a)	---
2-Nitrotoluene	1 / 10	0.168 - 0.168	0.174 - 0.2	NP	1.01E-01			3.70E+02	N (a)	---
2,4,6-Trinitrotoluene	7 / 10	0.0635 - 4.6	0.087 - 0.1	L	8.47E-01			1.60E+01	N (a)	---
Dinitrotoluene, total	6 / 10	0.0455 - 0.576	0.087 - 0.1	NP	2.10E-01			7.20E-01	N (a)	---
PCBs										
Aroclor 1260	4 / 10	0.0204 - 0.731	0.0842 - 0.186	NP	1.23E-01	7.31E-01		2.20E-01	Y	7.31E-01
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2 / 10	0.116 - 0.147	0.421 - 0.504	NP	2.05E-01			7.20E-01 i	N (a)	---
2,6-Dinitrotoluene	3 / 10	0.0492 - 0.0844	0.421 - 0.504	NP	1.76E-01			7.20E-01 i	N (a)	---
Benzo(a)anthracene	1 / 10	0.286 - 0.286	0.421 - 0.504	L	2.32E-01			6.20E-01	N (a)	---
Benzo(a)pyrene	2 / 10	0.044 - 0.136	0.421 - 0.504	NP	1.98E-01	2.20E-01		6.20E-02	Y	1.36E-01
Benzo(b)fluoranthene	1 / 10	0.182 - 0.182	0.421 - 0.504	N	2.22E-01			6.20E-01	N (a)	---
Bis(2-ethylhexyl)phthalate	1 / 10	0.0216 - 0.0216	0.421 - 0.504	NP	2.06E-01			3.50E+01	N (a)	---
Chrysene	1 / 10	0.163 - 0.163	0.421 - 0.504	N	2.20E-01			6.20E+01	N (a)	---

Table 2-8

Statistical Summary and COPC Selection for Chemicals Detected in Sediment at On-Site Locations
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [a]	Background Screening Criterion [b]	Risk-Based Screening Criterion [c]	COPC? [d,e]	Source Term Concentration [f]
Fluoranthene	1 / 10	0.688 - 0.688	0.421 - 0.504	NP	2.72E-01			2.30E+03	N (a)	---
Phenanthrene	1 / 10	0.107 - 0.107	0.421 - 0.504	NP	2.14E-01			2.30E+03 h	N (a)	---
Pyrene	1 / 10	0.458 - 0.458	0.421 - 0.504	NP	2.49E-01			2.30E+03	N (a)	---
Volatile Organic Compounds										
Acetone	7 / 10	0.010745 - 0.0207	0.0126 - 0.0151	N	1.32E-02			1.60E+03	N (a)	---
Carbon disulfide	1 / 10	0.0102 - 0.0102	0.00631 - 0.00756	NP	4.05E-03			3.60E+02	N (a)	---
Methylene chloride	2 / 2	0.00373 - 0.00459	0.00677 - 0.00696	N	4.16E-03			8.90E+00	N (a)	---

[a] Method of estimation based on statistical distribution (please see Section 2.2.1).
[b] Please see Table 2-3 and Section 2.3.1.
[c] Please see Section 2.1.5.
[d] N = Chemical is not chosen as a COPC:
(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).
(b) = maximum detected concentration is less than the background screening concentration.
(c) = essential nutrient.
[e] Y = Chemical is chosen as COPC.
[f] 95% UCL or maximum detected concentration, whichever is lower, is chosen as the source term concentration.
[g] Based on PRG for total chromium.
[h] Calculated; reference Appendix B.
[i] Based on PRG for mixed dinitrotoluene.
COPC = Chemical of Potential Concern; UCL - Upper Confidence Limit.
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparametric; data are found to be neither normally nor lognormally distributed.
mg/kg - milligrams per kilogram
PCB - Polychlorinated biphenyl.

Table 2-9

Statistical Summary and COPC Selection for Chemicals Detected in Sediment at Off-Site Locations[a]
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]		COPC? [e,f]	Source Term Concentration [g]
Metals											
Aluminum	5 / 5	9750 - 11400	56.1 - 70.8	L	1.04E+04		1.55E+04	7.60E+04		N (a)	---
Arsenic	5 / 5	3.53 - 6.69	1.4 - 1.77	NP	5.41E+00		3.65E+01	3.90E-01		N (b)	---
Barium	5 / 5	60.5 - 70	1.4 - 1.77	L	6.49E+01		8.26E+02	5.40E+03		N (a)	---
Beryllium	5 / 5	0.525 - 0.732	0.281 - 0.354	N	6.29E-01		1.00E+00	1.50E+02		N (a)	---
Cadmium	5 / 5	0.228 - 0.673	0.842 - 1.06	N	4.49E-01			3.70E+01		N (a)	---
Calcium	5 / 5	5360 - 15800	140 - 177	N	1.04E+04			Nutrient		N (c)	---
Chromium	5 / 5	15.8 - 31.8	1.4 - 1.77	L	2.21E+01		2.90E+01	2.10E+02	h	N (a)	---
Cobalt	5 / 5	7.39 - 17.6	1.4 - 1.77	N	1.17E+01		1.16E+02	4.70E+03		N (a)	---
Copper	5 / 5	20.1 - 29.5	1.4 - 1.77	N	2.55E+01		5.62E+01	2.90E+03		N (a)	---
Iron	5 / 5	13400 - 21900	28.1 - 35.4	N	1.77E+04			Nutrient		N (c)	---
Lead	5 / 5	13.4 - 32.4	0.842 - 1.06	N	2.68E+01		4.86E+01	4.00E+02		N (a)	---
Magnesium	5 / 5	2680 - 4850	70.2 - 88.5	N	3.96E+03			Nutrient		N (c)	---
Manganese	5 / 5	144 - 331	1.4 - 1.77	N	2.41E+02		3.51E+03	1.80E+03		N (a)	---
Mercury	5 / 5	0.037 - 0.117	0.045 - 0.057	N	7.64E-02		8.50E-02	2.30E+01		N (a)	---
Nickel	5 / 5	21.1 - 49.9	1.4 - 1.77	N	3.49E+01		5.51E+01	1.60E+03		N (a)	---
Potassium	5 / 5	860 - 1400	70.2 - 88.5	N	1.19E+03			Nutrient		N (c)	---
Selenium	1 / 4	1.23 - 1.23	1.4 - 1.77	L	9.24E-01		2.00E+00	3.90E+02		N (a)	---
Sodium	3 / 5	132 - 174	281 - 354	N	1.62E+02			Nutrient		N (c)	---
Vanadium	5 / 5	19.7 - 20.6	1.4 - 1.77	N	2.03E+01		4.09E+01	5.50E+02		N (a)	---
Zinc	5 / 5	54.5 - 115	4.21 - 5.31	N	8.79E+01		3.22E+02	2.30E+04		N (a)	---
Nitroaromatics											
Nitrobenzene	5 / 5	0.0501 - 0.27	0.1 - 0.1	NP	1.03E-01			2.00E+01		N (a)	---
PCBs											
Aroclor 1260	4 / 5	0.0194 - 0.116	0.0936 - 0.123	L	5.70E-02			2.20E-01		N (a)	---
Semivolatile Organic Compounds											
Acenaphthene	1 / 5	0.109 - 0.109	0.468 - 0.615	N	2.40E-01			3.70E+03		N (a)	---
Acenaphthylene	1 / 5	0.298 - 0.298	0.468 - 0.615	N	2.78E-01			3.70E+03		N (a)	---
Anthracene	1 / 5	0.6 - 0.6	0.468 - 0.615	L	3.39E-01			2.20E+04		N (a)	---
Benzo(a)anthracene	3 / 5	0.0683 - 2.81	0.468 - 0.615	L	7.09E-01	1.36E+02		6.20E-01		Y	2.81E+00
Benzo(a)pyrene	4 / 5	0.0578 - 1.93	0.468 - 0.615	L	4.83E-01	8.11E+01		6.20E-02		Y	1.93E+00
Benzo(b)fluoranthene	2 / 5	0.104 - 2.34	0.468 - 0.615	L	6.61E-01	1.61E+01		6.20E-01		Y	2.34E+00
Benzo(ghi)perylene	1 / 5	0.861 - 0.861	0.468 - 0.615	NP	3.91E-01			2.30E+03	i	N (a)	---
Benzo(k)fluoranthene	1 / 5	1.11 - 1.11	0.468 - 0.615	NP	4.41E-01			6.20E+00		N (a)	---
Bis(2-ethylhexyl)phthalate	2 / 5	0.0354 - 0.0686	0.468 - 0.615	N	1.91E-01			3.50E+01		N (a)	---
Carbazole	1 / 5	0.0896 - 0.0896	0.468 - 0.615	N	2.37E-01			2.40E+01		N (a)	---
Chrysene	3 / 5	0.0664 - 2.92	0.468 - 0.615	L	7.28E-01			6.20E+01		N (a)	---
Dibenz(a,h)anthracene	1 / 5	0.327 - 0.327	0.468 - 0.615	N	2.84E-01	3.18E-01		6.20E-02		Y	3.18E-01
Fluoranthene	4 / 5	0.143 - 5.95	0.468 - 0.615	NP	1.34E+00			2.30E+03		N (a)	---
Fluorene	1 / 5	0.223 - 0.223	0.468 - 0.615	N	2.63E-01			2.60E+03		N (a)	---
Indeno(1,2,3-cd)pyrene	1 / 5	0.778 - 0.778	0.468 - 0.615	NP	3.74E-01	7.78E-01		6.20E-01		Y	7.78E-01

Table 2-9

Statistical Summary and COPC Selection for Chemicals Detected in Sediment at Off-Site Locations[a]
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration [g]
Phenanthrene	2 / 5	0.101 - 3.58	0.468 - 0.615	L	9.08E-01			2.30E+03 [i]	N (a)	---
Pyrene	3 / 5	0.119 - 4.74	0.468 - 0.615	L	1.11E+00			2.30E+03	N (a)	---
Volatile Organic Compounds										
Acetone	4 / 5	0.0168 - 0.0284	0.014 - 0.0184	N	2.18E-02			1.60E+03	N (a)	---
Carbon disulfide	2 / 5	0.00262 - 0.00458	0.00702 - 0.00922	N	3.80E-03			3.60E+02	N (a)	---

[a] Off-site sediment locations include sample # AA-1013, -1014, -1015, -1016, and -1017, (please see Table 2-1).
[b] Method of estimation based on statistical distribution (please see Section 2.2.1).
[c] Please see Table 2-3 and Section 2.3.1.
[d] Please see Section 2.1.5.
[e] N = Chemical is not chosen as a COPC:
(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).
(b) = maximum detected concentration is less than the background screening concentration.
(c) = essential nutrient.
[f] Y = Chemical is chosen as COPC.
[g] 95% UCL or maximum detected concentration, whichever is lower, is chosen as the source term concentration.
[h] Based on PRG for total chromium.
[i] Calculated; reference Appendix B.
COPC - Chemical of Potential Concern; UCL - Upper Confidence Limit.

mg/kg - milligrams per kilogram.
PCB - Polychlorinated biphenyl.

Table 2-10

Statistical Summary and COPC Selection of Chemicals Detected in Surface Water at On-Site Locations
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (µg/L)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [a]	Risk-Based Screening Criterion [b]	COPC? [c,d]	Source Term Concentration [e]
Metals									
Aluminum	8 / 8	72.6 - 2880	200 - 200	L	7.33E+02		3.60E+04	N (a)	---
Arsenic	1 / 8	3.75 - 3.75	5 - 5	NP	2.66E+00	3.75E+00	4.50E-02	Y	3.75E+00
Barium	8 / 8	22.5 - 53.9	5 - 5	NP	3.13E+01		2.60E+03	N (a)	---
Beryllium	5 / 8	0.134 - 0.3045	1 - 1	L	3.15E-01		7.30E+01	N (a)	---
Calcium	8 / 8	35950 - 168000	500 - 500	N	1.04E+05		Nutrient	N (b)	---
Chromium	2 / 4	4.37 - 9.845	5 - 5	L	4.80E+00		1.10E+01 [f]	N (a)	---
Cobalt	3 / 8	1.3 - 6.19	5 - 5	L	2.92E+00		2.20E+03	N (a)	---
Copper	8 / 8	1.62 - 6.28	5 - 5	L	3.62E+00		1.40E+03	N (a)	---
Iron	6 / 6	190 - 9850	100 - 100	L	2.45E+03		Nutrient	N (b)	---
Lead	6 / 8	1.51 - 5.49	3 - 3	NP	2.49E+00		1.50E+01 [g]	N (a)	---
Magnesium	8 / 8	9100 - 44400	250 - 250	N	2.60E+04		Nutrient	N (b)	---
Manganese	8 / 8	24.9 - 1030	5 - 5	L	2.26E+02	1.62E+03	8.80E+02	Y	1.03E+03
Nickel	1 / 6	15 - 15	5 - 5	NP	4.58E+00		7.30E+02	N (a)	---
Potassium	8 / 8	1830 - 5550	250 - 250	L	2.85E+03		Nutrient	N (b)	---
Selenium	1 / 8	2.63 - 2.63	5 - 5	NP	2.52E+00		1.80E+02	N (a)	---
Silver	3 / 8	0.779 - 0.941	3 - 3	NP	1.25E+00		1.80E+02	N (a)	---
Sodium	8 / 8	7710 - 54300	1000 - 1000	L	1.72E+04		Nutrient	N (b)	---
Vanadium	5 / 8	0.935 - 6.23	5 - 5	L	2.51E+00		2.60E+02	N (a)	---
Zinc	7 / 8	5.03 - 61.7	15 - 15	L	1.95E+01		1.10E+04	N (a)	---
Nitroaromatics									
2-Amino-4,6-dinitrotoluene	1 / 8	1.96 - 1.96	0.26 - 0.26	NP	3.59E-01		2.20E+00 [h]	N (a)	---
4-Amino-2,6-dinitrotoluene	2 / 8	0.165 - 2.34	0.26 - 0.26	NP	4.11E-01	2.34E+00	2.20E+00 [h]	Y	2.34E+00
Semivolatile Organics									
Di-n-butyl phthalate	2 / 8	1.17 - 1.735	10.05 - 11.5	NP	4.46E+00		3.60E+03	N (a)	---
Volatile Organics									
Carbon disulfide	8 / 8	1.04 - 11.5	1 - 1	L	4.64E+00		6.10E+02	N (a)	---
Acetone	1 / 1	2.95 - 2.95	5 - 5		2.95E+00		1.00E+03	N (a)	---

COPC - Chemical of Potential Concern; UCL - Upper Confidence Limit.

L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparametric; data are found to be neither normally nor lognormally di

µg/L - micrograms per Liter.

[a] Method of estimation based on statistical distribution (please see Section 2.2.1).

[b] Please see Section 2.1.5.

[c] N = Chemical is not chosen as a COPC:

(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).

(b) = essential nutrient.

[d] Y = Chemical is chosen as COPC.

[e] 95% UCL or maximum detected concentration, whichever is lower, is chosen as the source term concentration.

[f] RBSC based on the PRG for chromium VI.

[g] EPA, 1996, ***Drinking Water Regulations and Health Advisories***, Office of Water, Washington, DC, October.

[h] Calculated; reference Appendix B.

Table 2-11

Statistical Summary and COPC Selection of Chemicals Detected in a Single Surface Water[a] Sample
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (ug/L)	Detection Frequency	Detected Concentration	Reporting Limit	Arithmetic Mean	Risk-Based Screening Concentration [b]		COPC? [c,d]	Source Term Concentration [e]
Nitroaromatics								
2-Amino-4,6-dinitrotoluene	1 / 1	64.7	0.65	64.7	2.20E+00	f	Y	6.47E+01
4-Amino-2,6-dinitrotoluene	1 / 1	58.6	0.65	58.6	2.20E+00	f	Y	5.86E+01
1,3,5-Trinitrobenzene	1 / 1	466	325	466	1.10E+03		N (a)	--
2,4,6-Trinitrotoluene	1 / 1	11000	325	11000	2.20E+00		Y	1.10E+04

COPC - Chemical of Potential Concern

µg/L - micrograms per liter

[a] Surface water based on sample location TNTA-SO080, sample number AA2018.

[c] Please see Section 2.1.5.

[c] N = Chemical is not chosen as a COPC:

(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).

[d] Y = Chemical is chosen as COPC.

[e] The source term conncentration is equal to the maximum detected concentration.

[f] Calculated; reference Appendix B.

Table 2-12

Statistical Summary and COPC Selection of Chemicals Detected in a Single Off-Site Surface Water[a] Sample
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (µg/L)	Frequency of Detection	Detected Concentration	Reporting Limit	Arithmetic Mean	Risk-Based Screening Concentration [b]		COPC? [c,d]	Source Term Concentration [e]
Metals								
Aluminum	1 / 1	892	200	8.92E+02	3.60E+04		N (a)	---
Barium	1 / 1	42.4	5	4.24E+01	2.60E+03		N (a)	---
Beryllium	1 / 1	0.123	1	1.23E-01	7.30E+01		N (a)	---
Calcium	1 / 1	64600	500	6.46E+04	Nutrient		N (b)	---
Chromium	1 / 1	2.72	5	2.72E+00	1.10E+01	f	N (a)	---
Cobalt	1 / 1	1.57	5	1.57E+00	2.20E+03		N (a)	---
Copper	1 / 1	8.93	5	8.93E+00	1.40E+03		N (a)	---
Iron	1 / 1	1330	100	1.33E+03	Nutrient		N (b)	---
Magnesium	1 / 1	20600	250	2.06E+04	Nutrient		N (b)	---
Manganese	1 / 1	57.7	5	5.77E+01	8.80E+02		N (a)	---
Nickel	1 / 1	6.76	5	6.76E+00	7.30E+02		N (a)	---
Potassium	1 / 1	3720	250	3.72E+03	Nutrient		N (b)	---
Sodium	1 / 1	22700	1000	2.27E+04	Nutrient		N (b)	---
Vanadium	1 / 1	3.31	5	3.31E+00	2.60E+02		N (a)	---
Zinc	1 / 1	13.3	15	1.33E+01	1.10E+04		N (a)	---
Volatile Organics								
Acetone	1 / 1	13.3	5	1.33E+01	1.00E+03		N (a)	---

[a] Surface water based on sample location TNTA-SW14, sample number AA2016.

[b] Please see Section 2.1.5.

[c] N = Chemical is not chosen as a COPC:

(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).

(b) = essential nutrient.

[d] Y = Chemical is chosen as COPC.

[e] The source term concentration is equal to the maximum detected concentration.

[f] RBSC based on the PRG for chromium VI.

Table 2-13

Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil [a]
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]		COPC? [e,f]	Source Term Concentration [g]
Metals											
Aluminum	14 / 14	2210 - 7340	42.7 - 83.1	N	4.79E+03		1.55E+04	7.60E+03		N (a)	---
Antimony	5 / 13	0.68 - 4.496	1.28 - 2.49	NP	1.07E+00		9.30E+00	3.10E+00		N (b)	---
Arsenic	11 / 11	2.14 - 10.5	1.07 - 2.07	N	6.03E+00		3.65E+01	3.90E-02		N (b)	---
Barium	14 / 14	14.1 - 251	1.07 - 2.07	L	6.39E+01		8.26E+02	5.40E+02		N (a)	---
Beryllium	14 / 14	0.175 - 0.823	0.214 - 0.4145	L	3.90E-01		1.00E+00	1.50E+01		N (a)	---
Cadmium	12 / 13	0.2355 - 2.19	0.641 - 1.241	L	6.42E-01			3.70E+00		N (a)	---
Calcium	14 / 14	2590 - 55100	107 - 207	L	2.34E+04			Nutrient		N (c)	---
Chromium	14 / 14	3.77 - 24.55	1.07 - 2.07	L	1.09E+01		2.90E+01	2.10E+01	h	N (b)	---
Cobalt	14 / 14	1.685 - 7.495	1.07 - 2.07	L	3.97E+00		1.16E+02	4.70E+02		N (a)	---
Copper	14 / 14	3.73 - 99.8	1.07 - 2.07	L	2.60E+01		5.62E+01	2.90E+02		N (a)	---
Iron	14 / 14	6570 - 32150	21.4 - 41.45	L	1.56E+04			Nutrient		N (c)	---
Lead	14 / 14	8.07 - 934	0.641 - 1.241	L	2.76E+02	1.86E+03	4.86E+01	4.00E+02		Y	9.34E+02
Magnesium	14 / 14	1170 - 11300	53.4 - 103.35	L	4.11E+03			Nutrient		N (c)	---
Manganese	14 / 14	63.7 - 3800	1.07 - 2.07	L	6.59E+02		3.51E+03	1.80E+02		N (d)	---
Mercury	12 / 13	0.021 - 0.39	0.033 - 0.043	L	1.17E-01		8.50E-02	2.30E+00		N (a)	---
Nickel	14 / 14	4.43 - 22.1	1.07 - 2.07	N	1.34E+01		5.51E+01	1.60E+02		N (a)	---
Potassium	14 / 14	339 - 1140	53.4 - 103.35	N	6.93E+02			Nutrient		N (c)	---
Silver	2 / 14	0.455 - 0.677	0.641 - 1.241	NP	3.81E-01		1.11E+01	3.90E+01		N (a)	---
Sodium	11 / 11	170 - 403	214 - 414.5	L	2.31E+02			Nutrient		N (c)	---
Vanadium	14 / 14	7.185 - 28.8	1.07 - 2.07	L	1.52E+01		4.09E+01	5.50E+01		N (a)	---
Zinc	14 / 14	19.2 - 708	3.21 - 6.215	L	1.80E+02		3.22E+02	2.30E+03		N (a)	---
Nitroaromatics											
2-Amino-4,6-dinitrotoluene	12 / 14	0.07115 - 38	0.08 - 1	L	7.10E+00	4.55E+02		3.70E-01	i	Y	3.80E+01
4-Amino-2,6-dinitrotoluene	12 / 14	0.08755 - 14.6	0.08 - 0.1	NP	4.66E+00	1.13E+01		3.70E-01	i	Y	1.13E+01
1,3-Dinitrobenzene	5 / 14	0.0778 - 0.751	0.08 - 0.1	NP	1.41E-01	7.51E-01		6.10E-01		Y	7.51E-01
3-Nitrotoluene	2 / 14	0.3195 - 1.71	0.16 - 0.2	NP	2.27E-01			3.70E+01		N (a)	---
1,3,5-Trinitrobenzene	8 / 14	0.153 - 7.79	0.08 - 0.1	NP	1.16E+00			1.80E+02		N (a)	---
2,4,6-Trinitrotoluene	14 / 14	0.1975 - 41261	0.08 - 95.2	L	3.50E+03	3.43E+08		1.60E+00		Y	4.13E+04
Dinitrotoluene, total	9 / 14	0.288 - 16.7	0.08 - 0.1	L	2.54E+00			7.20E-02		N (e)	---
Nitrobenzene	2 / 14	0.1765 - 0.309	0.08 - 0.1	NP	7.62E-02			2.00E+00		N (a)	---
PCBs											
Aroclor 1260	13 / 14	0.0366 - 4.875	0.0741 - 0.8375	L	9.01E-01	6.08E+00		2.20E-02		Y	4.88E+00
Semivolatile Organic Compounds											
2,4-Dinitrotoluene	10 / 14	0.06 - 9.845	0.368 - 4.37	L	1.80E+00	1.12E+01		7.20E-02	j	Y	9.85E+00
2,6-Dinitrotoluene	5 / 14	0.06155 - 10.7	0.368 - 4.37	L	1.84E+00	9.52E+00		7.20E-02	j	Y	9.52E+00
Acenaphthylene	1 / 14	0.545 - 0.545	0.368 - 4.37	NP	8.77E-01			3.70E+02	i	N (a)	---
Anthracene	2 / 14	0.351 - 1.34	0.368 - 4.37	NP	8.03E-01			2.20E+03		N (a)	---
Benzo(a)anthracene	7 / 14	0.0498 - 6.94	0.368 - 4.37	L	1.32E+00	9.45E+00		6.20E-02		Y	6.94E+00
Benzo(a)pyrene	7 / 14	0.0449 - 6.33	0.368 - 4.37	L	1.28E+00	9.17E+00		6.20E-03		Y	6.33E+00
Benzo(b)fluoranthene	7 / 14	0.0826 - 9.05	0.368 - 4.37	L	1.59E+00	8.43E+00		6.20E-02		Y	8.43E+00
Benzo(ghi)perylene	3 / 14	0.222 - 2.78	0.368 - 4.37	NP	1.01E+00			2.30E+02		N (a)	---
Benzo(k)fluoranthene	3 / 14	0.178 - 3.02	0.368 - 4.37	NP	1.01E+00	2.05E+00		6.20E-01		Y	2.05E+00

Table 2-13

Statistical Summary and COPC Selection of Chemicals Detected in Surface Soil [a]
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration [g]
Bis(2-ethylhexyl)phthalate	5 / 14	0.0302 - 0.0493	0.368 - 4.37	NP	8.12E-01			3.50E+00	N (a)	---
Chrysene	6 / 14	0.0656 - 6.28	0.368 - 4.37	L	1.25E+00	5.85E+00		6.20E+00	Y	5.85E+00
Dibenz(a,h)anthracene	3 / 14	0.0817 - 1.03	0.368 - 4.37	NP	7.89E-01	2.04E+00		6.20E-03	Y	1.03E+00
Di-n-butyl phthalate	1 / 14	0.0494 - 0.0494	0.368 - 4.37	NP	8.58E-01			6.10E+02	N (a)	---
Fluoranthene	7 / 14	0.086 - 12.9	0.368 - 4.37	L	1.94E+00			2.30E+02	N (a)	---
Indeno(1,2,3-cd)pyrene	3 / 14	0.21 - 2.91	0.368 - 4.37	NP	1.02E+00	2.05E+00		6.20E-02	Y	2.05E+00
Phenanthrene	4 / 14	0.0543 - 4.13	0.368 - 4.37	L	9.57E-01			2.30E+02	N (a)	---
Pyrene	6 / 14	0.0873 - 10.1	0.368 - 4.37	L	1.69E+00			2.30E+02	N (a)	---
Volatile Organic Compounds										
2-Butanone	2 / 14	0.0104 - 0.06165	0.00976 - 0.0135	NP	9.90E-03			7.30E+02	N (a)	---
Acetone	14 / 14	0.03585 - 0.456	0.00976 - 0.0135	L	1.30E-01			1.60E+02	N (a)	---
Benzene	4 / 14	0.00162 - 0.00601	0.00488 - 0.00674	L	2.82E-03			6.50E-02	N (a)	---
Carbon disulfide	5 / 14	0.003028 - 0.01	0.00488 - 0.00674	NP	4.07E-03			3.60E+01	N (a)	---
Ethylbenzene	2 / 14	0.00156 - 0.00207	0.00488 - 0.00674	N	2.67E-03			1.50E+02	N (a)	---
Methylene chloride	2 / 2	0.0211 - 0.0355	0.00495 - 0.00581	L	2.83E-02			8.90E-01	N (a)	---
Styrene	1 / 14	0.00197 - 0.00197	0.00488 - 0.00674	N	2.76E-03			4.60E+02	N (a)	---
Toluene	7 / 14	0.00184 - 0.0264	0.00488 - 0.00674	NP	5.34E-03			5.90E+01	N (a)	---
Xylene, o-	2 / 14	0.00246 - 0.00307	0.00488 - 0.00674	L	2.81E-03			1.40E+02	N (a)	---
Xylenes, m,p-	1 / 14	0.0075 - 0.0075	0.00488 - 0.00674	NP	3.15E-03			1.40E+02	N (a)	---

COPC - Chemical of Potential Concern; UCL - Upper Confidence Limit
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparametric; data are found to be neither normally nor lognormally distributed.
mg/kg - milligrams per kilogram

[a] Surface soil is defined by samples taken from 0 to 2 feet below ground surface.
[b] Method of estimation based on statistical distribution (please see Section 2.2.1).
[c] Please see Table 2-3.
[d] Please see Section 2.1.5.
[e] N = Chemical is not chosen as a COPC:
(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).
(b) = maximum detected concentration is less than the background screening concentration.
(c) = essential nutrient.
(d) = Mann-Whitney U test demonstrated site data set is equivalent to background data set (please see Appendix A).
(e) = please see Section 2.3.1.
[f] Y = Chemical is chosen as COPC.
[g] 95% UCL or maximum detected concentration, whichever is lower, is chosen as the source term concentration.
[h] Based on PRG for total chromium.
[i] Calculated; reference Appendix B.
[j] Based on PRG for mixed dinitrotoluene.

Table 2-14

Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil[a]
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]		COPC? [e,f]	Source Term Concentration [g]
Metals											
Aluminum	26 / 26	1420 - 11200	40.5 - 50.2	L	5.40E+03		1.55E+04	7.60E+03		N (b)	---
Antimony	5 / 23	0.757 - 1.15	1.22 - 1.51	NP	7.21E-01		9.30E+00	3.10E+00		N (a)	---
Arsenic	24 / 24	1.77 - 18.5	1.01 - 1.21	L	5.45E+00		3.65E+01	3.90E-02		N (b)	---
Barium	26 / 26	14.6 - 427	1.01 - 1.25	NP	6.95E+01		8.26E+02	5.40E+02		N (a)	---
Beryllium	26 / 26	0.154 - 0.721	0.203 - 0.251	L	3.81E-01		1.00E+00	1.50E+01		N (a)	---
Cadmium	11 / 26	0.136 - 0.913	0.608 - 0.753	NP	3.45E-01			3.70E+00		N (a)	---
Calcium	26 / 26	1410 - 252000	101 - 2740	L	4.93E+04			Nutrient		N (c)	---
Chromium	26 / 26	3.71 - 202	1.01 - 1.25	NP	1.67E+01	2.02E+02	2.90E+01	2.10E+01	h	Y	2.02E+02
Cobalt	26 / 26	0.297 - 12.1	1.01 - 1.25	L	4.63E+00		1.16E+02	4.70E+02		N (a)	---
Copper	23 / 23	1.36 - 35.9	1.07 - 1.25	L	1.50E+01		5.62E+01	2.90E+02		N (a)	---
Iron	26 / 26	4010 - 32600	20.3 - 25.1	L	1.42E+04			Nutrient		N (c)	---
Lead	24 / 24	4.05 - 761	0.608 - 0.753	L	8.90E+01	2.15E+02	4.86E+01	4.00E+02		Y	2.15E+02
Magnesium	26 / 26	422 - 18700	50.7 - 62.7	L	4.37E+03			Nutrient		N (c)	---
Manganese	26 / 26	33.7 - 2120	1.01 - 1.25	L	5.30E+02		3.51E+03	1.80E+02		N (b)	---
Mercury	14 / 24	0.019 - 0.113	0.031 - 0.04	NP	3.44E-02		8.50E-02	2.30E+00		N (a)	---
Nickel	26 / 26	3.29 - 90.8	1.01 - 1.25	L	1.73E+01		5.51E+01	1.60E+02		N (a)	---
Potassium	26 / 26	242 - 2830	50.7 - 62.7	L	1.08E+03			Nutrient		N (c)	---
Silver	2 / 26	0.421 - 0.497	0.608 - 0.753	NP	3.49E-01		1.11E+01	3.90E+01		N (a)	---
Sodium	12 / 12	110 - 387	203 - 251	L	2.38E+02			Nutrient		N (c)	---
Vanadium	26 / 26	5.87 - 24.6	1.01 - 1.25	L	1.31E+01		4.09E+01	5.50E+01		N (a)	---
Zinc	26 / 26	5.8 - 193	3.04 - 3.76	L	6.20E+01		3.22E+02	2.30E+03		N (a)	---
Nitroaromatics											
2-Amino-4,6-dinitrotoluene	17 / 26	0.136 - 11.9	0.087 - 0.1	NP	2.15E+00	5.22E+00		3.70E-01	i	Y	5.22E+00
4-Amino-2,6-dinitrotoluene	16 / 26	0.151 - 7.28	0.087 - 0.1	NP	1.03E+00	5.18E+00		3.70E-01	i	Y	5.18E+00
1,3-Dinitrobenzene	1 / 26	0.127 - 0.127	0.087 - 0.1	NP	5.15E-02			6.10E-01		N (a)	---
2-Nitrotoluene	9 / 26	0.27 - 50.8	0.174 - 19	NP	2.70E+00	5.08E+01		3.70E+01		Y	5.08E+01
3-Nitrotoluene	11 / 26	0.263 - 8.61	0.174 - 0.2	NP	7.55E-01			3.70E+01		N (a)	---
4-Nitrotoluene	8 / 26	0.29 - 67.4	0.174 - 19	NP	3.23E+00	6.74E+01		3.70E+01		Y	6.74E+01
1,3,5-Trinitrobenzene	12 / 26	0.0616 - 7.93	0.087 - 0.1	NP	7.97E-01			1.80E+02		N (a)	---
2,4,6-Trinitrotoluene	24 / 26	0.06215 - 2588	0.087 - 20	L	2.77E+02	2.31E+05		1.60E+00		Y	2.59E+03
Dinitrotoluene, total	17 / 26	0.121 - 297	0.087 - 10	NP	3.14E+01	2.78E+02		7.20E-02		N (d)	---
Nitrobenzene	4 / 26	0.0963 - 0.212	0.087 - 0.1	NP	6.40E-02			2.00E+00		N (a)	---
Tetryl	1 / 26	0.626 - 0.626	0.174 - 0.2	NP	1.17E-01			6.10E+01		N (a)	---
PCBs											
Aroclor 1254	3 / 26	0.176 - 0.969	0.0361 - 0.201	NP	7.75E-02	7.45E-01		2.20E-02		Y	7.45E-01
Aroclor 1260	21 / 26	0.00951 - 2.09	0.0723 - 0.402	L	2.74E-01	5.57E-01		2.20E-02		Y	5.57E-01
Semivolatile Organic Compounds											
2,4-Dinitrotoluene	17 / 26	0.0493 - 275	0.372 - 30.7	NP	2.12E+01	2.75E+02		7.20E-02	j	Y	2.75E+02
2,6-Dinitrotoluene	11 / 26	0.0977 - 65.5	0.372 - 30.7	NP	4.95E+00	1.94E+01		7.20E-02	j	Y	1.94E+01
2-Methylnaphthalene	1 / 26	0.0381 - 0.0381	0.372 - 7.96	NP	8.32E-01			1.20E+02	i	N (a)	---
Anthracene	3 / 26	0.113 - 4.14	0.372 - 7.96	NP	9.20E-01			2.20E+03		N (a)	---
Benzo(a)anthracene	6 / 26	0.0384 - 11.1	0.372 - 7.96	NP	1.18E+00	3.90E+00		6.20E-02		Y	3.90E+00
Benzo(a)pyrene	6 / 26	0.0361 - 8.2	0.372 - 7.96	L	1.06E+00	2.76E+00		6.20E-03		Y	2.76E+00
Benzo(b)fluoranthene	3 / 26	0.116 - 10.2	0.372 - 7.96	NP	1.17E+00	3.90E+00		6.20E-02		Y	3.90E+00
Benzo(ghi)perylene	2 / 26	0.352 - 3.4	0.372 - 7.96	NP	9.02E-01			2.30E+02	i	N (a)	---

Table 2-14

Statistical Summary and COPC Selection of Chemicals Detected in Subsurface Soil[a]
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [b]	Background Screening Criterion [c]	Risk-Based Screening Criterion [d]	COPC? [e,f]	Source Term Concentration [g]
Benzo(k)fluoranthene	2 / 26	0.155 - 4.38	0.372 - 7.96	NP	9.32E-01	1.95E+00		6.20E-01	Y	1.95E+00
Bis(2-ethylhexyl)phthalate	8 / 26	0.0207 - 0.202	0.372 - 7.96	L	7.95E-01			3.50E+00	N (a)	---
Carbazole	1 / 26	0.109 - 0.109	0.372 - 7.96	NP	8.35E-01			2.40E+00	N (a)	---
Chrysene	4 / 26	0.0535 - 8.74	0.372 - 7.96	NP	1.10E+00	3.89E+00		6.20E+00	Y	3.89E+00
Dibenz(a,h)anthracene	2 / 26	0.123 - 1.4	0.372 - 7.96	NP	8.16E-01	1.86E+00		6.20E-03	Y	1.40E+00
Di-n-butyl phthalate	1 / 26	0.169 - 0.169	0.372 - 7.96	NP	8.37E-01			6.10E+02	N (a)	---
Fluoranthene	3 / 26	0.469 - 20.3	0.372 - 7.96	NP	1.57E+00			2.30E+02	N (a)	---
Indeno(1,2,3-cd)pyrene	2 / 26	0.27 - 3.64	0.372 - 7.96	NP	9.08E-01	1.95E+00		6.20E-02	Y	1.95E+00
Phenanthrene	3 / 26	0.227 - 5.21	0.372 - 7.96	NP	9.81E-01			2.30E+02 [i]	N (a)	---
Pyrene	3 / 26	0.248 - 17.1	0.372 - 7.96	NP	1.44E+00			2.30E+02	N (a)	---
Volatile Organic Compounds										
2-Butanone	2 / 25	0.00545 - 0.0165	0.00896 - 0.0131	NP	5.82E-03			7.30E+02	N (a)	---
Acetone	16 / 18	0.0081 - 0.151	0.00896 - 0.0131	L	4.47E-02			1.60E+02	N (a)	---
Benzene	7 / 26	0.00185 - 0.00492	0.00448 - 0.00653	NP	2.77E-03			6.50E-02	N (a)	---
Carbon disulfide	14 / 26	0.00175 - 0.0272	0.00448 - 0.00653	NP	4.55E-03			3.60E+01	N (a)	---
Ethylbenzene	2 / 26	0.00119 - 0.00248	0.00448 - 0.00653	NP	2.64E-03			1.50E+02	N (a)	---
Methylene chloride	2 / 4	0.0104 - 0.0514	0.00484 - 0.00517	L	1.67E-02			8.90E-01	N (a)	---
Toluene	11 / 26	0.00194 - 0.0781	0.00448 - 0.00653	NP	7.01E-03			5.90E+01	N (a)	---
Xylene, o-	3 / 26	0.00166 - 0.00323	0.00448 - 0.00653	N	2.64E-03			1.40E+02	N (a)	---
Xylenes, m,p-	4 / 26	0.00114 - 0.00605	0.00448 - 0.00653	NP	2.89E-03			1.40E+02	N (a)	---

COPC - Chemical of Potential Concern
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparametric; data are found to be of neither normal or lognormal distribution.
UCL - Upper Confidence Limit
mg/kg - milligrams per kilogram

[a] Subsurface soil is defined by samples taken from 1.3 to 10 feet below ground surface.
[b] Method of estimation based on statistical distribution (please see Section 2.2.1).
[c] Please see Table 2-3.
[d] Please see Section 2.1.5.
[e] N = Chemical is not chosen as a COPC:
(a) = maximum detection is less than the Risk Based Screening Concentration (RBSC).
(b) = maximum detection is less than the background screening concentration.
(c) = essential nutrient.
(d) = please see section 2.3.
[f] Y = Chemical is chosen as COPC.
[g] 95% UCL or maximum detected concentration, whichever is lower, is chosen as the source term concentration.
[h] Based on PRG for total chromium.
[i] Calculated; reference Appendix B.
[j] Based on PRG for mixed dinitrotoluene.

Table 2-15

Screening of VOCs from Subsurface Soil in Indoor Air
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Chemical Concentration In Soil (mg/kg)	VOC Concentration In Soil Gas C_{source} (g/cm^3)	Effective Diffusion Coefficient D^{eff} (cm^2/sec)	Attenuation Coefficient α (unitless)	VOC Concentration in Indoor Air In the Building (mg/m^3)	Risk-Based Screening Criterion [a] (mg/m^3)	COPC?
Volatile Organic Compounds							
2-Butanone	1.65E-02	1.11E-10	6.36E-03	4.51E-06	4.99E-07	1.00E-01	No
Acetone	1.51E-01	2.32E-09	9.74E-03	6.91E-06	1.60E-05	3.70E-02	No
Benzene	4.92E-03	2.26E-09	6.86E-03	4.87E-06	1.10E-05	2.50E-04	No
Carbon disulfide	2.72E-02	5.56E-08	8.11E-03	5.75E-06	3.20E-04	7.30E-02	No
Ethylbenzene	2.48E-03	3.43E-10	5.85E-03	4.15E-06	1.42E-06	1.10E-01	No
Methylene chloride	5.14E-02	2.46E-08	7.88E-03	5.59E-06	1.38E-04	4.10E-03	No
Toluene	7.81E-02	1.71E-08	6.79E-03	4.81E-06	8.22E-05	4.00E-02	No
Xylene, o-	3.23E-03	3.74E-10	5.46E-03	3.87E-06	1.45E-06	7.30E-02	No
Xylenes, m,p-	6.05E-03	7.00E-10	5.46E-03	3.87E-06	2.71E-06	7.30E-02	No

[a] Please see Section 2.1.5.
cm^2/sec = Square centimeters per second.
COPC = chemical of potential concern
g/cm^3 = Grams per cubic centimeter.
mg/kg = Milligrams per kilogram.
mg/m^3 = Milligrams per cubic meter.
VOC = volatile organic compounds

Table 2-16

COPC Selection for Total Soil[a]
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	STC Surface Soil [b]	STC Subsurface Soil [c]	Source Term Concentration
Metals			
Chromium	--	2.02E+02	2.02E+02
Lead	9.34E+02	2.15E+02	9.34E+02
Nitroaromatics			
2-Amino-4,6-dinitrotoluene	3.80E+01	5.22E+00	3.80E+01
4-Amino-2,6-dinitrotoluene	1.13E+01	5.18E+00	1.13E+01
1,3-Dinitrobenzene	7.51E-01	--	7.51E-01
2-Nitrotoluene	--	5.08E+01	5.08E+01
4-Nitrotoluene	--	6.74E+01	6.74E+01
2,4,6-Trinitrotoluene	4.13E+04	2.59E+03	4.13E+04
PCBs			
Aroclor 1254	--	7.45E-01	7.45E-01
Aroclor 1260	4.88E+00	5.57E-01	4.88E+00
Semivolatile Organic Compounds			
2,4-Dinitrotoluene	9.85E+00	2.75E+02	2.75E+02
2,6-Dinitrotoluene	9.52E+00	1.94E+01	1.94E+01
Benzo(a)anthracene	6.94E+00	3.90E+00	6.94E+00
Benzo(a)pyrene	6.33E+00	2.76E+00	6.33E+00
Benzo(b)fluoranthene	8.43E+00	3.90E+00	8.43E+00
Benzo(k)fluoranthene	2.05E+00	1.95E+00	2.05E+00
Chrysene	5.85E+00	3.89E+00	5.85E+00
Dibenz(a,h)anthracene	1.03E+00	1.40E+00	1.40E+00
Indeno(1,2,3-cd)pyrene	2.05E+00	1.95E+00	2.05E+00

COPC = Chemical of potential concern
STC = Source term concentration
mg/kg = Milligram per killogram
-- = Chemical was either not selected as a COPC, or not detected.

[a] Total soil is defined in Section 2.1.1 of the text.
[b] Please see Table 2-13.
[c] Please see Table 2-14.

Table 2-17

Statistical Summary and COPC Selection of Chemicals Detected in Sediment
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [a]	Background Screening Criterion [b]	Risk-Based Screening Criterion [c]		COPC? [d,e]	Source Term Concentration [f]
Metals											
Aluminum	15 / 15	1200 - 15600	44.5 - 66.9	L	6.52E+03		1.55E+04	7.60E+04		N (a)	---
Arsenic	13 / 15	1.14 - 25.3	1.11 - 1.66	L	8.22E+00		3.65E+01	3.90E-01		N (b)	---
Barium	15 / 15	15.3 - 324	1.11 - 1.66	L	7.20E+01		8.26E+02	5.40E+03		N (a)	---
Beryllium	14 / 15	0.101 - 0.8475	0.222 - 0.33	N	4.40E-01		1.00E+00	1.50E+02		N (a)	---
Cadmium	8 / 8	0.673 - 1.24	0.694 - 1	L	8.27E-01			3.70E+01		N (a)	---
Calcium	15 / 15	1320 - 182000	111 - 326.78	L	2.75E+04			Nutrient		N (c)	---
Chromium	15 / 15	4.05 - 22.35	1.11 - 1.66	N	1.17E+01		2.90E+01	2.10E+02	g	N (a)	---
Cobalt	15 / 15	0.871 - 18.4	1.11 - 1.66	N	7.97E+00		1.16E+02	4.70E+03		N (a)	---
Copper	9 / 9	12 - 38.8	1.16 - 1.62	N	2.49E+01		5.62E+01	2.90E+03		N (a)	---
Iron	15 / 15	5320 - 64600	22.2 - 33.19	L	2.26E+04			Nutrient		N (c)	---
Lead	15 / 15	2.83 - 86.3	0.667 - 1	L	2.62E+01		4.86E+01	4.00E+02		N (a)	---
Magnesium	15 / 15	297 - 8230	55.6 - 82.97	L	2.70E+03			Nutrient		N (c)	---
Manganese	15 / 15	37.3 - 1230	1.11 - 1.66	N	5.01E+02		3.51E+03	1.80E+03		N (a)	---
Mercury	10 / 15	0.0215 - 0.156	0.029 - 0.055	NP	4.48E-02		8.50E-02	2.30E+01		N (a)	---
Nickel	11 / 11	11.5 - 47.3	1.16 - 1.66	L	2.80E+01		5.51E+01	1.60E+03		N (a)	---
Potassium	15 / 15	155 - 3310	55.6 - 82.97	L	1.51E+03			Nutrient		N (c)	---
Selenium	11 / 15	0.904 - 2.47	1.11 - 1.66	L	1.32E+00		2.00E+00	3.90E+02		N (a)	---
Sodium	10 / 10	180 - 272	222 - 267	NP	2.06E+02			Nutrient		N (c)	---
Vanadium	15 / 15	6.93 - 31.15	1.11 - 1.66	N	1.77E+01		4.09E+01	5.50E+02		N (a)	---
Zinc	15 / 15	11.1 - 131	3.34 - 4.98	L	5.49E+01		3.22E+02	2.30E+04		N (a)	---
Nitroaromatics											
4-Amino-2,6-dinitrotoluene	4 / 15	0.126 - 11.2	0.083 - 0.1	NP	9.97E-01	1.12E+01		3.70E+00	h	Y	1.12E+01
2-Amino-4,6-dinitrotoluene	4 / 15	0.214 - 12.8	0.083 - 0.1	NP	1.14E+00	1.28E+01		3.70E+00	h	Y	1.28E+01
1,3,5-Trinitrobenzene	1 / 15	0.832 - 0.832	0.083 - 0.1	NP	1.00E-01			1.80E+03		N (a)	---
2,4,6-Trinitrotoluene	8 / 15	0.0715 - 1496	0.083 - 0.1	NP	1.00E+02	1.50E+03		1.60E+00		Y	1.50E+03
Dinitrotoluene, total	7 / 15	0.102 - 0.414	0.083 - 0.1	NP	1.23E-01	3.96E-01		7.20E-02		N (d)	---
Nitrobenzene	1 / 15	0.051 - 0.051	0.083 - 0.1	NP	4.85E-02			2.00E+01		N (a)	---
RDX	1 / 15	0.521 - 0.521	0.167 - 0.2	NP	1.25E-01			4.40E+00		N (a)	---
PCBs											
Aroclor 1260	8 / 15	0.0292 - 0.769	0.077 - 0.5532	NP	1.88E-01	7.68E-01		2.20E-01		Y	7.68E-01
Semivolatile Organic Compounds											
2,4-Dinitrotoluene	3 / 15	0.08835 - 0.276	0.385 - 0.5683	NP	2.19E-01	2.34E-01		7.20E-02	i	Y	2.34E-01
2,6-Dinitrotoluene	1 / 15	0.183 - 0.183	0.385 - 0.5683	L	2.25E-01	2.38E-01		7.20E-02	i	Y	1.83E-01
Benzo(a)anthracene	2 / 15	0.0693 - 0.0947	0.385 - 0.5683	NP	2.05E-01			6.20E-01		N (a)	---
Benzo(a)pyrene	3 / 15	0.0324 - 0.0699	0.385 - 0.5683	NP	1.92E-01	2.12E-01		6.20E-02		Y	6.99E-02
Benzo(b)fluoranthene	1 / 15	0.12 - 0.12	0.385 - 0.5683	NP	2.21E-01			6.20E-01		N (a)	---
Bis(2-ethylhexyl)phthalate	2 / 15	0.0299 - 0.0553	0.385 - 0.5683	NP	2.03E-01			3.50E+01		N (a)	---
Chrysene	1 / 15	0.0737 - 0.0737	0.385 - 0.5683	NP	2.18E-01			6.20E+01		N (a)	---
Di-n-butyl phthalate	1 / 15	0.0702 - 0.0702	0.385 - 0.5683	NP	2.16E-01			6.10E+03		N (a)	---

Table 2-17

Statistical Summary and COPC Selection of Chemicals Detected in Sediment
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [a]	Background Screening Criterion [b]	Risk-Based Screening Criterion [c]	COPC? [d,e]	Source Term Concentration [f]
Fluoranthene	1 / 15	0.147 - 0.147	0.385 - 0.5683	N	2.18E-01			2.30E+03	N (a)	---
Pyrene	1 / 15	0.11 - 0.11	0.385 - 0.5683	NP	2.20E-01			2.30E+03	N (a)	---
Volatile Organic Compounds										
2-Butanone	1 / 15	0.00862 - 0.00862	0.0116 - 0.01722	NP	6.94E-03			7.30E+02	N (a)	---
Acetone	4 / 11	0.00351 - 0.0379	0.0116 - 0.0145	NP	8.82E-03			1.60E+03	N (a)	---
Benzene	1 / 15	0.00355 - 0.00355	0.00578 - 0.00861	L	3.42E-03			6.50E-01	N (a)	---
Methylene chloride	10 / 11	0.00366 - 0.074	0.00578 - 0.00861	NP	1.51E-02			8.90E+00	N (a)	---
Toluene	3 / 15	0.0034 - 0.00633	0.00578 - 0.00861	NP	3.71E-03			5.90E+02	N (a)	---

COPC - Chemical of Potential Concern
UCL - Upper Confidence Limit
mg/kg - milligrams per kilogram
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparametric; data are found to be neither normally nor lognormally distributed.
[a] Method of estimation based on statistical distribution (please see Section 2.2.1).
[b] Please see Table 2-3.
[c] Please see Section 2.1.5.
[d] N = Chemical is not chosen as a COPC:
(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).
(b) = maximum detected concentration is less than the background screening concentration.
(c) = essential nutrient.
[e] Y = Chemical is chosen as COPC.
[f] 95% UCL or maximum detected concentration, whichever is lower, is chosen as the source term concentration.
[g] RBSC based on the PRG for total chromium.
[h] Calculated; reference Appendix B.
[i] Based on PRG for mixed dinitrotoluene.

Table 2-18

Statistical Summary and COPC Selection of Chemicals Detected in Surface Water
TNT Area C, Plum Brook Ordnance Work
Sandusky, Ohio

Chemical Name (µg/L)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UCL [a]	Risk-Based Screening Criterion [b]	COPC? [c,d]	Source Term Concentration [e]
Metals									
Aluminum	7 / 7	497.5 - 3830	200 - 200	L	1.30E+03		3.60E+04	N (a)	---
Barium	10 / 10	28 - 125	5 - 5	L	5.66E+01		2.60E+03	N (a)	---
Cadmium	2 / 10	2.12 - 5.185	3 - 3	NP	1.93E+00		1.80E+01	N (a)	---
Calcium	10 / 10	99700 - 235000	500 - 500	N	1.68E+05		Nutrient	N (b)	---
Chromium	8 / 10	1.01 - 4.45	5 - 5	L	2.14E+00		1.10E+02 f	N (a)	---
Cobalt	4 / 10	1.23 - 4.4	5 - 5	NP	2.58E+00		2.20E+03	N (a)	---
Copper	7 / 10	1.29 - 5.81	5 - 5	L	2.67E+00		1.40E+03	N (a)	---
Iron	10 / 10	360 - 15300	100 - 100	L	3.42E+03		Nutrient	N (b)	---
Lead	5 / 10	1.62 - 6.89	3 - 3	NP	2.66E+00		1.50E+01 g	N (a)	---
Magnesium	10 / 10	25600 - 51700	250 - 250	N	3.61E+04		Nutrient	N (b)	---
Manganese	10 / 10	60.95 - 3010	5 - 5	L	7.80E+02	4.76E+03	8.80E+02	Y	3.01E+03
Nickel	6 / 10	2.86 - 8.69	5 - 5	NP	4.39E+00		7.30E+02	N (a)	---
Potassium	10 / 10	967 - 3100	250 - 250	L	1.99E+03		Nutrient	N (b)	---
Selenium	3 / 10	2.78 - 3.105	5 - 5	NP	2.65E+00		1.80E+02	N (a)	---
Sodium	10 / 10	1350 - 5480	1000 - 1000	N	3.94E+03		Nutrient	N (b)	---
Vanadium	7 / 10	1.16 - 7.12	5 - 5	L	2.59E+00		2.60E+02	N (a)	---
Zinc	10 / 10	5.415 - 27.9	15 - 15	N	1.60E+01		1.10E+04	N (a)	---
Nitroaromatics									
2-Amino-4,6-dinitrotoluene	1 / 10	0.984 - 0.984	0.26 - 0.26	NP	2.15E-01		2.20E+00 h	N (a)	---
4-Amino-2,6-dinitrotoluene	2 / 10	0.332 - 0.549	0.26 - 0.26	NP	1.92E-01		2.20E+00 h	N (a)	---
2-Nitrotoluene	1 / 10	10.4 - 10.4	0.52 - 0.52	NP	1.27E+00		6.10E+01	N (a)	---
3-Nitrotoluene	1 / 10	1.47 - 1.47	0.52 - 0.52	NP	3.81E-01		6.10E+01	N (a)	---
4-Nitrotoluene	1 / 10	4.3 - 4.3	0.52 - 0.52	NP	6.64E-01		6.10E+01	N (a)	---
2,4,6-Trinitrotoluene	1 / 10	0.344 - 0.344	0.26 - 0.26	NP	1.51E-01		2.20E+00	N (a)	---
Dinitrotoluene, total	2 / 10	0.969 - 7.92	0.26 - 0.26	NP	9.93E-01	7.92E+00	9.90E-02	Y	7.92E+00
Semivolatile Organic Compounds									
2,4-Dinitrotoluene	1 / 10	2.57 - 2.57	10.25 - 12	NP	5.20E+00	5.58E+00	9.90E-02 i	N (c)	---
2,6-Dinitrotoluene	1 / 10	2.95 - 2.95	10.25 - 12	NP	5.24E+00	5.60E+00	9.90E-02 i	N (c)	---
Di-n-butyl phthalate	1 / 10	5.25 - 5.25	10.25 - 12	L	5.45E+00		3.60E+03	N (a)	---
Volatile Organic Compounds									
Acetone	2 / 2	3.58 - 10.8	5 - 5	N	7.19E+00		6.10E+02	N (a)	---
Carbon disulfide	10 / 10	1.1 - 23.1	1 - 1	L	8.11E+00		1.00E+03	N (a)	---

[a] Method of estimation based on statistical distribution (please see Section 2.2.1).

[b] Please see Section 2.1.5.

[c] N = Chemical is not chosen as a COPC:

(a) = maximum detected concentration is less than the Risk Based Screening Concentration (RBSC).

(b) = essential nutrient.

(c) = please see Section 2.3.2.

Table 2-18

Statistical Summary and COPC Selection of Chemicals Detected in Surface Water
TNT Area C, Plum Brook Ordnance Work
Sandusky, Ohio

[d] Y = Chemical is chosen as COPC.
[e] 95% UCL or maximum detected concentration, which ever is lower, is chosen as the source term concentration.
f RBSC based on the PRG for chromium VI.
[g] EPA, 1996, ***Drinking Water Regulations and Health Advisories***, Office of Water, Washington, DC, October.
[h] Calculated; reference Appendix B.
[i] Based on PRG for mixed dinitrotoluene.
COPC - Chemical of Potential Concern
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; NP - Nonparametric; data are found to be neither normally nor lognormally dist
µg/L - micrograms per Liter
NA - not applicable
UCL - Upper Confidence Limit

Table 3-1

Receptor/Exposure Scenarios
TNT Areas A and C
Plum Brook Ordnance Works, Sandusky, Ohio

Source Medium	Model	Exposure Medium	Exposure Pathway
Groundskeeper			
Surface soil	None	Soil	Incidental ingestion
			Dermal contact
	Volatilization from soil	Ambient air	Inhalation
	Dust emissions based on activity	Ambient air	Inhalation
Total soil	Not quantified[a]		
Surface water	Not quantified[b]		
Sediment	Not quantified[b]		
Indoor Worker			
Surface soil	None	Soil	Incidental ingestion
			Dermal contact[c]
	Dust emissions; volatilization	Ambient air	Inhalation[c]
Subsurface soil	Volatilization from soil	Indoor air	Inhalation
Total soil	Not quantified[a]		
Surface water	Not quantified[a]		
Sediment	Not quantified[a]		

Table 3-1

Receptor/Exposure Scenarios
TNT Areas A and C
Plum Brook Ordnance Works, Sandusky, Ohio

Source Medium	Model	Exposure Medium	Exposure Pathway
Construction Worker			
Total soil	None	Soil	Incidental ingestion
			Dermal contact
	Volatilization from soil	Ambient air	Inhalation
	Dust emissions based on activity	Ambient air	Inhalation
Surface water	None	Surface water	Incidental ingestion[c]
			Dermal contact
	Volatilization from water	Ambient air	Inhalation[c]
Sediment	None	Sediment	Incidental ingestion
			Dermal contact

Table 3-1

Receptor/Exposure Scenarios
TNT Areas A and C
Plum Brook Ordnance Works, Sandusky, Ohio

Source Medium	Model	Exposure Medium	Exposure Pathway
On-Site Resident			
Total soil	None	Soil	Incidental ingestion
			Dermal contact
	Volatilization from soil	Ambient air	Inhalation
	Dust emissions based on wind erosion	Ambient air	Inhalation
Subsurface soil	Volatilization from soil	Indoor air	Inhalation
Surface water	None	Surface water	Dermal contact
	Volatilization from water	Ambient air	Inhalation[c]
Sediment	None	Sediment	Incidental ingestion
			Dermal contact
	Volatilization	Indoor air	Inhalation
Hunter			
Surface soil	None	Soil	Incidental ingestion
			Dermal contact
	Dust, volatilization	Ambient air	Inhalation[c]
	Biouptake	Venison	Venison consumption

[a] There is no plausible pathway for exposure to this medium.
[b] Although contact with this medium is possible, exposure would be sporadic, rather than continuous or predictable. Such exposures do not lend themselves to evaluation under the chronic toxicity paradigm used in a baseline risk assessment.
[c] Although theoretically complete, this pathway is not quantified as explained in text.

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors TNT Areas A and C, Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter
General Variables Used in All Intake Models					
Body weight (BW), kg	70[a]	70[a]	Child: 15[b] Adult: 70[a]	70[a]	Child: 15[b] Adult: 70[a]
Averaging time, noncancer (AT), days[d]	9125	183	Child: 2190 Adult: 8760	9125	Child: 2190 Adult: 10950
Averaging time, cancer (AT), days[e]	25550	25550	25550	25550	25550
Inhalation of VOCs and Resuspended Dust from Surface Soil, Total Soil or Subsurface Soil					
Fraction exposed to contaminated medium (FI_a), unitless	1[c]	1[c]	1[c]	NA	NA
Inhalation rate (IR_a), m^3/day	20[a]	20[a]	Child: 10[b] Adult: 20[a]	NA	NA
Exposure frequency (EF), days/year	250[a]	250[a]	350[a]	NA	NA
Exposure duration (ED), years	25[a]	0.5[b]	Child: 6[b] Adult: 24[b]	NA	NA

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors TNT Areas A and C, Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter
Inhalation of VOCs in Indoor Air from Subsurface Soil					
Fraction exposed to contaminated medium (FI_a), unitless	NA	NA	1[c]	1[c]	NA
Inhalation rate (IR_a), m^3/day	NA	NA	Child: 6.8[c] Adult: 13.7[c]	20[a]	NA
Exposure frequency (EF), days/year	NA	NA	350[a]	250[a]	NA
Exposure duration (ED), years	NA	NA	Child: 6[b] Adult: 24[b]	25[a]	NA
Incidental Ingestion of Soil					
Fraction exposed to contaminated medium (FI_{so}), unitless	1[c]	1[c]	0.9[c]	1[c]	1[c]
Soil incidental ingestion rate (IR_{so}), mg/day	100[a]	290[c]	Child: 200[b] Adult: 100[a]	50[a]	Child: NA Adult: 100[a]
Exposure frequency (EF), days/year	250[a]	250[a]	350[a]	250[a]	14[c]
Exposure duration (ED), years	25[a]	0.5[c]	Child: 6[b] Adult: 24[b]	25[a]	30[a]

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors TNT Areas A and C, Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter
Incidental Ingestion of Sediment					
Fraction exposed to contaminated medium (FI_{sd}), unitless	NA	1[c]	0.1[c]	NA	NA
Sediment incidental ingestion rate (IR_{sd}), mg/day	NA	290[c]	Child: 200[b] Adult: 100[a]	NA	NA
Exposure frequency (EF), days/year	NA	250[a]	350[a]	NA	NA
Exposure duration (ED), years	NA	0.5[c]	Child: 6[b] Adult: 24[b]	NA	NA
Dermal Contact with Soil					
Fraction exposed to contaminated medium (FI_{so}), unitless	1[c]	1[c]	0.9[c]	NA	1[c]
Body surface area exposed to soil (SA_{so}), cm^2	11,300[f]	11,300[f]	Child: 1750[g] Adult: 4550[g]	NA	Child: NA Adult: 4550[g]
Soil-to-skin adherence factor (AF_{so}), mg/cm^2	0.009[f]	0.08[f]	0.2[g]	NA	0.2[g]
Dermal absorption factor (ABS), unitless	csv	csv	csv	NA	csv
Exposure frequency (EF), days/year	250[a]	250[a]	350[a]	NA	14[c]
Exposure duration (ED), years	25[a]	0.5[c]	Child: 6[b] Adult: 24[b]	NA	30[a]

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors TNT Areas A and C, Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter
Dermal Contact with Sediment					
Fraction exposed to contaminated medium (FI_{sd}), unitless	NA	1[c]	0.1[c]	NA	NA
Body surface area exposed to sediment (SA_{sd}), cm^2	NA	3100[f]	Child: 1750[g] Adult: 4550[g]	NA	NA
Sediment-to-skin adherence factor (AF_{sd}), mg/cm^2	NA	0.24[f]	0.2[g]	NA	NA
Dermal absorption factor (ABS), unitless	NA	csv	csv	NA	NA
Exposure frequency (EF), days/year	NA	250[a]	350[a]	NA	NA
Exposure duration (ED), years	NA	0.5[c]	Child: 6[b] Adult: 24[b]	NA	NA
Dermal Contact with Surface Water					
Body surface area exposed to surface water (SA_{sw}), cm^2	NA	3100[f]	Child: 2100[g] Adult: 5450[g]	NA	NA
Permeability coefficient (PC), cm/hour	NA	csv	csv	NA	NA
Exposure time (ET_{sw}), hour/day	NA	4[c]	3[c]	NA	NA
Exposure frequency (EF), days/year	NA	250[a]	52[c]	NA	NA
Exposure duration (ED), years	NA	0.5[c]	Child: 6[b] Adult: 24[b]	NA	NA

Table 3-2

Variables Used to Estimate Potential Chemical Intakes and Contact Rates for Receptors TNT Areas A and C, Plum Brook Ordnance Works, Sandusky, Ohio

Pathway Variable	Grounds-keeper	Construction Worker	On-Site Resident	Indoor Worker	Hunter
Venison Consumption					
Venison ingestion rate (IR_v), kg/day	NA	NA	NA	NA	Child: 0.005[c] Adult: 0.013[c]
Exposure frequency (EF), days/year	NA	NA	NA	NA	350[a]
Exposure duration (ED), years	NA	NA	NA	NA	Child: 6[b] Adult: 30[a]

[a] U.S. Environmental Protection Agency (EPA), 1991, *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors*, Interim Final, Office of Solid Waste and Emergency Response, OSWER Directive: 9285.603.

[b] U.S. Environmental Protection Agency (EPA), 1999, *EPA Region 9: Preliminary Remediation Goals (PRGs) 1999*, 3 December, on-line.

[c] Assumed; see text.

[d] Calculated as the product of ED (years) x 365 days/year.

[e] Calculated as the product of 70 years (assumed human lifetime) x 365 days/year.

[f] U.S. Environmental Protection Agency (EPA), 1997b, *Exposure Factors Handbook*, Final, National Center for Environmental Assessment, Washington, DC, EPA/600/P-95/002Fa, August.

[g] EPA, 1992b, *Dermal Exposure Assessment: Principles and Applications*, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, including Supplemental Guidance dated August 18, 1992.

NA = not applicable to this receptor; csv = chemical-specific value.

Table 3-3

Chemical-Specific Physical Property Values Used in Exposure Assessment[a]
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	ABS (unitless)	PC (cm/hr)	Henry's Law Constant	H' (H * 41)	log Koc unitless	Koc unitless	Kd cm^3/g	Da cm^2/sec	Dw cm^2/sec	Bp unitless	Bb days/kg	Bv unitless
Metals												
Arsenic	0.01	1.00E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	0.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	0.01	NA	NA	NA	NA	NA	NA	NA	NA	4.50E-02	3.00E-04	6.00E-05
Manganese	0.01	1.00E-03	NA	NA	NA	NA	NA	NA	NA	2.50E-01	4.00E-04	8.00E-05
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	0.1	1.07E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrotoluene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitrotoluene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrotoluene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dinitrotoluene, tota	0.1	3.80E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PCBs												
Aroclor 1254	0.06	7.10E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor 1260	0.06	7.10E-01	NA	NA	NA	NA	NA	NA	NA	4.55E-03	1.58E-01	3.16E-02
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	0.1	3.80E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	0.1	2.50E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	2.07E-02	1.15E-02	2.30E-03
Benzo(a)pyrene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	1.07E-02	3.63E-02	7.26E-03
Benzo(b)fluoranthene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	1.12E-02	3.31E-02	6.62E-03
Benzo(k)fluoranthene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	1.22E-02	2.88E-02	5.76E-03
Chrysene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	2.07E-02	1.15E-02	2.30E-03
Dibenz(a,h)anthracene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	4.31E-03	1.74E-01	3.48E-02
Indeno(1,2,3-cd)pyrene	0.1	NA	NA	NA	NA	NA	NA	NA	NA	6.09E-03	9.55E-02	1.91E-02
Volatile Organic Compounds												
2-Butanone	NA	NA	4.75E-05	1.95E-03	1.50E+00	3.16E+01	1.90E-01	8.09E-02	9.40E-06	NA	NA	NA
Acetone	NA	NA	3.88E-05	1.59E-03	-2.40E-01	5.75E-01	3.45E-03	1.24E-01	1.14E-05	NA	NA	NA
Benzene	NA	NA	5.56E-03	2.28E-01	1.77E+00	5.89E+01	3.53E-01	8.80E-02	9.80E-06	NA	NA	NA
Carbon disulfide	NA	NA	3.02E-02	1.24E+00	1.66E+00	4.57E+01	2.74E-01	1.04E-01	1.00E-05	NA	NA	NA
Ethylbenzene	NA	NA	7.88E-03	3.23E-01	2.56E+00	3.63E+02	2.18E+00	7.50E-02	7.80E-06	NA	NA	NA
Methylene chloride	NA	NA	2.19E-03	8.98E-02	1.07E+00	1.17E+01	7.05E-02	1.01E-01	1.17E-05	NA	NA	NA
Toluene	NA	NA	6.63E-03	2.72E-01	2.26E+00	1.82E+02	1.09E+00	8.70E-02	8.60E-06	NA	NA	NA
Xylene, o-	NA	NA	7.34E-03	3.01E-01	2.61E+00	4.07E+02	2.44E+00	7.00E-02	7.80E-06	NA	NA	NA
Xylenes, m,p-	NA	NA	7.34E-03	3.01E-01	2.61E+00	4.07E+02	2.44E+00	7.00E-02	7.80E-06	NA	NA	NA

[a] Please see toxicity profiles in Appendix B for documentation of the values.
ABS = Absorption fraction
PC = Permeability coefficient
H' = Dimensionless Henry's law constant
Koc = Soil organic carbon-water partition coefficient
Kd = Soil-water partition coefficient
Da = Diffusivity in air
Dw = Diffusivity in water
Bp = Soil-to-forage biotransfer factor
Bb = Biotransfer factor for beef
Bv = Biotransfer factor for venison
NA = not applicable

Table 4-1

COPC-Specific Toxicity Values[a] Used in Risk Assessment
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	GAF	Oral RfD (mg/kg-day)	Target Organs (Oral)	Dermal RfD (mg/kg-day)	Inhalation RfD (mg/kg-day)	Target Organs (Inhalation)	Cancer Weight-of-Evidence Group	Oral SF (/mg/kg-day)	Dermal SF (/mg/kg-day)	Inhalation SF (/mg/kg-day)
Metals										
Arsenic	0.95	3.00E-04	S, PVS	2.85E-04	ND	NA	A	1.50E+00	1.58E+00	1.50E+01
Chromium	0.01	1.50E+00	ND	1.50E-02	2.90E-05	Lung	A	ND	ND	4.20E+01
Lead	0.1	ND	NA	NA	ND	NA	B2	ND	ND	ND
Manganese	0.05	4.70E-02	CNS	2.35E-03	1.40E-05	CNS	D	ND	ND	ND
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	0.6	6.00E-05	L, E	3.60E-05	ND	NA	D	ND	ND	ND
4-Amino-2,6-dinitrotoluene	0.6	6.00E-05	L, E	3.60E-05	ND	NA	D	ND	ND	ND
1,3-Dinitrobenzene	0.8	1.00E-04	E, T	8.00E-05	ND	NA	D	ND	ND	ND
2-Nitrotoluene	0.9	1.00E-02	L, Sp, K	9.00E-03	ND	NA	ND	ND	ND	ND
3-Nitrotoluene	0.9	1.00E-02	L, Sp, K	9.00E-03	ND	NA	ND	ND	ND	ND
4-Nitrotoluene	0.9	1.00E-02	L, Sp, K	9.00E-03	ND	NA	ND	ND	ND	ND
2,4,6-Trinitrotoluene	0.6	5.00E-04	L, E	3.00E-04	ND	NA	C	3.00E-02	5.00E-02	ND
Dinitrotoluene, total	1	1.00E-03	CNS, L, E, K	1.00E-03	ND	NA	B2	6.80E-01	6.80E-01	ND
PCBs										
Aroclor 1254	0.9	2.00E-05	IS, S	1.80E-05	ND	NA	B2	2.00E+00	2.00E+00	2.00E+00
Aroclor 1260	0.9	ND	NA	NA	ND	NA	B2	2.00E+00	2.00E+00	2.00E+00
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1	2.00E-03	CNS, L, E	2.00E-03	ND	NA	B2	6.80E-01	6.80E-01	ND
2,6-Dinitrotoluene	1	1.00E-03	CNS, L, E, K	1.00E-03	ND	NA	B2	6.80E-01	6.80E-01	ND
Benzo(a)anthracene	0.5	ND	NA	NA	ND	NA	B2	7.30E-01	1.46E+00	3.10E-01
Benzo(a)pyrene	0.5	ND	NA	NA	ND	NA	B2	7.30E+00	1.46E+01	3.10E+00
Benzo(b)fluoranthene	0.5	ND	NA	NA	ND	NA	B2	7.30E-01	1.46E+00	3.10E-01
Benzo(k)fluoranthene	0.5	ND	NA	NA	ND	NA	B2	7.30E-02	1.46E-01	3.10E-02
Chrysene	0.8	ND	NA	NA	ND	NA	B2	7.30E-03	9.13E-03	3.10E-03
Dibenz(a,h)anthracene	0.8	ND	NA	NA	ND	NA	B2	7.30E+00	9.13E+00	3.10E+00
Indeno(1,2,3-cd)pyrene	0.5	ND	NA	NA	ND	NA	B2	7.30E-01	1.46E+00	3.10E-01

[a] Please see toxicity profiles in Appendix B for documentation of the values.
GAF = Gastrointestinal absorption factors
RfD = Reference dose
SF = Slope factor
ND = No data; NA = Not applicable

Target Organs:
S = skin, PVS = peripheral vascular system, CNS = central nervous system, L = liver, E = erythrocyte, T = testis, Sp = spleen, K = kidney, IS = immune system.

Weight of Evidence Group:
A - Human carcinogen; B1 - Probable human carcinogen (human data); B2 - Probable human carcinogen (animal data);
C - Possible human carcinogen; D - Not classifiable as to carcinogenicity to humans.

Table 5-1

Summary of Total Hazard and Total Cancer Risk by Source Medium
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

(Page 1 of 2)

Source Medium	Groundskeeper Total HI	Indoor Worker Total HI	Construction Worker Total HI	On-Site Resident Total HI	Adult Hunter Total HI	Child Venison Consumer Total HI
Surface Soil	6.45E-01	2.76E-01	NA	NA	3.30E-02	NA
Total Soil	NA	NA	6.04E+01	2.19E+02	NA	NA
Surface Water	NA	NA	5.93E-02	2.93E-02	NA	NA
Sediment	NA	NA	NA	NA	NA	NA
Total across all media	**6.45E-01**	**2.76E-01**	**6.05E+01**	**2.19E+02**	**3.30E-02**	**NA**

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - Not applicable.

Table 5-1

Summary of Total Hazard and Total Cancer Risk by Source Medium
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

	Groundskeeper	Indoor Worker	Construction Worker	On-Site Resident			Adult Hunter	Child Venison Consumer
Source Medium	Total ILCR	Total ILCR	Total ILCR	Adult ILCR	Child ILCR	Total ILCR	Total ILCR	Total ILCR
Surface Soil	6.08E-06	2.71E-06	NA	NA	NA	NA	4.46E-07	2.34E-08
Total Soil	NA	NA	3.51E-04	1.06E-02	1.53E-02	2.59E-02	NA	NA
Surface Water	NA	NA	5.13E-09	6.76E-08	3.04E-08	9.79E-08	NA	NA
Sediment	NA	NA	6.46E-08	2.38E-07	4.63E-10	2.38E-07	NA	NA
Total across all media	**6.08E-06**	**2.71E-06**	**3.51E-04**	**1.06E-02**	**1.53E-02**	**2.59E-02**	**4.46E-07**	**2.34E-08**

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - Not applicable.

Table 5-2

Chemicals of Concern and Risk-Based Remediation Criteria
Construction Worker Exposure to Total Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	Target Hazard Index 1.0	Target Hazard Index 0.1	Total ILCR All Pathways	Target Risk Level 1.00E-06	Target Risk Level 1.00E-05
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	3.36E+01	2.41E+00	1.40E+01	1.40E+00	NA	NA	NA
4-Amino-2,6-dinitrotoluene	9.77E+00	7.00E-01	1.40E+01	1.40E+00	NA	NA	NA
2-Nitrotoluene	5.82E+02	2.22E-01	2.62E+03	2.62E+02	NA	NA	NA
4-Nitrotoluene	4.84E+02	1.84E-01	2.62E+03	2.62E+02	NA	NA	NA
2,4,6-Trinitrotoluene	2.59E+02	2.23E+00	1.16E+02	1.16E+01	NA	NA	NA
PCB							
Aroclor 1260	6.98E+01	NA	NA	NA	3.43E-06	2.04E+01	2.04E+02
Semivolatile Organic Compounds							
2,4-Dinitrotoluene	8.91E+03	1.65E+01	5.39E+02	5.39E+01	1.61E-04	5.53E+01	5.53E+02
2,6-Dinitrotoluene	1.03E+04	3.81E+01	2.69E+02	2.69E+01	1.86E-04	5.53E+01	5.53E+02

HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table 5-3

Chemicals of Concern and Risk-Based Remediation Criteria
On-Site Resident Exposure to Total Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	Target Hazard Index 1.0	Target Hazard Index 0.1	Total ILCR All Pathways	Target Risk Level 1.00E-06	Target Risk Level 1.00E-05
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	3.36E+01	8.32E+00	4.04E+00	4.04E-01	NA	NA	NA
4-Amino-2,6-dinitrotoluene	9.77E+00	2.42E+00	4.04E+00	4.04E-01	NA	NA	NA
2-Nitrotoluene	5.82E+02	8.00E-01	7.28E+02	7.28E+01	NA	NA	NA
4-Nitrotoluene	4.84E+02	6.65E-01	7.28E+02	7.28E+01	NA	NA	NA
2,4,6-Trinitrotoluene	2.59E+02	7.70E+00	3.36E+01	3.36E+00	1.82E-05	1.43E+01	1.43E+02
PCB							
Aroclor 1260	6.98E+01	NA	NA	NA	2.43E-04	2.87E-01	2.87E+00
Semivolatile Organic Compounds							
2,4-Dinitrotoluene	8.91E+03	6.02E+01	1.48E+02	1.48E+01	1.19E-02	7.48E-01	7.48E+00
2,6-Dinitrotoluene	1.03E+04	1.39E+02	7.40E+01	7.40E+00	1.37E-02	7.48E-01	7.48E+00
Benzo(a)pyrene	2.18E-01	NA	NA	NA	4.02E-06	5.43E-02	5.43E-01

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
mg/kg - Milligrams per kilogram.
NA - Not applicable.

Table 5-4

Summary by Building of Total Cancer Risk and Noncancer Hazard by Receptor
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Former Building Number	Total Soil Receptors					
	Construction Worker		**On-Site Resident**			
	HI	ILCR	HI	ILCR		
				Adult	Child	Total
111	2.85E-02	2.04E-08	9.90E-02	5.94E-07	8.94E-07	1.49E-06
112	5.34E-01	9.32E-08	1.85E+00	2.62E-06	4.10E-06	6.72E-06
116	6.98E-04	1.36E-08	2.54E-03	4.72E-07	5.60E-07	1.03E-06
119	4.06E+00	1.96E-06	1.42E+01	5.84E-05	8.54E-05	1.44E-04
126	2.33E+00	2.65E-07	8.07E+00	8.98E-06	1.10E-05	2.00E-05
129	NA	2.39E-09	NA	6.35E-08	1.06E-07	1.69E-07
131	1.64E+00	4.34E-07	5.71E+00	1.32E-05	1.89E-05	3.21E-05
136	NA	3.26E-08	NA	1.17E-06	1.31E-06	2.49E-06
139	1.88E-01	3.89E-06	6.52E-01	1.04E-04	1.73E-04	2.77E-04
141	7.75E-01	1.69E-07	2.68E+00	5.22E-06	7.30E-06	1.25E-05
142	3.60E-01	1.57E-07	1.24E+00	4.30E-06	6.92E-06	1.12E-05
143	6.71E-02	8.39E-08	2.32E-01	2.93E-06	3.43E-06	6.36E-06
146	8.04E+00	5.03E-07	2.78E+01	1.73E-05	2.08E-05	3.81E-05
148	7.70E-02	2.40E-08	2.67E-01	6.85E-07	1.06E-06	1.74E-06
182	7.00E-02	5.02E-07	2.55E-01	1.52E-05	2.19E-05	3.71E-05
185	1.68E-03	1.02E-08	6.12E-03	3.10E-07	4.44E-07	7.54E-07
192	1.20E+01	5.93E-05	4.38E+01	1.80E-03	2.59E-03	4.39E-03
195	5.69E+01	3.47E-04	2.07E+02	1.05E-02	1.51E-02	2.57E-02

HI = Hazard Index.
ILCR = Incremental Lifetime Cancer Risk.
NA = Not applicable.

Table 5-5

TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio
(Page 1 of 2)

Source Medium	Groundskeeper Total HI	Indoor Worker Total HI	Construction Worker Total HI	On-Site Resident Total HI	Adult Hunter Total HI	Child Venison Consumer Total HI
Surface Soil	9.54E+01	4.08E+01	NA	NA	4.88E+00	NA
Total Soil	NA	NA	3.60E+02	1.24E+03	NA	NA
Surface Water	NA	NA	1.59E-01	7.84E-02	NA	NA
Sediment	NA	NA	1.37E+01	5.60E+00	NA	NA
Total across all media	**9.54E+01**	**4.08E+01**	**3.74E+02**	**1.25E+03**	**4.88E+00**	**NA**

HI - Hazard index
ILCR - Incremental lifetime cancer risk
NA - Not applicable

Table 5-5

TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio
(Page 2 of 2)

Source Medium	Groundskeeper Total ILCR	Indoor Worker Total ILCR	Construction Worker Total ILCR	On-Site Resident Adult ILCR	On-Site Resident Child ILCR	On-Site Resident Total ILCR	Adult Hunter Total ILCR	Child Venison Consumer Total ILCR
Surface Soil	5.43E-04	2.32E-04	NA	NA	NA	NA	3.39E-05	2.09E-07
Total Soil	NA	NA	5.01E-05	1.57E-03	1.91E-03	3.48E-03	NA	NA
Surface Water	NA	NA	1.77E-08	2.33E-07	1.05E-07	3.38E-07	NA	NA
Sediment	NA	NA	1.36E-06	5.51E-06	6.65E-06	1.22E-05	NA	NA
Total across all media	**5.43E-04**	**2.32E-04**	**5.15E-05**	**1.57E-03**	**1.92E-03**	**3.49E-03**	**3.39E-05**	**2.09E-07**

HI - Hazard index
ILCR - Incremental lifetime cancer risk
NA - Not applicable

Table 5-6

Chemicals of Concern and Risk-Based Remediation Criteria
Groundskeeper Exposure to Surface Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	Target Hazard Index		Total ILCR All Pathways	Target Risk Level	
			1.0	0.1		1.00E-06	1.00E-05
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	3.80E+01	7.25E-01	5.24E+01	5.24E+00	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	2.15E-01	5.24E+01	5.24E+00	NA	NA	NA
2,4,6-Trinitrotoluene	4.13E+04	9.44E+01	4.37E+02	4.37E+01	5.06E-04	8.16E+01	8.16E+02
PCBs							
Aroclor 1260	4.88E+00	NA	NA	NA	3.68E-06	1.32E+00	1.32E+01
Semivolatile Organic Compounds							
2,4-Dinitrotoluene	9.85E+00	NA	NA	NA	2.58E-06	3.82E+00	3.82E+01
2,6-Dinitrotoluene	9.52E+00	NA	NA	NA	2.49E-06	3.82E+00	3.82E+01
Benzo(a)anthracene	6.94E+00	NA	NA	NA	2.15E-06	3.23E+00	3.23E+01
Benzo(a)pyrene	6.33E+00	NA	NA	NA	1.96E-05	3.23E-01	3.23E+00
Benzo(b)fluoranthene	8.43E+00	NA	NA	NA	2.61E-06	3.23E+00	3.23E+01
Dibenz(a,h)anthracene	1.03E+00	NA	NA	NA	2.98E-06	3.45E-01	3.45E+00

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - Not applicable.
PCB = Polychlorinated biphenyl.

Table 5-7

Chemicals of Concern and Risk-Based Remediation Criteria
Indoor Worker Exposure to Surface Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	Target Hazard Index		Total ILCR All Pathways	Target Risk Level	
			1.0	0.1		1.00E-06	1.00E-05
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	3.80E+01	3.10E-01	1.23E+02	1.23E+01	NA	NA	NA
2,4,6-Trinitrotoluene	4.13E+04	4.04E+01	1.02E+03	1.02E+02	2.16E-04	1.91E+02	1.91E+03
PCBs							
Aroclor 1260	4.88E+00	NA	NA	NA	1.70E-06	2.86E+00	2.86E+01
Semivolatile Organic Compounds							
2,4-Dinitrotoluene	9.85E+00	NA	NA	NA	1.17E-06	8.42E+00	8.42E+01
2,6-Dinitrotoluene	9.52E+00	NA	NA	NA	1.13E-06	8.42E+00	8.42E+01
Benzo(a)pyrene	6.33E+00	NA	NA	NA	8.07E-06	7.84E-01	7.84E+00
Benzo(b)fluoranthene	8.43E+00	NA	NA	NA	1.08E-06	7.84E+00	7.84E+01
Dibenz(a,h)anthracene	1.03E+00	NA	NA	NA	1.31E-06	7.84E-01	7.84E+00

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
NA - Not applicable.
PCB = Polychlorinated biphenyl.

Table 5-8

Chemicals of Concern and Risk-Based Remediation Criteria
Adult Hunter Exposure to Surface Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	Target Hazard Index 1.0	Target Hazard Index 0.1
Nitroaromatics				
2,4,6-Trinitrotoluene	4.13E+04	4.83E+00	8.54E+03	8.54E+02

HI - Hazard index.
ILCR - Incremental lifetime cancer risk.
mg/kg = Milligrams per kilogram.
NA - Not applicable.

Table 5-9

Chemicals of Concern and Risk-Based Remediation Criteria
Construction Worker Exposure to Total Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	Target Hazard Index 1.0	Target Hazard Index 0.1
Metals				
Chromium	2.02E+02	4.77E-01	4.23E+02	4.23E+01
Nitroaromatics				
2-Amino-4,6-dinitrotoluene	3.80E+01	2.72E+00	1.40E+01	1.40E+00
4-Amino-2,6-dinitrotoluene	1.13E+01	8.08E-01	1.40E+01	1.40E+00
2,4,6-Trinitrotoluene	4.13E+04	3.55E+02	1.16E+02	1.16E+01
PCBs				
Aroclor 1254	7.45E-01	1.27E-01	5.85E+00	5.85E-01
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	2.75E+02	5.10E-01	5.39E+02	5.39E+01

HI - Hazard index
ILCR - Incremental lifetime cancer risk
NA - Not applicable

Table 5-10

Chemicals of Concern and Risk-Based Remediation Criteria
On-Site Resident Exposure to Total Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	Target Hazard Index		Total ILCR All Pathways	Target Risk Level	
			1.0	0.1		1.00E-06	1.00E-05
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	3.80E+01	9.41E+00	4.04E+00	4.04E-01	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	2.79E+00	4.04E+00	4.04E-01	NA	NA	NA
2,4,6-Trinitrotoluene	4.13E+04	1.23E+03	3.36E+01	3.36E+00	2.89E-03	1.43E+01	1.43E+02
PCBs							
Aroclor 1254	7.45E-01	4.79E-01	1.56E+00	1.56E-01	2.60E-06	2.87E-01	2.87E+00
Aroclor 1260	4.88E+00	NA	NA	NA	1.70E-05	2.87E-01	2.87E+00
Semivolatile Organic Compounds							
2,4-Dinitrotoluene	2.75E+02	1.86E+00	1.48E+02	1.48E+01	3.68E-04	7.48E-01	7.48E+00
2,6-Dinitrotoluene	1.94E+01	2.62E-01	7.40E+01	7.40E+00	2.59E-05	7.48E-01	7.48E+00
Benzo(a)anthracene	6.94E+00	NA	NA	NA	1.28E-05	5.43E-01	5.43E+00
Benzo(a)pyrene	6.33E+00	NA	NA	NA	1.17E-04	5.43E-02	5.43E-01
Benzo(b)fluoranthene	8.43E+00	NA	NA	NA	1.55E-05	5.43E-01	5.43E+00
Dibenz(a,h)anthracene	1.40E+00	NA	NA	NA	2.15E-05	6.51E-02	6.51E-01
Indeno(1,2,3-cd)pyrene	2.05E+00	NA	NA	NA	3.77E-06	5.43E-01	5.43E+00

HI - Hazard index
ILCR - Incremental lifetime cancer risk
NA - Not applicable

Table 5-11

Chemicals of Concern and Risk-Based Remediation Criteria
Construction Worker Exposure to Sediment
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	Target Hazard Index		Total ILCR All Pathways	Target Risk Level	
			1.0	0.1		1.00E-06	1.00E-05
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	1.12E+01	7.54E-01	1.49E+01	1.49E+00	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.28E+01	8.62E-01	1.49E+01	1.49E+00	NA	NA	NA
2,4,6-Trinitrotoluene	1.50E+03	1.21E+01	1.24E+02	1.24E+01	NA	NA	NA

HI - Hazard index
ILCR - Incremental lifetime cancer risk
mg/kg = Milligrams per kilogram.
NA - Not applicable

Table 5-12

Chemicals of Concern and Risk-Based Remediation Criteria
On-Site Resident Exposure to Sediment
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Total HI All Pathways	Target Hazard Index 1.0	Target Hazard Index 0.1
Nitroaromatics				
2-Amino-4,6-dinitrotoluene	1.12E+01	3.08E-01	3.63E+01	3.63E+00
4-Amino-2,6-dinitrotoluene	1.28E+01	3.52E-01	3.63E+01	3.63E+00
2,4,6-Trinitrotoluene	1.50E+03	4.94E+00	3.03E+02	3.03E+01

HI - Hazard index
ILCR - Incremental lifetime cancer risk
mg/kg - Milligrams per kilogram.
NA - Not applicable

Table 5-13

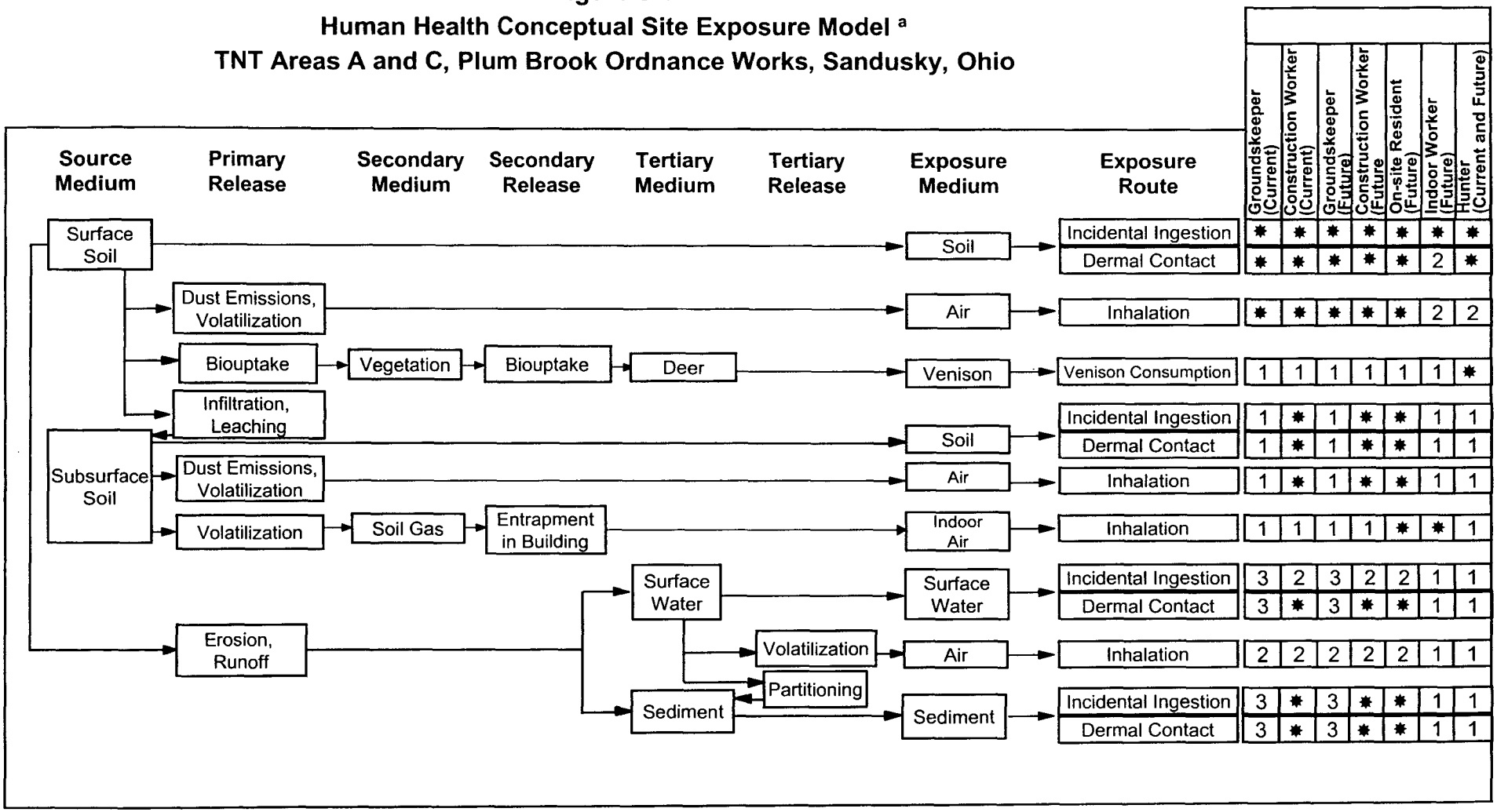
Summary by Building of Total Cancer Risk and Noncancer Hazard by Receptor
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Former Building Number	Total Soil Receptors					
	Construction Worker		**On-Site Resident**			
	HI	ILCR	HI	ILCR		
				Adult	Child	Total
602	4.56E-02	2.10E-08	1.71E-01	5.64E-07	9.32E-07	1.50E-06
603	9.77E-01	2.92E-07	3.38E+00	8.94E-06	1.27E-05	2.16E-05
606	8.45E-01	2.29E-08	2.92E+00	7.56E-07	9.54E-07	1.71E-06
611	NA	1.20E-09	NA	3.19E-08	5.32E-08	8.51E-08
616	1.99E+01	2.22E-06	6.87E+01	7.64E-05	9.18E-05	1.68E-04
626	2.48E-01	2.64E-08	8.56E-01	8.81E-07	1.09E-06	1.97E-06
629	1.10E+00	4.59E-06	3.95E+00	1.39E-04	2.00E-04	3.39E-04
657	NA	1.40E-07	NA	4.90E-06	5.69E-06	1.06E-05
681	6.96E-02	2.71E-08	2.41E-01	8.62E-07	1.16E-06	2.02E-06
682	3.56E+02	3.85E-05	1.23E+03	1.33E-03	1.59E-03	2.92E-03
683	4.77E+00	5.82E-06	1.66E+01	1.78E-04	2.53E-04	4.31E-04
686	4.52E+01	7.02E-06	1.56E+02	2.44E-04	2.89E-04	5.33E-04
689	4.21E+00	1.39E-06	1.46E+01	4.87E-05	5.67E-05	1.05E-04
692	9.85E+00	1.15E-06	3.41E+01	3.84E-05	4.84E-05	8.68E-05
693	3.23E-01	1.11E-08	1.12E+00	3.61E-07	4.69E-07	8.30E-07
696	8.91E+00	7.91E-06	2.91E+01	1.33E-04	1.53E-04	2.86E-04

HI = Hazard Index
ILCR = Incremental Lifetime Cancer Risk
NA = Not applicable

FIGURES

Figure 3-1
Human Health Conceptual Site Exposure Model [a]
TNT Areas A and C, Plum Brook Ordnance Works, Sandusky, Ohio



a = All groundwater evaluation is deferred to a site-wide groundwater investigation to be conducted in the future.
✱ = Complete exposure route quantified in the risk assessment.
1 = There is no plausible pathway for exposure to this medium.
2 = Although theoretically complete, this pathway is not quantified as explained in text.
3 = Contact with this medium, although plausible, is not part of this receptor's normal or expected activities; therefore contact would be sporadic and is not quantified.

APPENDIX A

RESULTS OF MANN-WHITNEY U-TESTS FOR BACKGROUND TESTING OF METALS IN SOIL

TNT Area A - Subsurface Soil Background Test for Chromium

Mann-Whitney U Test (crsbsa.sta)
By variable CHEMICAL
Group 1: 100-cr_site Group 2: 101-cr_bkg

	Rank Sum cr_site	Rank Sum cr_bkg	U	Z	p-level	Z adjusted	p-level	Valid N cr_site	Valid N cr_bkg	2*1sided exact p
Concentration mg/kg	807	846	311	-1.4740	0.14	-1.4742	0.14	31	26	0.1436

Interpretation:
Null hypothesis: Site data set does not differ from background data set.
p-Level > 0.05: accept null hypothesis, which is supported by visual inspection of box-and-whisker plot.
Conclusion: Chromium levels in site data are not significantly different from background.

TNT Area A - Subsurface Soil Background Test for Thallium

Mann-Whitney U Test (thlmstattest.sta)
By variable CHEMICAL
Group 1: 100-thalliu1 Group 2: 101-thallium

	Rank Sum thalliu1	Rank Sum thallium	U	Z	p-level	Z adjusted	p-level	Valid N thalliu1	Valid N thallium	2*1sided exact p
Concentration mg/kg	787	809	291	-1.5905	0.11	-1.5921	0.11	31	25	0.1141

Interpretation:
Null hypothesis: Site data set does not differ from background data set.
p-level > 0.05: accept null hypothesis, which is supported by visual inspection of box-and-whisker plot.
Conclusion: Thallium levels in site data are not significantly different from background.

TNT Area C - Surface Soil Background Test for Manganese

Mann-Whitney U Test (mnssctst.sta)
By variable MN_SITE
Group 1: 100-Mn_site Group 2: 101-Mn_bkgd

	Rank Sum Mn_site	Rank Sum Mn_bkgd	U	Z	p-level	Z adjusted	p-level	Valid N Mn_site	Valid N Mn_bkgd	2*1sided exact p
Concentration mg/kg	360	460	109	2.07	0.04	2.07	0.04	14	26	0.0387

Interpretation:
Null hypothesis: Site data set does not differ from background data set.
p-Level < 0.05: reject null hypothesis. However, visual inspection of box-and-whisker plot shows that site concentrations fall within the range of background
Low p-level probably reflects the fact that maximum detected concentration of site data set is far below that of background data set.
Conclusion: Manganese levels in site data fall within the range of background data.

TNT Area C - Subsurface Soil Background Test for Chromium

Mann-Whitney U Test (crsbsctst.sta)
By variable CHEMICAL
Group 1: 100-Cr_site Group 2: 101-Cr_bkgd

	Rank Sum Cr_site	Rank Sum Cr_bkgd	U	Z	p-level	Z adjusted	p-level	Valid N Cr_site	Valid N Cr_bkgd	2*1sided exact p
Concentration mg/kg	577.5	800.5	227	-2.0406	0.04	-2.0409	0.04	26	26	0.0406

Interpretation:
Null hypothesis: Site data set does not differ from background data set.
p-Level < 0.05: reject null hypothesis. Box-and-whiskers plot and data ranking exercise show unequivocally that failure to accept null hypothesis arises from Sample No. AB0446. All other data points clearly fall within the range of background.
Conclusion: Chromium levels in site data fall within the range of background with the sole exception of Sample No. AB0446.

APPENDIX B

RISK CALCULATIONS

APPENDIX B.1

RISK CALCULATIONS TNT AREA A

Table B.1-1

Cancer Risk and Noncancer Hazard: Groundskeeper Exposure to Surface Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Incidental Ingestion: Noncancer Dose (mg/kg-day)	Incidental Ingestion: Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption: Noncancer Dose (mg/kg-day)	Dermal Absorption: Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR
Metals										
Lead	5.88E+02	5.75E-04	2.05E-04	NA	NA	5.29E-08	5.85E-06	2.09E-06	NA	NA
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	9.23E+00	9.03E-06	3.23E-06	1.51E-01	NA	8.31E-09	9.18E-07	3.28E-07	2.55E-02	NA
4-Amino-2,6-dinitrotoluene	5.98E+00	5.85E-06	2.09E-06	9.74E-02	NA	5.38E-09	5.95E-07	2.12E-07	1.65E-02	NA
2,4,6-Trinitrotoluene	1.52E+02	1.48E-04	5.29E-05	2.96E-01	1.59E-06	1.36E-07	1.51E-05	5.38E-06	5.03E-02	2.69E-07
Dinitrotoluene, total	7.36E+00	7.20E-06	2.57E-06	7.20E-03	1.75E-06	6.62E-09	7.32E-07	2.62E-07	7.32E-04	1.78E-07
PCBs										
Aroclor 1260	2.48E+00	2.43E-06	8.67E-07	NA	1.73E-06	1.34E-09	1.48E-07	5.29E-08	NA	1.06E-07
Semivolatile Organic Compounds										
Benzo(a)anthracene	1.17E-01	1.14E-07	4.09E-08	NA	2.98E-08	1.05E-10	1.16E-08	4.16E-09	NA	6.07E-09
Benzo(a)pyrene	1.07E-01	1.05E-07	3.74E-08	NA	2.73E-07	9.63E-11	1.06E-08	3.80E-09	NA	5.55E-08
Benzo(b)fluoranthene	1.62E-01	1.59E-07	5.66E-08	NA	4.13E-08	1.46E-10	1.61E-08	5.76E-09	NA	8.41E-09
Total HI				**5.52E-01**					**9.30E-02**	
Total ILCR					**5.41E-06**					**6.23E-07**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.1-1

Cancer Risk and Noncancer Hazard: Groundskeeper Exposure to Surface Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Concentration in Air (mg/m^3)	Inhalation Noncancer Dose (mg/kg-day)	Inhalation Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals								
Lead	5.88E+02	5.88E-05	1.15E-05	4.11E-06	NA	NA	**NA**	**NA**
Nitroaromatics								
2-Amino-4,6-dinitrotoluene	9.23E+00	9.23E-07	1.81E-07	6.45E-08	NA	NA	**1.76E-01**	**NA**
4-Amino-2,6-dinitrotoluene	5.98E+00	5.98E-07	1.17E-07	4.18E-08	NA	NA	**1.14E-01**	**NA**
2,4,6-Trinitrotoluene	1.52E+02	1.52E-05	2.96E-06	1.06E-06	NA	NA	**3.47E-01**	**1.86E-06**
Dinitrotoluene, total	7.36E+00	7.36E-07	1.44E-07	5.14E-08	NA	NA	**7.93E-03**	**1.93E-06**
PCBs								
Aroclor 1260	2.48E+00	2.48E-07	4.85E-08	1.73E-08	NA	3.47E-08	**NA**	**1.87E-06**
Semivolatile Organic Compounds								
Benzo(a)anthracene	1.17E-01	1.17E-08	2.29E-09	8.18E-10	NA	2.53E-10	**NA**	**3.62E-08**
Benzo(a)pyrene	1.07E-01	1.07E-08	2.09E-09	7.48E-10	NA	2.32E-09	**NA**	**3.31E-07**
Benzo(b)fluoranthene	1.62E-01	1.62E-08	3.17E-09	1.13E-09	NA	3.51E-10	**NA**	**5.01E-08**
Total HI					**NA**		**6.45E-01**	
Total ILCR						**3.76E-08**		**6.08E-06**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.1-2

Cancer Risk and Noncancer Hazard: Indoor Worker Exposure to Surface Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR
Metals					
Lead	5.88E+02	2.88E-04	1.03E-04	NA	NA
Nitroaromatics					
2-Amino-4,6-dinitrotoluene	9.23E+00	4.52E-06	1.61E-06	7.53E-02	NA
4-Amino-2,6-dinitrotoluene	5.98E+00	2.92E-06	1.04E-06	4.87E-02	NA
2,4,6-Trinitrotoluene	1.52E+02	7.41E-05	2.65E-05	1.48E-01	7.94E-07
Dinitrotoluene, total	7.36E+00	3.60E-06	1.29E-06	3.60E-03	8.74E-07
PCBs					
Aroclor 1260	2.48E+00	1.21E-06	4.33E-07	NA	8.67E-07
Semivolatile Organic Compounds					
Benzo(a)anthracene	1.17E-01	5.72E-08	2.04E-08	NA	1.49E-08
Benzo(a)pyrene	1.07E-01	5.23E-08	1.87E-08	NA	1.36E-07
Benzo(b)fluoranthene	1.62E-01	7.93E-08	2.83E-08	NA	2.07E-08
Total HI				**2.76E-01**	
Total ILCR					**2.71E-06**

HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable.

Table B.1-3

Cancer Risk and Noncancer Hazard: Adult Hunter Exposure to Surface Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption			
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR
Metals										
Lead	5.88E+02	3.22E-05	1.38E-05	NA	NA	5.29E-08	1.32E-07	5.65E-08	NA	NA
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	9.23E+00	5.06E-07	2.17E-07	8.43E-03	NA	8.31E-09	2.07E-08	8.88E-09	5.75E-04	NA
4-Amino-2,6-dinitrotoluene	5.98E+00	3.27E-07	1.40E-07	5.46E-03	NA	5.38E-09	1.34E-08	5.75E-09	3.72E-04	NA
2,4,6-Trinitrotoluene	1.52E+02	8.30E-06	3.56E-06	1.66E-02	1.07E-07	1.36E-07	3.40E-07	1.46E-07	1.13E-03	7.28E-09
Dinitrotoluene, total	7.36E+00	4.03E-07	1.73E-07	4.03E-04	1.18E-07	6.62E-09	1.65E-08	7.08E-09	1.65E-05	4.81E-09
PCBs										
Aroclor 1260	2.48E+00	1.36E-07	5.82E-08	NA	1.16E-07	1.34E-09	3.34E-09	1.43E-09	NA	2.86E-09
Semivolatile Organic Compounds										
Benzo(a)anthracene	1.17E-01	6.41E-09	2.75E-09	NA	2.01E-09	1.05E-10	2.63E-10	1.13E-10	NA	1.64E-10
Benzo(a)pyrene	1.07E-01	5.86E-09	2.51E-09	NA	1.83E-08	9.63E-11	2.40E-10	1.03E-10	NA	1.50E-09
Benzo(b)fluoranthene	1.62E-01	8.88E-09	3.80E-09	NA	2.78E-09	1.46E-10	3.64E-10	1.56E-10	NA	2.27E-10
Total HI				**3.09E-02**					**2.10E-03**	
Total ILCR					**3.64E-07**					**1.69E-08**

DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
mg/cm^2-day = Milligrams per square centimeter per day.

Table B.1-3

Cancer Risk and Noncancer Hazard: Adult Hunter Exposure to Surface Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Concentration in Plant (mg/kg)	Concentration in Venison (mg/m^3)	Venison Consumption Noncancer Dose (mg/kg-day)	Venison Consumption Cancer Dose (mg/kg-day)	Venison Consumption HQ	Venison Consumption ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals									
Lead	5.88E+02	3.31E+01	1.73E-03	3.07E-07	1.32E-07	NA	NA	**NA**	**NA**
Nitroaromatics									
2-Amino-4,6-dinitrotoluene	9.23E+00	NA	NA	NA	NA	NA	NA	**9.00E-03**	**NA**
4-Amino-2,6-dinitrotoluene	5.98E+00	NA	NA	NA	NA	NA	NA	**5.83E-03**	**NA**
2,4,6-Trinitrotoluene	1.52E+02	NA	NA	NA	NA	NA	NA	**1.77E-02**	**1.14E-07**
Dinitrotoluene, total	7.36E+00	NA	NA	NA	NA	NA	NA	**4.20E-04**	**1.22E-07**
PCBs									
Aroclor 1260	2.48E+00	1.41E-02	3.88E-04	6.91E-08	2.96E-08	NA	5.92E-08	**NA**	**1.79E-07**
Semivolatile Organic Compounds									
Benzo(a)anthracene	1.17E-01	3.03E-03	6.06E-06	1.08E-09	4.62E-10	NA	3.38E-10	**NA**	**2.51E-09**
Benzo(a)pyrene	1.07E-01	1.43E-03	9.04E-06	1.61E-09	6.90E-10	NA	5.04E-09	**NA**	**2.49E-08**
Benzo(b)fluoranthene	1.62E-01	2.27E-03	1.31E-05	2.33E-09	9.97E-10	NA	7.28E-10	**NA**	**3.73E-09**
Total HI						**NA**		**3.30E-02**	
Total ILCR							**6.53E-08**		**4.46E-07**

DA = Dose absorbed per unit body surface area per
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
mg/cm^2-day = Milligrams per square centimeter per (

Table B.1-4

Cancer Risk and Noncancer Hazard: Child Venison Consumer
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Concentration in Plant (mg/kg)	Concentration in Venison (mg/m^3)	Venison Consumption Noncancer Dose (mg/kg-day)	Venison Consumption Cancer Dose (mg/kg-day)	Venison Consumption HQ	Venison Consumption ILCR
Metals							
Lead	5.88E+02	3.31E+01	1.73E-03	5.52E-07	4.73E-08	NA	NA
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	9.23E+00	NA	NA	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	5.98E+00	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	1.52E+02	NA	NA	NA	NA	NA	NA
Dinitrotoluene, total	7.36E+00	NA	NA	NA	NA	NA	NA
PCBs							
Aroclor 1260	2.48E+00	1.41E-02	3.88E-04	1.24E-07	1.06E-08	NA	2.12E-08
Semivolatile Organic Compounds							
Benzo(a)anthracene	1.17E-01	3.03E-03	6.06E-06	1.94E-09	1.66E-10	NA	1.21E-10
Benzo(a)pyrene	1.07E-01	1.43E-03	9.04E-06	2.89E-09	2.48E-10	NA	1.81E-09
Benzo(b)fluoranthene	1.62E-01	2.27E-03	1.31E-05	4.18E-09	3.58E-10	NA	2.61E-10
Total HI						**NA**	
Total ILCR							**2.34E-08**

HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.

Table B.1-5

TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Incidental Ingestion: Noncancer Dose (mg/kg-day)	Incidental Ingestion: Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption: Noncancer Dose (mg/kg-day)	Dermal Absorption: Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR
Metals										
Lead	1.19E+04	3.37E-02	2.41E-04	NA	NA	9.52E-06	1.05E-03	7.52E-06	NA	NA
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.36E+01	9.51E-05	6.81E-07	1.58E+00	NA	2.69E-07	2.96E-05	2.12E-07	8.23E-01	NA
4-Amino-2,6-dinitrotoluene	9.77E+00	2.77E-05	1.98E-07	4.61E-01	NA	7.82E-08	8.62E-06	6.17E-08	2.39E-01	NA
2-Nitrotoluene	5.82E+02	1.65E-03	1.18E-05	1.65E-01	NA	4.66E-06	5.13E-04	3.68E-06	5.70E-02	NA
3-Nitrotoluene	5.90E+01	1.67E-04	1.20E-06	1.67E-02	NA	4.72E-07	5.20E-05	3.73E-07	5.78E-03	NA
4-Nitrotoluene	4.84E+02	1.37E-03	9.81E-06	1.37E-01	NA	3.87E-06	4.27E-04	3.06E-06	4.74E-02	NA
2,4,6-Trinitrotoluene	2.59E+02	7.33E-04	5.25E-06	1.47E+00	1.57E-07	2.07E-06	2.28E-04	1.64E-06	7.62E-01	8.18E-08
PCB										
Aroclor 1260	6.98E+01	1.98E-04	1.41E-06	NA	2.83E-06	3.35E-07	3.69E-05	2.65E-07	NA	5.29E-07
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.91E+03	2.52E-02	1.81E-04	1.26E+01	1.23E-04	7.13E-05	7.86E-03	5.63E-05	3.93E+00	3.83E-05
2,6-Dinitrotoluene	1.03E+04	2.91E-02	2.08E-04	2.91E+01	1.42E-04	8.22E-05	9.06E-03	6.49E-05	9.06E+00	4.41E-05
Benzo(a)anthracene	2.95E-01	8.35E-07	5.98E-09	NA	4.36E-09	2.36E-09	2.60E-07	1.86E-09	NA	2.72E-09
Benzo(a)pyrene	2.18E-01	6.17E-07	4.42E-09	NA	3.23E-08	1.74E-09	1.92E-07	1.38E-09	NA	2.01E-08
Benzo(b)fluoranthene	3.05E-01	8.63E-07	6.18E-09	NA	4.51E-09	2.44E-09	2.69E-07	1.93E-09	NA	2.81E-09
Indeno(1,2,3-cd)pyrene	9.96E-02	2.82E-07	2.02E-09	NA	1.47E-09	7.97E-10	8.79E-08	6.29E-10	NA	9.19E-10
Total HI				**4.55E+01**					**1.49E+01**	
Total ILCR					**2.67E-04**					**8.31E-05**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm^2 = Milligrams per square centimeter.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.1-5

TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio
(Page 2 of 2)

Chemical	Source-Term Concentration (mg/kg)	Concentration in Air (mg/m^3)	Inhalation Noncancer Dose (mg/kg-day)	Inhalation Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals								
Lead	1.19E+04	4.17E-03	8.13E-04	5.82E-06	NA	NA	**NA**	**NA**
Nitroaromatics								
2-Amino-4,6-dinitrotoluene	3.36E+01	1.18E-05	2.30E-06	1.64E-08	NA	NA	**2.41E+00**	**NA**
4-Amino-2,6-dinitrotoluene	9.77E+00	3.42E-06	6.68E-07	4.78E-09	NA	NA	**7.00E-01**	**NA**
2-Nitrotoluene	5.82E+02	2.04E-04	3.98E-05	2.85E-07	NA	NA	**2.22E-01**	**NA**
3-Nitrotoluene	5.90E+01	2.07E-05	4.03E-06	2.89E-08	NA	NA	**2.25E-02**	**NA**
4-Nitrotoluene	4.84E+02	1.69E-04	3.31E-05	2.37E-07	NA	NA	**1.84E-01**	**NA**
2,4,6-Trinitrotoluene	2.59E+02	9.07E-05	1.77E-05	1.27E-07	NA	NA	**2.23E+00**	**2.39E-07**
PCB								
Aroclor 1260	6.98E+01	2.44E-05	4.77E-06	3.41E-08	NA	6.83E-08	**NA**	**3.43E-06**
Semivolatile Organic Compounds								
2,4-Dinitrotoluene	8.91E+03	3.12E-03	6.09E-04	4.36E-06	NA	NA	**1.65E+01**	**1.61E-04**
2,6-Dinitrotoluene	1.03E+04	3.60E-03	7.02E-04	5.03E-06	NA	NA	**3.81E+01**	**1.86E-04**
Benzo(a)anthracene	2.95E-01	1.03E-07	2.02E-08	1.44E-10	NA	4.47E-11	**NA**	**7.13E-09**
Benzo(a)pyrene	2.18E-01	7.63E-08	1.49E-08	1.07E-10	NA	3.31E-10	**NA**	**5.27E-08**
Benzo(b)fluoranthene	3.05E-01	1.07E-07	2.08E-08	1.49E-10	NA	4.63E-11	**NA**	**7.37E-09**
Indeno(1,2,3-cd)pyrene	9.96E-02	3.49E-08	6.80E-09	4.87E-11	NA	1.51E-11	**NA**	**2.41E-09**
Total HI					**NA**		**6.04E+01**	
Total ILCR						**6.87E-08**		**3.51E-04**

DA = Dose absorbed per unit body surface area per da
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm^2 = Milligrams per square centimeter.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.1-6

Cancer Risk: On-Site Resident Exposure to Total Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

(Page 1 of 2)

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Metals												
Lead	1.19E+04	5.03E-03	1.17E-02	NA	NA	NA	2.14E-05	4.58E-04	2.05E-04	NA	NA	NA
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	3.36E+01	1.42E-05	3.31E-05	NA	NA	NA	6.05E-07	1.29E-05	5.80E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	9.77E+00	4.13E-06	9.64E-06	NA	NA	NA	1.76E-07	3.76E-06	1.69E-06	NA	NA	NA
2-Nitrotoluene	5.82E+02	2.46E-04	5.74E-04	NA	NA	NA	1.05E-05	2.24E-04	1.00E-04	NA	NA	NA
3-Nitrotoluene	5.90E+01	2.49E-05	5.82E-05	NA	NA	NA	1.06E-06	2.27E-05	1.02E-05	NA	NA	NA
4-Nitrotoluene	4.84E+02	2.05E-04	4.77E-04	NA	NA	NA	8.71E-06	1.86E-04	8.35E-05	NA	NA	NA
2,4,6-Trinitrotoluene	2.59E+02	1.09E-04	2.55E-04	3.28E-06	7.66E-06	1.09E-05	4.66E-06	9.96E-05	4.47E-05	4.98E-06	2.24E-06	7.22E-06
PCB												
Aroclor 1260	6.98E+01	2.95E-05	6.88E-05	5.90E-05	1.38E-04	1.97E-04	7.54E-07	1.61E-05	7.23E-06	3.22E-05	1.45E-05	4.67E-05
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	8.91E+03	3.77E-03	8.79E-03	2.56E-03	5.98E-03	8.54E-03	1.60E-04	3.43E-03	1.54E-03	2.33E-03	1.05E-03	3.38E-03
2,6-Dinitrotoluene	1.03E+04	4.34E-03	1.01E-02	2.95E-03	6.89E-03	9.84E-03	1.85E-04	3.95E-03	1.77E-03	2.69E-03	1.21E-03	3.89E-03
Benzo(a)anthracene	2.95E-01	1.25E-07	2.91E-07	9.10E-08	2.12E-07	3.03E-07	5.31E-09	1.13E-07	5.09E-08	1.66E-07	7.43E-08	2.40E-07
Benzo(a)pyrene	2.18E-01	9.21E-08	2.15E-07	6.73E-07	1.57E-06	2.24E-06	3.92E-09	8.39E-08	3.76E-08	1.22E-06	5.49E-07	1.77E-06
Benzo(b)fluoranthene	3.05E-01	1.29E-07	3.01E-07	9.41E-08	2.20E-07	3.14E-07	5.49E-09	1.17E-07	5.26E-08	1.71E-07	7.69E-08	2.48E-07
Indeno(1,2,3-cd)pyrene	9.96E-02	4.21E-08	9.82E-08	3.07E-08	7.17E-08	1.02E-07	1.79E-09	3.83E-08	1.72E-08	5.59E-08	2.51E-08	8.10E-08
Total ILCR				**5.58E-03**	**1.30E-02**	**1.86E-02**				**5.06E-03**	**2.27E-03**	**7.33E-03**

DA = Dose absorbed per unit body surface area per day.
ILCR = Incremental lifetime cancer risk.
mg/cm^2 = Milligrams per square centimeter.

Table B.1-6

Cancer Risk: On-Site Resident Exposure to Total Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio
(Page 2 of 2)

Chemical	Source Term Concentration (mg/kg)	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Metals										
Lead	1.19E+04	7.62E-06	7.16E-07	4.18E-07	NA	NA	NA	**NA**	**NA**	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.36E+01	2.15E-08	2.02E-09	1.18E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	9.77E+00	6.26E-09	5.88E-10	3.43E-10	NA	NA	NA	**NA**	**NA**	**NA**
2-Nitrotoluene	5.82E+02	3.73E-07	3.50E-08	2.04E-08	NA	NA	NA	**NA**	**NA**	**NA**
3-Nitrotoluene	5.90E+01	3.78E-08	3.55E-09	2.07E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Nitrotoluene	4.84E+02	3.10E-07	2.91E-08	1.70E-08	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	2.59E+02	1.66E-07	1.56E-08	9.09E-09	NA	NA	NA	**8.27E-06**	**9.90E-06**	**1.82E-05**
PCB										
Aroclor 1260	6.98E+01	4.47E-08	4.20E-09	2.45E-09	8.40E-09	4.90E-09	1.33E-08	**9.12E-05**	**1.52E-04**	**2.43E-04**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.91E+03	5.71E-06	5.36E-07	3.13E-07	NA	NA	NA	**4.89E-03**	**7.02E-03**	**1.19E-02**
2,6-Dinitrotoluene	1.03E+04	6.58E-06	6.18E-07	3.61E-07	NA	NA	NA	**5.64E-03**	**8.10E-03**	**1.37E-02**
Benzo(a)anthracene	2.95E-01	1.89E-10	1.77E-11	1.04E-11	5.50E-12	3.21E-12	8.71E-12	**2.57E-07**	**2.87E-07**	**5.43E-07**
Benzo(a)pyrene	2.18E-01	1.40E-10	1.31E-11	7.65E-12	4.07E-11	2.37E-11	6.44E-11	**1.90E-06**	**2.12E-06**	**4.02E-06**
Benzo(b)fluoranthene	3.05E-01	1.95E-10	1.84E-11	1.07E-11	5.69E-12	3.32E-12	9.01E-12	**2.65E-07**	**2.96E-07**	**5.62E-07**
Indeno(1,2,3-cd)pyrene	9.96E-02	6.38E-11	5.99E-12	3.50E-12	1.86E-12	1.08E-12	2.94E-12	**8.67E-08**	**9.68E-08**	**1.83E-07**
Total ILCR					**8.45E-09**	**4.93E-09**	**1.34E-08**	**1.06E-02**	**1.53E-02**	**2.59E-02**

DA = Dose absorbed per unit body surface area per day.
ILCR = Incremental lifetime cancer risk.
mg/cm^2 = Milligrams per square centimeter.

Table B.1-7

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Metals										
Lead	1.19E+04	1.37E-01	NA	2.14E-05	2.40E-03	NA	7.62E-06	4.87E-06	NA	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.36E+01	3.87E-04	6.44E+00	6.05E-07	6.77E-05	1.88E+00	2.15E-08	1.38E-08	NA	**8.32E+00**
4-Amino-2,6-dinitrotoluene	9.77E+00	1.12E-04	1.87E+00	1.76E-07	1.97E-05	5.47E-01	6.26E-09	4.00E-09	NA	**2.42E+00**
2-Nitrotoluene	5.82E+02	6.70E-03	6.70E-01	1.05E-05	1.17E-03	1.30E-01	3.73E-07	2.38E-07	NA	**8.00E-01**
3-Nitrotoluene	5.90E+01	6.79E-04	6.79E-02	1.06E-06	1.19E-04	1.32E-02	3.78E-08	2.42E-08	NA	**8.11E-02**
4-Nitrotoluene	4.84E+02	5.57E-03	5.57E-01	8.71E-06	9.75E-04	1.08E-01	3.10E-07	1.98E-07	NA	**6.65E-01**
2,4,6-Trinitrotoluene	2.59E+02	2.98E-03	5.96E+00	4.66E-06	5.22E-04	1.74E+00	1.66E-07	1.06E-07	NA	**7.70E+00**
PCB										
Aroclor 1260	6.98E+01	8.03E-04	NA	7.54E-07	8.43E-05	NA	4.47E-08	2.86E-08	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.91E+03	1.03E-01	5.13E+01	1.60E-04	1.79E-02	8.97E+00	5.71E-06	3.65E-06	NA	**6.02E+01**
2,6-Dinitrotoluene	1.03E+04	1.18E-01	1.18E+02	1.85E-04	2.07E-02	2.07E+01	6.58E-06	4.21E-06	NA	**1.39E+02**
Benzo(a)anthracene	2.95E-01	3.39E-06	NA	5.31E-09	5.94E-07	NA	1.89E-10	1.21E-10	NA	**NA**
Benzo(a)pyrene	2.18E-01	2.51E-06	NA	3.92E-09	4.39E-07	NA	1.40E-10	8.93E-11	NA	**NA**
Benzo(b)fluoranthene	3.05E-01	3.51E-06	NA	5.49E-09	6.14E-07	NA	1.95E-10	1.25E-10	NA	**NA**
Indeno(1,2,3-cd)pyrene	9.96E-02	1.15E-06	NA	1.79E-09	2.01E-07	NA	6.38E-11	4.08E-11	NA	**NA**
Total HI			**1.85E+02**			**3.41E+01**			**NA**	**2.19E+02**

DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
mg/cm^2 = Milligrams per square centimeter.

Table B.1-8

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Surface Water
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/L)	DA (mg/cm^2-day)	Dermal Absorption Noncancer Dose (mg/kg-day)	Dermal Absorption Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR
Metals						
Arsenic	3.75E-03	1.50E-08	4.54E-07	3.25E-09	1.59E-03	5.13E-09
Manganese	9.58E-01	3.83E-06	1.16E-04	8.30E-07	4.93E-02	NA
Nitroaromatics						
4-Amino-2,6-dinitrotoluene	2.34E-03	1.00E-08	3.03E-07	2.17E-09	8.42E-03	NA
Total HI					**5.93E-02**	
Total ILCR						**5.13E-09**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/L = Milligrams per liter.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg-day = Milligrams per kilogram per day.
NA = Not applicable.

Table B.1-9

Cancer Risk: On-Site Resident Exposure to Surface Water
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/L)	DA (mg/cm^2-day)	Adult Dermally Absorbed Dose (mg/kg-day)	Child Dermally Absorbed Dose (mg/kg-day)	Adult On-Site Resident Dermal ILCR	Child On-Site Resident Dermal ILCR	On-Site Resident Dermal ILCR
Metals							
Arsenic	3.75E-03	1.13E-08	4.28E-08	1.92E-08	6.76E-08	3.04E-08	9.79E-08
Manganese	9.58E-01	2.87E-06	1.09E-05	4.91E-06	NA	NA	NA
Nitroaromatics							
4-Amino-2,6-dinitrotoluene	2.34E-03	7.51E-09	2.86E-08	1.28E-08	NA	NA	NA
Total ILCR					**6.76E-08**	**3.04E-08**	**9.79E-08**

DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
mg/L = Milligrams per liter.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg-day = Milligrams per kilogram per day.
NA = Not applicable.

Table B.1-10

Noncancer Hazard: On-Site Resident Child Exposure to Surface Water
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/L)	DA (mg/cm^2-day)	Dermally Absorbed Dose (mg/kg-day)	Dermal HQ
Metals				
Arsenic	3.75E-03	1.13E-08	2.24E-07	7.87E-04
Manganese	9.58E-01	2.87E-06	5.73E-05	2.44E-02
Nitroaromatics				
4-Amino-2,6-dinitrotoluene	2.34E-03	7.51E-09	1.50E-07	4.16E-03
Total HI				**2.93E-02**

DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
mg/L = Milligrams per liter.

Table B.1-11

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Sediment at On-Site Locations
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Noncancer Dose (mg/kg-day)	Dermal Absorption Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
PCBs												
Aroclor 1260	7.31E-01	2.07E-06	1.48E-08	NA	2.96E-08	1.05E-08	3.18E-07	2.28E-09	NA	4.56E-09	**NA**	**3.42E-08**
Semivolatile Organic Compounds												
Benzo(a)pyrene	1.36E-01	3.85E-07	2.76E-09	NA	2.01E-08	3.26E-09	9.87E-08	7.07E-10	NA	1.03E-08	**NA**	**3.04E-08**
Total HI				**NA**					**NA**		**NA**	
Total ILCR					**4.98E-08**					**1.49E-08**		**6.46E-08**

DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
mg/kg = Milligrams per kilogram.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg-day = mg/kg per day.
NA = Not applicable

Table B.1-12

Cancer Risk: On-Site Resident Exposure to Sediment at On-Site Locations
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Adult Ingested Dose (mg/kg-day)	Child Ingested Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR
PCBs						
Aroclor 1260	7.31E-01	3.43E-08	1.14E-10	6.87E-08	2.29E-10	6.89E-08
Semivolatile Organic Compounds						
Benzo(a)pyrene	1.36E-01	6.39E-09	2.13E-11	4.66E-08	1.55E-10	4.68E-08
Total ILCR				**1.15E-07**	**3.84E-10**	**1.16E-07**

DA = Dose absorbed per unit body surface area per day.
ILCR = Incremental lifetime cancer risk.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable.

Table B.1-12

Cancer Risk: On-Site Resident Exposure to Sediment at On-Site Locations
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	DA (mg/cm^2-day)	Adult Dermally Absorbed Dose (mg/kg-day)	Child Dermally Absorbed Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR	**Adult Resident Total All Pathways ILCR**	**Child Resident Total All Pathways ILCR**
PCBs									
Aroclor 1260	7.31E-01	8.77E-10	1.87E-08	1.20E-11	3.75E-08	2.40E-11	3.75E-08	**1.06E-07**	**2.53E-10**
Semivolatile Organic Compounds									
Benzo(a)pyrene	1.36E-01	2.72E-10	5.81E-09	3.73E-12	8.49E-08	5.44E-11	8.49E-08	**1.31E-07**	**2.10E-10**
Total ILCR					**1.22E-07**	**7.84E-11**	**1.22E-07**	**2.38E-07**	**4.63E-10**

DA = Dose absorbed per unit body surface area per day.
ILCR = Incremental lifetime cancer risk.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable.

Table B.1-12

Cancer Risk: On-Site Resident Exposure to Sediment at On-Site Locations
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

(Page 3 of 3)

Chemical	Source Term Concentration (mg/kg)	**On-Site Resident Total All Pathways ILCR**
PCBs		
Aroclor 1260	7.31E-01	**1.06E-07**
Semivolatile Organic Compounds		
Benzo(a)pyrene	1.36E-01	**1.32E-07**
Total ILCR		**2.38E-07**

DA = Dose absorbed per unit body surface area per day.
ILCR = Incremental lifetime cancer risk.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable.

Table B.1-13

Noncancer Hazard: On-Site Resident Child Exposure to Sediment at On-Site Locations
TNT Area A, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Child Ingested Dose (mg/kg-day)	Child Resident Oral HQ	DA (mg/cm^2-day)	Child Dermally Absorbed Dose (mg/kg-day)	Child Resident Dermal HQ	Child Resident Total All Pathways HI
PCBs							
Aroclor 1260	7.31E-01	1.34E-09	NA	8.77E-10	1.40E-10	NA	NA
Semivolatile Organic Compounds							
Benzo(a)pyrene	1.36E-01	2.48E-10	NA	2.72E-10	4.35E-11	NA	NA
Total HI			**NA**			**NA**	**NA**

DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable

Table B.1-14

COPCs in Soil Associated with Former Building 111
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion (RBSC)	TNTA-SO111 AA0441 1 - 2	TNTA-SO111 AA0468 4 - 6	TNTA-SO111 AA0469 8 - 10	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)					
Nitroaromatics					
4-Amino-2,6-dinitrotoluene	3.70E-01	ND	3.73E-01	ND	3.73E-01
PCBs					
Aroclor 1260	2.20E-02	1.33E-01	NA	ND	1.33E-01
Semivolatile Organic Compounds					
2,4-Dinitrotoluene	7.20E-02	ND	5.58E-01	ND	5.58E-01
2,6-Dinitrotoluene	7.20E-02	ND	2.08E-01	ND	2.08E-01

[a] Maximum detected concentration.
NA = Not Applicable (detected concentration did not exceed RBSC).
mg/kg = Milligrams per kilogram.
ND = Not Detected.

Table B.1-15

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Building 111, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA (mg/cm^2-day)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
4-Amino-2,6-dinitrotoluene	3.73E-01	1.06E-06	7.56E-09	1.76E-02	NA	2.98E-09	3.29E-07	2.36E-09	9.14E-03	NA	1.31E-07	2.55E-08	1.82E-10	NA	NA	**2.67E-02**	**NA**
PCBs																	
Aroclor 1260	1.33E-01	3.76E-07	2.70E-09	NA	5.39E-09	6.38E-10	7.04E-08	5.04E-10	NA	1.01E-09	4.66E-08	9.08E-09	6.51E-11	NA	1.30E-10	**NA**	**6.53E-09**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	5.58E-01	1.58E-06	1.13E-08	7.90E-04	7.69E-09	4.46E-09	4.92E-07	3.53E-09	2.46E-04	2.40E-09	1.95E-07	3.81E-08	2.73E-10	NA	NA	**1.04E-03**	**1.01E-08**
2,6-Dinitrotoluene	2.08E-01	5.89E-07	4.22E-09	5.89E-04	2.87E-09	1.66E-09	1.83E-07	1.31E-09	1.83E-04	8.94E-10	7.28E-08	1.42E-08	1.02E-10	NA	NA	**7.72E-04**	**3.76E-09**
Total HI				1.90E-02					9.57E-03					NA		**2.85E-02**	
Total ILCR					1.59E-08					4.30E-09					1.30E-10		**2.04E-08**

COPC = Chemical of Potential Concern.
DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = Milligrams per kilogram per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.

Table B.1-16

Cancer Risk: On-Site Resident Exposure to Total Soil
Building 111, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source-Term Concentration (mg/kg)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Nitroaromatics												
4-Amino-2,6-dinitrotoluene	3.73E-01	1.58E-07	3.68E-07	NA	NA	NA	6.71E-09	1.43E-07	6.44E-08	NA	NA	NA
PCBs												
Aroclor 1260	1.33E-01	5.62E-08	1.31E-07	1.12E-07	2.62E-07	3.75E-07	1.44E-09	3.07E-08	1.38E-08	6.14E-08	2.75E-08	8.89E-08
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	5.58E-01	2.36E-07	5.50E-07	1.60E-07	3.74E-07	5.35E-07	1.00E-08	2.15E-07	9.63E-08	1.46E-07	6.55E-08	2.11E-07
2,6-Dinitrotoluene	2.08E-01	8.79E-08	2.05E-07	5.98E-08	1.40E-07	1.99E-07	3.74E-09	8.00E-08	3.59E-08	5.44E-08	2.44E-08	7.88E-08
Total ILCR				3.33E-07	7.76E-07	1.11E-06				2.62E-07	1.17E-07	3.79E-07

COPC = Chemical of Potential Concern.
DA = Dose absorbed per unit body surface area per day.
ILCR = Incremental lifetime cancer risk.
mg/cm^2-day = Milligrams per square centimeter per day.

Table B.1-16

Cancer Risk: On-Site Resident Exposure to Total Soil
Building 111, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source-Term Concentration (mg/kg)	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	3.73E-01	2.39E-10	2.24E-11	1.31E-11	NA	NA	NA	**NA**	**NA**	**NA**
PCBs										
Aroclor 1260	1.33E-01	8.52E-11	8.00E-12	4.67E-12	1.60E-11	9.34E-12	2.53E-11	**1.74E-07**	**2.90E-07**	**4.64E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	5.58E-01	3.57E-10	3.36E-11	1.96E-11	NA	NA	NA	**3.06E-07**	**4.40E-07**	**7.46E-07**
2,6-Dinitrotoluene	2.08E-01	1.33E-10	1.25E-11	7.30E-12	NA	NA	NA	**1.14E-07**	**1.64E-07**	**2.78E-07**
Total ILCR					1.60E-11	9.34E-12	2.53E-11	**5.94E-07**	**8.94E-07**	**1.49E-06**

COPC = Chemical of Potential Concern.
DA = Dose absorbed per unit body surface area per day.
ILCR = Incremental lifetime cancer risk.
mg/cm^2-day = Milligrams per square centimeter per day.

Table B.1-17

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Building 111, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source-Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	3.73E-01	4.29E-06	7.15E-02	6.71E-09	7.51E-07	2.09E-02	2.39E-10	1.53E-10	NA	**9.24E-02**
PCBs										
Aroclor 1260	1.33E-01	1.53E-06	NA	1.44E-09	1.61E-07	NA	8.52E-11	4.67E-12	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	5.58E-01	6.42E-06	3.21E-03	1.00E-08	1.12E-06	5.62E-04	3.57E-10	1.96E-11	NA	**3.77E-03**
2,6-Dinitrotoluene	2.08E-01	2.39E-06	2.39E-03	3.74E-09	4.19E-07	4.19E-04	1.33E-10	7.30E-12	NA	**2.81E-03**
Total HI			7.71E-02			2.18E-02			NA	**9.90E-02**

COPC = Chemical of Potential Concern.
DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
mg/cm^2-day = Milligrams per square centimeter per day.

Table B.1-18

COPCs in Soil Associated with Former Building 112
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion (RBSC)	TNTA-SO409 AA0481 0.5 - 1.5	TNTA-SO128 AA0445 1.5 - 2.5	TNTA-SO123 AA0442AA0443 2 - 3	TNTA-SO128 AA0470 4 - 6	TNTA-SO128 AA0471 8 - 10	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)							
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	3.70E-01	5.90E-01	1.24E+00	ND	1.18E+00	2.43E+00	2.43E+00
4-Amino-2,6-dinitrotoluene	3.70E-01	7.39E-01	1.78E+00	ND	3.96E+00	1.62E+00	3.96E+00
2,4,6-Trinitrotoluene	1.60E+00	NA	3.99E+00	ND	7.89E+00	8.57E+00	8.57E+00
PCBs							
Aroclor 1260	2.20E-02	1.34E+00	3.52E-02	4.87E-01	4.48E-02	ND	1.34E+00
Semivolatile Organic Compounds							
2,4-Dinitrotoluene	7.20E-02	ND	ND	ND	ND	8.31E-01	8.31E-01
2,6-Dinitrotoluene	7.20E-02	ND	ND	ND	ND	2.48E-01	2.48E-01

[a] Maximum detected concentration.
NA = Not Applicable (detected concentration did not exceed RBSC).
ND = Not Detected.

Table B.1-19

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Building 112, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	2.43E+00	6.88E-06	4.93E-08	1.15E-01	NA	1.94E-08	2.14E-06	1.54E-08	5.95E-02	NA	8.51E-07	1.66E-07	1.19E-09	NA	NA	**1.74E-01**	**NA**
4-Amino-2,6-dinitrotoluene	3.96E+00	1.12E-05	8.03E-08	1.87E-01	NA	3.17E-08	3.49E-06	2.50E-08	9.70E-02	NA	1.39E-06	2.70E-07	1.94E-09	NA	NA	**2.84E-01**	**NA**
2,4,6-Trinitrotoluene	8.57E+00	2.43E-05	1.74E-07	4.85E-02	5.21E-09	6.86E-08	7.56E-06	5.41E-08	2.52E-02	2.71E-09	3.00E-06	5.85E-07	4.19E-09	NA	NA	**7.37E-02**	**7.92E-09**
PCBs																	
Aroclor 1260	1.34E+00	3.79E-06	2.72E-08	NA	5.43E-08	6.43E-09	7.09E-07	5.08E-09	NA	1.02E-08	4.69E-07	9.15E-08	6.56E-10	NA	1.31E-09	**NA**	**6.58E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	8.31E-01	2.35E-06	1.68E-08	1.18E-03	1.15E-08	6.65E-09	7.33E-07	5.25E-09	3.67E-04	3.57E-09	2.91E-07	5.68E-08	4.07E-10	NA	NA	**1.54E-03**	**1.50E-08**
2,6-Dinitrotoluene	2.48E-01	7.02E-07	5.03E-09	7.02E-04	3.42E-09	1.98E-09	2.19E-07	1.57E-09	2.19E-04	1.07E-09	8.68E-08	1.69E-08	1.21E-10	NA	NA	**9.21E-04**	**4.48E-09**
Total HI				3.52E-01					1.82E-01					NA		**5.34E-01**	
Total ILCR					7.44E-08					1.75E-08					1.31E-09		**9.32E-08**

COPC = Chemical of Potential Concern.
DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = Milligrams per kilogram per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.1-20

Cancer Risk: On-Site Resident Exposure to Total Soil
Building 112, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	2.43E+00	1.03E-06	2.40E-06	NA	NA	NA	4.37E-08	9.35E-07	4.19E-07	NA	NA	NA
4-Amino-2,6-dinitrotoluene	3.96E+00	1.67E-06	3.91E-06	NA	NA	NA	7.13E-08	1.52E-06	6.84E-07	NA	NA	NA
2,4,6-Trinitrotoluene	8.57E+00	3.62E-06	8.45E-06	1.09E-07	2.54E-07	3.62E-07	1.54E-07	3.30E-06	1.48E-06	1.65E-07	7.40E-08	2.39E-07
PCBs												
Aroclor 1260	1.34E+00	5.66E-07	1.32E-06	1.13E-06	2.64E-06	3.78E-06	1.45E-08	3.09E-07	1.39E-07	6.19E-07	2.78E-07	8.96E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	8.31E-01	3.51E-07	8.20E-07	2.39E-07	5.57E-07	7.96E-07	1.50E-08	3.20E-07	1.43E-07	2.17E-07	9.75E-08	3.15E-07
2,6-Dinitrotoluene	2.48E-01	1.05E-07	2.45E-07	7.13E-08	1.66E-07	2.38E-07	4.46E-09	9.54E-08	4.28E-08	6.49E-08	2.91E-08	9.40E-08
Total ILCR				1.55E-06	3.62E-06	5.17E-06				1.07E-06	4.78E-07	1.54E-06

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-20

Cancer Risk: On-Site Resident Exposure to Total Soil
Building 112, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	2.43E+00	1.56E-09	1.46E-10	8.53E-11	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	3.96E+00	2.54E-09	2.38E-10	1.39E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	8.57E+00	5.49E-09	5.16E-10	3.01E-10	NA	NA	NA	**2.74E-07**	**3.28E-07**	**6.01E-07**
PCBs										
Aroclor 1260	1.34E+00	8.58E-10	8.06E-11	4.70E-11	1.61E-10	9.41E-11	2.55E-10	**1.75E-06**	**2.92E-06**	**4.67E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.31E-01	5.32E-10	5.00E-11	2.92E-11	NA	NA	NA	**4.56E-07**	**6.55E-07**	**1.11E-06**
2,6-Dinitrotoluene	2.48E-01	1.59E-10	1.49E-11	8.70E-12	NA	NA	NA	**1.36E-07**	**1.95E-07**	**3.32E-07**
Total ILCR					1.61E-10	9.41E-11	2.55E-10	**2.62E-06**	**4.10E-06**	**6.72E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-21

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Building 112, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	2.43E+00	2.80E-05	4.66E-01	4.37E-08	4.89E-06	1.36E-01	1.56E-09	9.95E-10	NA	**6.02E-01**
4-Amino-2,6-dinitrotoluene	3.96E+00	4.56E-05	7.59E-01	7.13E-08	7.97E-06	2.22E-01	2.54E-09	1.62E-09	NA	**9.81E-01**
2,4,6-Trinitrotoluene	8.57E+00	9.86E-05	1.97E-01	1.54E-07	1.73E-05	5.75E-02	5.49E-09	3.51E-09	NA	**2.55E-01**
PCBs										
Aroclor 1260	1.34E+00	1.54E-05	NA	1.45E-08	1.62E-06	NA	8.58E-10	5.49E-10	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.31E-01	9.56E-06	4.78E-03	1.50E-08	1.67E-06	8.37E-04	5.32E-10	3.40E-10	NA	**5.62E-03**
2,6-Dinitrotoluene	2.48E-01	2.85E-06	2.85E-03	4.46E-09	4.99E-07	4.99E-04	1.59E-10	1.02E-10	NA	**3.35E-03**
Total HI			1.43E+00			4.16E-01			NA	**1.85E+00**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-22

COPCs in Soil Associated with Former Building 116
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO196 AA0446 1 - 2	TNTA-SO201 AA0472 4 - 6	TNTA-SO201 AA0473 8 - 10	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)					
Nitroaromatics					
Dinitrotoluene, total	7.20E-02	1.88E-01	ND	ND	1.88E-01
Semivolatile Organic Compounds					
Benzo(a)pyrene	6.20E-03	4.24E-02	ND	ND	4.24E-02

[a] Maximum detected concentration.
ND = Not Detected

Table B.1-23

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 116, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
Dinitrotoluene, total	1.88E-01	5.32E-07	3.81E-09	5.32E-04	2.59E-09	1.50E-09	1.66E-07	1.19E-09	1.66E-04	8.08E-10	6.58E-08	1.28E-08	9.20E-11	NA	NA	**6.98E-04**	**3.40E-09**
Semivolatile Organic Compounds																	
Benzo(a)pyrene	4.24E-02	1.20E-07	8.59E-10	NA	6.27E-09	3.39E-10	3.74E-08	2.68E-10	NA	3.91E-09	1.48E-08	2.90E-09	2.07E-11	NA	6.43E-11	**NA**	**1.02E-08**
Total HI				5.32E-04					1.66E-04					NA		**6.98E-04**	
Total ILCR					8.86E-09					4.72E-09					6.43E-11		**1.36E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-24

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 116, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
Dinitrotoluene, total	1.88E-01	7.95E-08	1.85E-07	5.40E-08	1.26E-07	1.80E-07	3.38E-09	7.23E-08	3.24E-08	4.92E-08	2.21E-08	7.12E-08
Semivolatile Organic Compounds												
Benzo(a)pyrene	4.24E-02	1.79E-08	4.18E-08	1.31E-07	3.05E-07	4.36E-07	7.63E-10	1.63E-08	7.32E-09	2.38E-07	1.07E-07	3.45E-07
Total ILCR				1.85E-07	4.31E-07	6.16E-07				2.87E-07	1.29E-07	4.16E-07

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-24

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 116, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
Dinitrotoluene, total	1.88E-01	1.20E-10	1.13E-11	6.60E-12	NA	NA	NA	**1.03E-07**	**1.48E-07**	**2.51E-07**
Semivolatile Organic Compounds										
Benzo(a)pyrene	4.24E-02	2.72E-11	2.55E-12	1.49E-12	7.91E-12	4.61E-12	1.25E-11	**3.69E-07**	**4.12E-07**	**7.81E-07**
Total ILCR					7.91E-12	4.61E-12	1.25E-11	**4.72E-07**	**5.60E-07**	**1.03E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-25

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 116, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
Dinitrotoluene, total	1.88E-01	2.16E-06	2.16E-03	3.38E-09	3.79E-07	3.79E-04	1.20E-10	7.70E-11	NA	**2.54E-03**
Semivolatile Organic Compounds										
Benzo(a)pyrene	4.24E-02	4.88E-07	NA	7.63E-10	8.54E-08	NA	2.72E-11	1.49E-12	NA	**NA**
Total HI			2.16E-03			3.79E-04			NA	**2.54E-03**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-26

COPCs in Soil Associated with Former Building 119
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO105 AA0440 2 - 3	TNTA-SO105 AA0466 4 - 6	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)				
Metals				
Lead	4.00E+02	1.66E+03	NA	1.66E+03
Nitroaromatics				
2-Amino-4,6-dinitrotoluene	3.70E-01	ND	3.36E+01	3.36E+01
4-Amino-2,6-dinitrotoluene	3.70E-01	9.91E+00	1.06E+01	1.06E+01
2-Nitrotoluene	3.70E+01	NA	5.82E+02	5.82E+02
3-Nitrotoluene	3.70E+01	NA	5.90E+01	5.90E+01
4-Nitrotoluene	3.70E+01	NA	4.84E+02	4.84E+02
2,4,6-Trinitrotoluene	1.60E+00	2.10E+01	NA	2.10E+01
PCBs				
Aroclor 1260	2.20E-02	5.55E+00	1.13E-01	5.55E+00
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	--	3.02E+01	3.02E+01
2,6-Dinitrotoluene	7.20E-02	6.18E+01	5.01E+00	6.18E+01

[a] Maximum detected concentration.
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected
-- = No result was available from this sample.

Table B.1-27

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 119, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals																	
Lead	1.66E+03	4.70E-03	3.36E-05	NA	NA	1.33E-06	1.46E-04	1.05E-06	NA	NA	5.81E-04	1.13E-04	8.12E-07	NA	NA	**NA**	**NA**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	3.36E+01	9.51E-05	6.81E-07	1.58E+00	NA	2.69E-07	2.96E-05	2.12E-07	8.23E-01	NA	1.18E-05	2.30E-06	1.64E-08	NA	NA	**2.41E+00**	**NA**
4-Amino-2,6-dinitrotoluene	1.06E+01	3.00E-05	2.15E-07	5.00E-01	NA	8.48E-08	9.35E-06	6.70E-08	2.60E-01	NA	3.71E-06	7.24E-07	5.19E-09	NA	NA	**7.60E-01**	**NA**
2-Nitrotoluene	5.82E+02	1.65E-03	1.18E-05	1.65E-01	NA	4.66E-06	5.13E-04	3.68E-06	5.70E-02	NA	2.04E-04	3.98E-05	2.85E-07	NA	NA	**2.22E-01**	**NA**
3-Nitrotoluene	5.90E+01	1.67E-04	1.20E-06	1.67E-02	NA	4.72E-07	5.20E-05	3.73E-07	5.78E-03	NA	2.07E-05	4.03E-06	2.89E-08	NA	NA	**2.25E-02**	**NA**
4-Nitrotoluene	4.84E+02	1.37E-03	9.81E-06	1.37E-01	NA	3.87E-06	4.27E-04	3.06E-06	4.74E-02	NA	1.69E-04	3.31E-05	2.37E-07	NA	NA	**1.84E-01**	**NA**
2,4,6-Trinitrotoluene	2.10E+01	5.94E-05	4.26E-07	1.19E-01	1.28E-08	1.68E-07	1.85E-05	1.33E-07	6.17E-02	6.63E-09	7.35E-06	1.43E-06	1.03E-08	NA	NA	**1.81E-01**	**1.94E-08**
PCBs																	
Aroclor 1260	5.55E+00	1.57E-05	1.12E-07	NA	2.25E-07	2.66E-08	2.94E-06	2.10E-08	NA	4.21E-08	1.94E-06	3.79E-07	2.72E-09	NA	5.43E-09	**NA**	**2.72E-07**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	3.02E+01	8.55E-05	6.12E-07	4.27E-02	4.16E-07	2.42E-07	2.66E-05	1.91E-07	1.33E-02	1.30E-07	1.06E-05	2.06E-06	1.48E-08	NA	NA	**5.61E-02**	**5.46E-07**
2,6-Dinitrotoluene	6.18E+01	1.75E-04	1.25E-06	1.75E-01	8.52E-07	4.94E-07	5.45E-05	3.90E-07	5.45E-02	2.66E-07	2.16E-05	4.22E-06	3.02E-08	NA	NA	**2.29E-01**	**1.12E-06**
Total HI				2.74E+00					1.32E+00					NA		**4.06E+00**	
Total ILCR					1.51E-06					4.44E-07					5.43E-09		**1.96E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-28

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 119, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Metals												
Lead	1.66E+03	7.02E-04	1.64E-03	NA	NA	NA	2.99E-06	6.39E-05	2.87E-05	NA	NA	NA
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	3.36E+01	1.42E-05	3.31E-05	NA	NA	NA	6.05E-07	1.29E-05	5.80E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.06E+01	4.48E-06	1.05E-05	NA	NA	NA	1.91E-07	4.08E-06	1.83E-06	NA	NA	NA
2-Nitrotoluene	5.82E+02	2.46E-04	5.74E-04	NA	NA	NA	1.05E-05	2.24E-04	1.00E-04	NA	NA	NA
3-Nitrotoluene	5.90E+01	2.49E-05	5.82E-05	NA	NA	NA	1.06E-06	2.27E-05	1.02E-05	NA	NA	NA
4-Nitrotoluene	4.84E+02	2.05E-04	4.77E-04	NA	NA	NA	8.71E-06	1.86E-04	8.35E-05	NA	NA	NA
2,4,6-Trinitrotoluene	2.10E+01	8.88E-06	2.07E-05	2.66E-07	6.21E-07	8.88E-07	3.78E-07	8.08E-06	3.62E-06	4.04E-07	1.81E-07	5.85E-07
PCBs												
Aroclor 1260	5.55E+00	2.35E-06	5.47E-06	4.69E-06	1.09E-05	1.56E-05	5.99E-08	1.28E-06	5.75E-07	2.56E-06	1.15E-06	3.71E-06
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	3.02E+01	1.28E-05	2.98E-05	8.68E-06	2.03E-05	2.89E-05	5.44E-07	1.16E-05	5.21E-06	7.90E-06	3.54E-06	1.14E-05
2,6-Dinitrotoluene	6.18E+01	2.61E-05	6.10E-05	1.78E-05	4.14E-05	5.92E-05	1.11E-06	2.38E-05	1.07E-05	1.62E-05	7.25E-06	2.34E-05
Total ILCR				3.14E-05	7.33E-05	1.05E-04				2.70E-05	1.21E-05	3.92E-05

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-28

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 119, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Metals										
Lead	1.66E+03	1.06E-06	9.99E-08	5.83E-08	NA	NA	NA	**NA**	**NA**	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.36E+01	2.15E-08	2.02E-09	1.18E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	1.06E+01	6.79E-09	6.38E-10	3.72E-10	NA	NA	NA	**NA**	**NA**	**NA**
2-Nitrotoluene	5.82E+02	3.73E-07	3.50E-08	2.04E-08	NA	NA	NA	**NA**	**NA**	**NA**
3-Nitrotoluene	5.90E+01	3.78E-08	3.55E-09	2.07E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Nitrotoluene	4.84E+02	3.10E-07	2.91E-08	1.70E-08	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	2.10E+01	1.35E-08	1.26E-09	7.37E-10	NA	NA	NA	**6.70E-07**	**8.03E-07**	**1.47E-06**
PCBs										
Aroclor 1260	5.55E+00	3.55E-09	3.34E-10	1.95E-10	6.68E-10	3.90E-10	1.06E-09	**7.25E-06**	**1.21E-05**	**1.94E-05**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	3.02E+01	1.93E-08	1.82E-09	1.06E-09	NA	NA	NA	**1.66E-05**	**2.38E-05**	**4.04E-05**
2,6-Dinitrotoluene	6.18E+01	3.96E-08	3.72E-09	2.17E-09	NA	NA	NA	**3.39E-05**	**4.87E-05**	**8.26E-05**
Total ILCR					6.68E-10	3.90E-10	1.06E-09	**5.84E-05**	**8.54E-05**	**1.44E-04**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-29

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 119, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Metals										
Lead	1.66E+03	1.91E-02	NA	2.99E-06	3.34E-04	NA	1.06E-06	6.80E-07	NA	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.36E+01	3.87E-04	6.44E+00	6.05E-07	6.77E-05	1.88E+00	2.15E-08	1.38E-08	NA	**8.32E+00**
4-Amino-2,6-dinitrotoluene	1.06E+01	1.22E-04	2.03E+00	1.91E-07	2.13E-05	5.93E-01	6.79E-09	4.34E-09	NA	**2.63E+00**
2-Nitrotoluene	5.82E+02	6.70E-03	6.70E-01	1.05E-05	1.17E-03	1.30E-01	3.73E-07	2.38E-07	NA	**8.00E-01**
3-Nitrotoluene	5.90E+01	6.79E-04	6.79E-02	1.06E-06	1.19E-04	1.32E-02	3.78E-08	2.42E-08	NA	**8.11E-02**
4-Nitrotoluene	4.84E+02	5.57E-03	5.57E-01	8.71E-06	9.75E-04	1.08E-01	3.10E-07	1.98E-07	NA	**6.65E-01**
2,4,6-Trinitrotoluene	2.10E+01	2.42E-04	4.83E-01	3.78E-07	4.23E-05	1.41E-01	1.35E-08	8.60E-09	NA	**6.24E-01**
PCBs										
Aroclor 1260	5.55E+00	6.39E-05	NA	5.99E-08	6.71E-06	NA	3.55E-09	2.27E-09	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	3.02E+01	3.48E-04	1.74E-01	5.44E-07	6.08E-05	3.04E-02	1.93E-08	1.24E-08	NA	**2.04E-01**
2,6-Dinitrotoluene	6.18E+01	7.11E-04	7.11E-01	1.11E-06	1.24E-04	1.24E-01	3.96E-08	2.53E-08	NA	**8.36E-01**
Total HI			1.11E+01			3.02E+00			NA	**1.42E+01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-30

COPCs in Soil Associated with Former Building 126
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO261 AA0447 1.5 - 2.5	TNTA-SO263 AA0448 2 - 3	TNTA-SO261 AA0474 4 - 6	TNTA-SO261 AA0475 8 - 10	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)						
Nitroaromatics						
2-Amino-4,6-dinitrotoluene	3.70E-01	4.67E-01	8.78E-01	ND	ND	8.78E-01
4-Amino-2,6-dinitrotoluene	3.70E-01	NA	5.99E-01	ND	ND	5.99E-01
2,4,6-Trinitrotoluene	1.60E+00	6.28E+01	NA	4.81E+00	2.59E+02	2.59E+02
PCBs						
Aroclor 1260	2.20E-02	3.46E-01	NA	ND	ND	3.46E-01
Semivolatile Organic Compounds						
2,4-Dinitrotoluene	7.20E-02	4.80E-01	ND	ND	ND	4.80E-01

[a] Maximum detected concentration.
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.1-31

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 126, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	8.78E-01	2.48E-06	1.78E-08	4.14E-02	NA	7.02E-09	7.75E-07	5.55E-09	2.15E-02	NA	3.07E-07	6.00E-08	4.30E-10	NA	NA	**6.29E-02**	**NA**
4-Amino-2,6-dinitrotoluene	5.99E-01	1.70E-06	1.21E-08	2.83E-02	NA	4.79E-09	5.28E-07	3.78E-09	1.47E-02	NA	2.10E-07	4.09E-08	2.93E-10	NA	NA	**4.29E-02**	**NA**
2,4,6-Trinitrotoluene	2.59E+02	7.33E-04	5.25E-06	1.47E+00	1.57E-07	2.07E-06	2.28E-04	1.64E-06	7.62E-01	8.18E-08	9.07E-05	1.77E-05	1.27E-07	NA	NA	**2.23E+00**	**2.39E-07**
PCBs																	
Aroclor 1260	3.46E-01	9.79E-07	7.01E-09	NA	1.40E-08	1.66E-09	1.83E-07	1.31E-09	NA	2.62E-09	1.21E-07	2.36E-08	1.69E-10	NA	3.39E-10	**NA**	**1.70E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	4.80E-01	1.36E-06	9.73E-09	6.79E-04	6.62E-09	3.84E-09	4.23E-07	3.03E-09	2.12E-04	2.06E-09	1.68E-07	3.28E-08	2.35E-10	NA	NA	**8.91E-04**	**8.68E-09**
Total HI				1.54E+00					7.98E-01					NA		**2.33E+00**	
Total ILCR					1.78E-07					8.65E-08					3.39E-10		**2.65E-07**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-32

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 126, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	8.78E-01	3.71E-07	8.66E-07	NA	NA	NA	1.58E-08	3.38E-07	1.52E-07	NA	NA	NA
4-Amino-2,6-dinitrotoluene	5.99E-01	2.53E-07	5.91E-07	NA	NA	NA	1.08E-08	2.30E-07	1.03E-07	NA	NA	NA
2,4,6-Trinitrotoluene	2.59E+02	1.09E-04	2.55E-04	3.28E-06	7.66E-06	1.09E-05	4.66E-06	9.96E-05	4.47E-05	4.98E-06	2.24E-06	7.22E-06
PCBs												
Aroclor 1260	3.46E-01	1.46E-07	3.41E-07	2.93E-07	6.83E-07	9.75E-07	3.74E-09	7.99E-08	3.58E-08	1.60E-07	7.17E-08	2.31E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	4.80E-01	2.03E-07	4.73E-07	1.38E-07	3.22E-07	4.60E-07	8.64E-09	1.85E-07	8.28E-08	1.26E-07	5.63E-08	1.82E-07
Total ILCR				3.71E-06	8.67E-06	1.24E-05				5.27E-06	2.36E-06	7.63E-06

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-32

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 126, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	8.78E-01	5.62E-10	5.28E-11	3.08E-11	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	5.99E-01	3.84E-10	3.60E-11	2.10E-11	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	2.59E+02	1.66E-07	1.56E-08	9.09E-09	NA	NA	NA	**8.27E-06**	**9.90E-06**	**1.82E-05**
PCBs										
Aroclor 1260	3.46E-01	2.22E-10	2.08E-11	1.21E-11	4.16E-11	2.43E-11	6.59E-11	**4.52E-07**	**7.54E-07**	**1.21E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	4.80E-01	3.07E-10	2.89E-11	1.68E-11	NA	NA	NA	**2.64E-07**	**3.78E-07**	**6.42E-07**
Total ILCR					4.16E-11	2.43E-11	6.59E-11	**8.98E-06**	**1.10E-05**	**2.00E-05**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-33

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 126, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	8.78E-01	1.01E-05	1.68E-01	1.58E-08	1.77E-06	4.91E-02	5.62E-10	3.60E-10	NA	**2.17E-01**
4-Amino-2,6-dinitrotoluene	5.99E-01	6.89E-06	1.15E-01	1.08E-08	1.21E-06	3.35E-02	3.84E-10	2.45E-10	NA	**1.48E-01**
2,4,6-Trinitrotoluene	2.59E+02	2.98E-03	5.96E+00	4.66E-06	5.22E-04	1.74E+00	1.66E-07	1.06E-07	NA	**7.70E+00**
PCBs										
Aroclor 1260	3.46E-01	3.98E-06	NA	3.74E-09	4.18E-07	NA	2.22E-10	1.42E-10	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	4.80E-01	5.52E-06	2.76E-03	8.64E-09	9.67E-07	4.83E-04	3.07E-10	1.97E-10	NA	**3.24E-03**
Total HI			6.25E+00			1.82E+00			NA	**8.07E+00**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-34

COPCs in Soil Associated with Former Building 129
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO303 AA0452 2 - 3	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)			
PCBs			
Aroclor 1260	2.20E-02	4.86E-02	4.86E-02

[a] Maximum detected concentration.

Table B.1-35

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Building 129, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
PCBs																	
Aroclor 1260	4.86E-02	1.38E-07	9.85E-10	NA	1.97E-09	2.33E-10	2.57E-08	1.84E-10	NA	3.68E-10	1.70E-08	3.32E-09	2.38E-11	NA	4.76E-11	**NA**	**2.39E-09**
Total HI				NA					NA					NA		**NA**	
Total ILCR					1.97E-09					3.68E-10					4.76E-11		**2.39E-09**

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-36

Cancer Risk: On-Site Resident Exposure to Total Soil
Building 129, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
PCBs												
Aroclor 1260	4.86E-02	2.05E-08	4.79E-08	4.11E-08	9.59E-08	1.37E-07	5.25E-10	1.12E-08	5.03E-09	2.24E-08	1.01E-08	3.25E-08
Total ILCR				4.11E-08	9.59E-08	1.37E-07				2.24E-08	1.01E-08	3.25E-08

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk

Table B.1-36

Cancer Risk: On-Site Resident Exposure to Total Soil
Building 129, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
PCBs										
Aroclor 1260	4.86E-02	3.11E-11	2.92E-12	1.71E-12	5.85E-12	3.41E-12	9.26E-12	**6.35E-08**	**1.06E-07**	**1.69E-07**
Total ILCR					5.85E-12	3.41E-12	9.26E-12	**6.35E-08**	**1.06E-07**	**1.69E-07**

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk

Table B.1-37

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Building 129, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
PCBs										
Aroclor 1260	4.86E-02	5.59E-07	NA	5.25E-10	5.87E-08	NA	3.11E-11	1.99E-11	NA	**NA**
Total HI			NA			NA			NA	**NA**

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-38

COPCs in Soil Associated with Former Building 131
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO062 AA0461 4 - 6	TNTA-SO062 AA0462 6 - 8	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)				
Nitroaromatics				
2-Amino-4,6-dinitrotoluene	3.70E-01	1.05E+00	9.49E+00	9.49E+00
4-Amino-2,6-dinitrotoluene	3.70E-01	2.24E+00	9.44E+00	9.44E+00
2-Nitrotoluene	3.70E+01	NA	1.52E+02	1.52E+02
4-Nitrotoluene	3.70E+01	NA	9.84E+01	9.84E+01
2,4,6-Trinitrotoluene	1.60E+00	NA	1.59E+01	1.59E+01
PCBs				
Aroclor 1260	2.20E-02	1.08E-01	2.51E-01	2.51E-01
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	1.73E+00	1.52E+01	1.52E+01
2,6-Dinitrotoluene	7.20E-02	1.50E+00	7.29E+00	7.29E+00

[a] Maximum detected concentration.
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.1-39

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 131, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	9.49E+00	2.69E-05	1.92E-07	4.48E-01	NA	7.59E-08	8.37E-06	6.00E-08	2.33E-01	NA	3.32E-06	6.48E-07	4.64E-09	NA	NA	**6.80E-01**	**NA**
4-Amino-2,6-dinitrotoluene	9.44E+00	2.67E-05	1.91E-07	4.45E-01	NA	7.55E-08	8.33E-06	5.96E-08	2.31E-01	NA	3.30E-06	6.45E-07	4.62E-09	NA	NA	**6.77E-01**	**NA**
2-Nitrotoluene	1.52E+02	4.30E-04	3.08E-06	4.30E-02	NA	1.22E-06	1.34E-04	9.60E-07	1.49E-02	NA	5.32E-05	1.04E-05	7.44E-08	NA	NA	**5.79E-02**	**NA**
4-Nitrotoluene	9.84E+01	2.78E-04	1.99E-06	2.78E-02	NA	7.87E-07	8.68E-05	6.22E-07	9.64E-03	NA	3.44E-05	6.72E-06	4.81E-08	NA	NA	**3.75E-02**	**NA**
2,4,6-Trinitrotoluene	1.59E+01	4.50E-05	3.22E-07	9.00E-02	9.67E-09	1.27E-07	1.40E-05	1.00E-07	4.68E-02	5.02E-09	5.57E-06	1.09E-06	7.78E-09	NA	NA	**1.37E-01**	**1.47E-08**
PCBs																	
Aroclor 1260	2.51E-01	7.10E-07	5.09E-09	NA	1.02E-08	1.20E-09	1.33E-07	9.52E-10	NA	1.90E-09	8.79E-08	1.71E-08	1.23E-10	NA	2.46E-10	**NA**	**1.23E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	1.52E+01	4.30E-05	3.08E-07	2.15E-02	2.09E-07	1.22E-07	1.34E-05	9.60E-08	6.70E-03	6.53E-08	5.32E-06	1.04E-06	7.44E-09	NA	NA	**2.82E-02**	**2.75E-07**
2,6-Dinitrotoluene	7.29E+00	2.06E-05	1.48E-07	2.06E-02	1.00E-07	5.83E-08	6.43E-06	4.61E-08	6.43E-03	3.13E-08	2.55E-06	4.98E-07	3.57E-09	NA	NA	**2.71E-02**	**1.32E-07**
Total HI				1.10E+00					5.48E-01					NA		**1.64E+00**	
Total ILCR					3.30E-07					1.04E-07					2.46E-10		**4.34E-07**

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-40

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 131, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	9.49E+00	4.01E-06	9.36E-06	NA	NA	NA	1.71E-07	3.65E-06	1.64E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	9.44E+00	3.99E-06	9.31E-06	NA	NA	NA	1.70E-07	3.63E-06	1.63E-06	NA	NA	NA
2-Nitrotoluene	1.52E+02	6.43E-05	1.50E-04	NA	NA	NA	2.74E-06	5.85E-05	2.62E-05	NA	NA	NA
4-Nitrotoluene	9.84E+01	4.16E-05	9.71E-05	NA	NA	NA	1.77E-06	3.79E-05	1.70E-05	NA	NA	NA
2,4,6-Trinitrotoluene	1.59E+01	6.72E-06	1.57E-05	2.02E-07	4.70E-07	6.72E-07	2.86E-07	6.12E-06	2.74E-06	3.06E-07	1.37E-07	4.43E-07
PCBs												
Aroclor 1260	2.51E-01	1.06E-07	2.48E-07	2.12E-07	4.95E-07	7.07E-07	2.71E-09	5.79E-08	2.60E-08	1.16E-07	5.20E-08	1.68E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	1.52E+01	6.43E-06	1.50E-05	4.37E-06	1.02E-05	1.46E-05	2.74E-07	5.85E-06	2.62E-06	3.98E-06	1.78E-06	5.76E-06
2,6-Dinitrotoluene	7.29E+00	3.08E-06	7.19E-06	2.10E-06	4.89E-06	6.98E-06	1.31E-07	2.80E-06	1.26E-06	1.91E-06	8.56E-07	2.76E-06
Total ILCR				6.88E-06	1.60E-05	2.29E-05				6.30E-06	2.83E-06	9.13E-06

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-40

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 131, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	9.49E+00	6.08E-09	5.71E-10	3.33E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	9.44E+00	6.05E-09	5.68E-10	3.31E-10	NA	NA	NA	**NA**	**NA**	**NA**
2-Nitrotoluene	1.52E+02	9.74E-08	9.15E-09	5.33E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Nitrotoluene	9.84E+01	6.30E-08	5.92E-09	3.45E-09	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	1.59E+01	1.02E-08	9.57E-10	5.58E-10	NA	NA	NA	**5.07E-07**	**6.08E-07**	**1.12E-06**
PCBs										
Aroclor 1260	2.51E-01	1.61E-10	1.51E-11	8.81E-12	3.02E-11	1.76E-11	4.78E-11	**3.28E-07**	**5.47E-07**	**8.75E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.52E+01	9.74E-09	9.15E-10	5.33E-10	NA	NA	NA	**8.34E-06**	**1.20E-05**	**2.03E-05**
2,6-Dinitrotoluene	7.29E+00	4.67E-09	4.39E-10	2.56E-10	NA	NA	NA	**4.00E-06**	**5.74E-06**	**9.75E-06**
Total ILCR					3.02E-11	1.76E-11	4.78E-11	**1.32E-05**	**1.89E-05**	**3.21E-05**

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-41

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 131, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	9.49E+00	1.09E-04	1.82E+00	1.71E-07	1.91E-05	5.31E-01	6.08E-09	3.89E-09	NA	**2.35E+00**
4-Amino-2,6-dinitrotoluene	9.44E+00	1.09E-04	1.81E+00	1.70E-07	1.90E-05	5.28E-01	6.05E-09	3.87E-09	NA	**2.34E+00**
2-Nitrotoluene	1.52E+02	1.75E-03	1.75E-01	2.74E-06	3.06E-04	3.40E-02	9.74E-08	6.22E-08	NA	**2.09E-01**
4-Nitrotoluene	9.84E+01	1.13E-03	1.13E-01	1.77E-06	1.98E-04	2.20E-02	6.30E-08	4.03E-08	NA	**1.35E-01**
2,4,6-Trinitrotoluene	1.59E+01	1.83E-04	3.66E-01	2.86E-07	3.20E-05	1.07E-01	1.02E-08	6.51E-09	NA	**4.73E-01**
PCBs										
Aroclor 1260	2.51E-01	2.89E-06	NA	2.71E-09	3.03E-07	NA	1.61E-10	1.03E-10	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.52E+01	1.75E-04	8.75E-02	2.74E-07	3.06E-05	1.53E-02	9.74E-09	6.22E-09	NA	**1.03E-01**
2,6-Dinitrotoluene	7.29E+00	8.39E-05	8.39E-02	1.31E-07	1.47E-05	1.47E-02	4.67E-09	2.99E-09	NA	**9.86E-02**
Total HI			4.46E+00			1.25E+00			NA	**5.71E+00**

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-42

COPCs in Soil Associated with Former Building 136
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO334 AA0453 1 - 2	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)			
Semivolatile Organic Compounds			
Benzo(a)anthracene	6.20E-02	1.17E-01	1.17E-01
Benzo(a)pyrene	6.20E-03	1.07E-01	1.07E-01
Benzo(b)fluoranthene	6.20E-02	1.62E-01	1.62E-01

[a] Maximum detected concentration.

Table B.1-43

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 136, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Semivolatile Organic Compounds																	
Benzo(a)anthracene	1.17E-01	3.31E-07	2.37E-09	NA	1.73E-09	9.36E-10	1.03E-07	7.39E-10	NA	1.08E-09	4.10E-08	7.99E-09	5.72E-11	NA	1.77E-11	**NA**	**2.83E-09**
Benzo(a)pyrene	1.07E-01	3.03E-07	2.17E-09	NA	1.58E-08	8.56E-10	9.44E-08	6.76E-10	NA	9.87E-09	3.75E-08	7.31E-09	5.23E-11	NA	1.62E-10	**NA**	**2.59E-08**
Benzo(b)fluoranthene	1.62E-01	4.58E-07	3.28E-09	NA	2.40E-09	1.30E-09	1.43E-07	1.02E-09	NA	1.49E-09	5.67E-08	1.11E-08	7.93E-11	NA	2.46E-11	**NA**	**3.92E-09**
Total HI				NA					NA					NA		**NA**	
Total ILCR					2.00E-08					1.24E-08					2.05E-10		**3.26E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-44

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 136, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Semivolatile Organic Compounds												
Benzo(a)anthracene	1.17E-01	4.95E-08	1.15E-07	3.61E-08	8.42E-08	1.20E-07	2.11E-09	4.50E-08	2.02E-08	6.57E-08	2.95E-08	9.52E-08
Benzo(a)pyrene	1.07E-01	4.52E-08	1.06E-07	3.30E-07	7.70E-07	1.10E-06	1.93E-09	4.12E-08	1.85E-08	6.01E-07	2.70E-07	8.71E-07
Benzo(b)fluoranthene	1.62E-01	6.85E-08	1.60E-07	5.00E-08	1.17E-07	1.67E-07	2.92E-09	6.23E-08	2.80E-08	9.10E-08	4.08E-08	1.32E-07
Total ILCR				4.16E-07	9.71E-07	1.39E-06				7.58E-07	3.40E-07	1.10E-06

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-44

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 136, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Semivolatile Organic Compounds										
Benzo(a)anthracene	1.17E-01	7.49E-11	7.04E-12	4.11E-12	2.18E-12	1.27E-12	3.46E-12	**1.02E-07**	**1.14E-07**	**2.16E-07**
Benzo(a)pyrene	1.07E-01	6.85E-11	6.44E-12	3.76E-12	2.00E-11	1.16E-11	3.16E-11	**9.31E-07**	**1.04E-06**	**1.97E-06**
Benzo(b)fluoranthene	1.62E-01	1.04E-10	9.75E-12	5.69E-12	3.02E-12	1.76E-12	4.78E-12	**1.41E-07**	**1.57E-07**	**2.98E-07**
Total ILCR					2.52E-11	1.47E-11	3.98E-11	**1.17E-06**	**1.31E-06**	**2.49E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-45

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 136, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Semivolatile Organic Compounds										
Benzo(a)anthracene	1.17E-01	1.35E-06	NA	2.11E-09	2.36E-07	NA	7.49E-11	4.79E-11	NA	**NA**
Benzo(a)pyrene	1.07E-01	1.23E-06	NA	1.93E-09	2.15E-07	NA	6.85E-11	4.38E-11	NA	**NA**
Benzo(b)fluoranthene	1.62E-01	1.86E-06	NA	2.92E-09	3.26E-07	NA	1.04E-10	6.63E-11	NA	**NA**
Total HI			NA			NA			NA	**NA**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-46

COPCs in Soil Associated with Former Building 139
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO040 AA0432 2 - 3	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)			
Metals			
Lead	4.00E+02	1.19E+04	1.19E+04
Nitroaromatics			
4-Amino-2,6-dinitrotoluene	3.70E-01	2.43E+00	2.43E+00
2,4,6-Trinitrotoluene	1.60E+00	7.21E+00	7.21E+00
PCBs			
Aroclor 1260	2.20E-02	6.98E+01	6.98E+01
Semivolatile Organic Compounds			
2,4-Dinitrotoluene	7.20E-02	4.72E+00	4.72E+00
2,6-Dinitrotoluene	7.20E-02	1.32E+00	1.32E+00

[a] Maximum detected concentration.

Table B.1-47

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 139, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals																	
Lead	1.19E+04	3.37E-02	2.41E-04	NA	NA	9.52E-06	1.05E-03	7.52E-06	NA	NA	4.17E-03	8.13E-04	5.82E-06	NA	NA	**NA**	**NA**
Nitroaromatics																	
4-Amino-2,6-dinitrotoluene	2.43E+00	6.88E-06	4.93E-08	1.15E-01	NA	1.94E-08	2.14E-06	1.54E-08	5.95E-02	NA	8.51E-07	1.66E-07	1.19E-09	NA	NA	**1.74E-01**	**NA**
2,4,6-Trinitrotoluene	7.21E+00	2.04E-05	1.46E-07	NA	2.92E-07	3.46E-08	3.82E-06	2.73E-08	NA	5.47E-08	2.52E-06	4.92E-07	3.53E-09	NA	7.05E-09	**NA**	**3.54E-07**
PCBs																	
Aroclor 1260	6.98E+01	1.98E-04	1.41E-06	NA	2.83E-06	3.35E-07	3.69E-05	2.65E-07	NA	5.29E-07	2.44E-05	4.77E-06	3.41E-08	NA	6.83E-08	**NA**	**3.43E-06**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	4.72E+00	1.34E-05	9.57E-08	6.68E-03	6.51E-08	3.78E-08	4.16E-06	2.98E-08	2.08E-03	2.03E-08	1.65E-06	3.22E-07	2.31E-09	NA	NA	**8.76E-03**	**8.53E-08**
2,6-Dinitrotoluene	1.32E+00	3.74E-06	2.68E-08	3.74E-03	1.82E-08	1.06E-08	1.16E-06	8.34E-09	1.16E-03	5.67E-09	4.62E-07	9.02E-08	6.46E-10	NA	NA	**4.90E-03**	**2.39E-08**
Total HI				1.25E-01					6.28E-02					NA		**1.88E-01**	
Total ILCR					3.20E-06					6.10E-07					7.54E-08		**3.89E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-48

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 139, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Metals												
Lead	1.19E+04	5.03E-03	1.17E-02	NA	NA	NA	2.14E-05	4.58E-04	2.05E-04	NA	NA	NA
Nitroaromatics												
4-Amino-2,6-dinitrotoluene	2.43E+00	1.03E-06	2.40E-06	NA	NA	NA	4.37E-08	9.35E-07	4.19E-07	NA	NA	NA
2,4,6-Trinitrotoluene	7.21E+00	3.05E-06	7.11E-06	6.10E-06	1.42E-05	2.03E-05	7.79E-08	1.66E-06	7.47E-07	3.33E-06	1.49E-06	4.82E-06
PCBs												
Aroclor 1260	6.98E+01	2.95E-05	6.88E-05	5.90E-05	1.38E-04	1.97E-04	7.54E-07	1.61E-05	7.23E-06	3.22E-05	1.45E-05	4.67E-05
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	4.72E+00	2.00E-06	4.66E-06	1.36E-06	3.17E-06	4.52E-06	8.50E-08	1.82E-06	8.15E-07	1.23E-06	5.54E-07	1.79E-06
2,6-Dinitrotoluene	1.32E+00	5.58E-07	1.30E-06	3.79E-07	8.85E-07	1.26E-06	2.38E-08	5.08E-07	2.28E-07	3.45E-07	1.55E-07	5.00E-07
Total ILCR				6.68E-05	1.56E-04	2.23E-04				3.71E-05	1.67E-05	5.38E-05

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-48

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 139, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Metals										
Lead	1.19E+04	7.62E-06	7.16E-07	4.18E-07	NA	NA	NA	**NA**	**NA**	**NA**
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	2.43E+00	1.56E-09	1.46E-10	8.53E-11	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	7.21E+00	4.62E-09	4.34E-10	2.53E-10	8.68E-10	5.06E-10	1.37E-09	**9.42E-06**	**1.57E-05**	**2.51E-05**
PCBs										
Aroclor 1260	6.98E+01	4.47E-08	4.20E-09	2.45E-09	8.40E-09	4.90E-09	1.33E-08	**9.12E-05**	**1.52E-04**	**2.43E-04**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	4.72E+00	3.02E-09	2.84E-10	1.66E-10	NA	NA	NA	**2.59E-06**	**3.72E-06**	**6.31E-06**
2,6-Dinitrotoluene	1.32E+00	8.45E-10	7.94E-11	4.63E-11	NA	NA	NA	**7.25E-07**	**1.04E-06**	**1.76E-06**
Total ILCR					9.27E-09	5.41E-09	1.47E-08	**1.04E-04**	**1.73E-04**	**2.77E-04**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-49

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 139, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Metals										
Lead	1.19E+04	1.37E-01	NA	2.14E-05	2.40E-03	NA	7.62E-06	4.87E-06	NA	**NA**
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	2.43E+00	2.80E-05	4.66E-01	4.37E-08	4.89E-06	1.36E-01	1.56E-09	9.95E-10	NA	**6.02E-01**
2,4,6-Trinitrotoluene	7.21E+00	8.30E-05	NA	7.79E-08	8.71E-06	NA	4.62E-09	2.95E-09	NA	**NA**
PCBs										
Aroclor 1260	6.98E+01	8.03E-04	NA	7.54E-07	8.43E-05	NA	4.47E-08	2.86E-08	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	4.72E+00	5.43E-05	2.72E-02	8.50E-08	9.50E-06	4.75E-03	3.02E-09	1.93E-09	NA	**3.19E-02**
2,6-Dinitrotoluene	1.32E+00	1.52E-05	1.52E-02	2.38E-08	2.66E-06	2.66E-03	8.45E-10	5.40E-10	NA	**1.78E-02**
Total HI			5.08E-01			1.43E-01			NA	**6.52E-01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-50

COPCs in Soil Associated with Former Building 141
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO297 AA0451 1 - 2	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)			
Nitroaromatics			
2-Amino-4,6-dinitrotoluene	3.70E-01	4.83E+00	4.83E+00
4-Amino-2,6-dinitrotoluene	3.70E-01	4.22E+00	4.22E+00
2,4,6-Trinitrotoluene	1.60E+00	1.15E+01	1.15E+01
Dinitrotoluene, total	7.20E-02	7.36E+00	7.36E+00
PCB			
Aroclor 1260	2.20E-02	2.15E-01	2.15E-01
Semivolatile Organic Compounds			
Benzo(a)pyrene	6.20E-03	4.84E-02	4.84E-02
Benzo(b)fluoranthene	6.20E-02	1.27E-01	1.27E-01

[a] Maximum detected concentration.

Table B.1-51

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 141, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	4.83E+00	1.37E-05	9.79E-08	2.28E-01	NA	3.86E-08	4.26E-06	3.05E-08	1.18E-01	NA	1.69E-06	3.30E-07	2.36E-09	NA	NA	**3.46E-01**	**NA**
4-Amino-2,6-dinitrotoluene	4.22E+00	1.19E-05	8.55E-08	1.99E-01	NA	3.38E-08	3.72E-06	2.67E-08	1.03E-01	NA	1.48E-06	2.88E-07	2.06E-09	NA	NA	**3.02E-01**	**NA**
2,4,6-Trinitrotoluene	1.15E+01	3.25E-05	2.33E-07	6.51E-02	6.99E-09	9.20E-08	1.01E-05	7.27E-08	3.38E-02	3.63E-09	4.03E-06	7.86E-07	5.63E-09	NA	NA	**9.89E-02**	**1.06E-08**
Dinitrotoluene, total	7.36E+00	2.08E-05	1.49E-07	2.08E-02	1.01E-07	5.89E-08	6.49E-06	4.65E-08	6.49E-03	3.16E-08	2.58E-06	5.03E-07	3.60E-09	NA	NA	**2.73E-02**	**1.33E-07**
PCB																	
Aroclor 1260	2.15E-01	6.08E-07	4.36E-09	NA	8.72E-09	1.03E-09	1.14E-07	8.15E-10	NA	1.63E-09	7.53E-08	1.47E-08	1.05E-10	NA	2.10E-10	**NA**	**1.06E-08**
Semivolatile Organic Compounds																	
Benzo(a)pyrene	4.84E-02	1.37E-07	9.81E-10	NA	7.16E-09	3.87E-10	4.27E-08	3.06E-10	NA	4.46E-09	1.69E-08	3.31E-09	2.37E-11	NA	7.34E-11	**NA**	**1.17E-08**
Benzo(b)fluoranthene	1.27E-01	3.59E-07	2.57E-09	NA	1.88E-09	1.02E-09	1.12E-07	8.02E-10	NA	1.17E-09	4.45E-08	8.67E-09	6.21E-11	NA	1.93E-11	**NA**	**3.07E-09**
Total HI				5.13E-01					2.62E-01					NA		**7.75E-01**	
Total ILCR					1.26E-07					4.25E-08					3.03E-10		**1.69E-07**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-52

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 141, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	4.83E+00	2.04E-06	4.76E-06	NA	NA	NA	8.69E-08	1.86E-06	8.34E-07	NA	NA	NA
4-Amino-2,6-dinitrotoluene	4.22E+00	1.78E-06	4.16E-06	NA	NA	NA	7.60E-08	1.62E-06	7.28E-07	NA	NA	NA
2,4,6-Trinitrotoluene	1.15E+01	4.86E-06	1.13E-05	1.46E-07	3.40E-07	4.86E-07	2.07E-07	4.42E-06	1.98E-06	2.21E-07	9.92E-08	3.20E-07
Dinitrotoluene, total	7.36E+00	3.11E-06	7.26E-06	2.12E-06	4.94E-06	7.05E-06	1.32E-07	2.83E-06	1.27E-06	1.93E-06	8.64E-07	2.79E-06
PCB												
Aroclor 1260	2.15E-01	9.09E-08	2.12E-07	1.82E-07	4.24E-07	6.06E-07	2.32E-09	4.96E-08	2.23E-08	9.92E-08	4.45E-08	1.44E-07
Semivolatile Organic Compounds												
Benzo(a)pyrene	4.84E-02	2.05E-08	4.77E-08	1.49E-07	3.48E-07	4.98E-07	8.71E-10	1.86E-08	8.35E-09	2.72E-07	1.22E-07	3.94E-07
Benzo(b)fluoranthene	1.27E-01	5.37E-08	1.25E-07	3.92E-08	9.14E-08	1.31E-07	2.29E-09	4.89E-08	2.19E-08	7.13E-08	3.20E-08	1.03E-07
Total ILCR				2.63E-06	6.14E-06	8.77E-06				2.59E-06	1.16E-06	3.75E-06

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-52

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 141, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	4.83E+00	3.09E-09	2.91E-10	1.70E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	4.22E+00	2.70E-09	2.54E-10	1.48E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	1.15E+01	7.37E-09	6.92E-10	4.04E-10	NA	NA	NA	**3.67E-07**	**4.40E-07**	**8.07E-07**
Dinitrotoluene, total	7.36E+00	4.71E-09	4.43E-10	2.58E-10	NA	NA	NA	**4.04E-06**	**5.80E-06**	**9.84E-06**
PCB										
Aroclor 1260	2.15E-01	1.38E-10	1.29E-11	7.55E-12	2.59E-11	1.51E-11	4.10E-11	**2.81E-07**	**4.69E-07**	**7.50E-07**
Semivolatile Organic Compounds										
Benzo(a)pyrene	4.84E-02	3.10E-11	2.91E-12	1.70E-12	9.03E-12	5.27E-12	1.43E-11	**4.21E-07**	**4.70E-07**	**8.92E-07**
Benzo(b)fluoranthene	1.27E-01	8.13E-11	7.64E-12	4.46E-12	2.37E-12	1.38E-12	3.75E-12	**1.11E-07**	**1.23E-07**	**2.34E-07**
Total ILCR					3.73E-11	2.17E-11	5.90E-11	**5.22E-06**	**7.30E-06**	**1.25E-05**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-53

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 141, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	4.83E+00	5.56E-05	9.26E-01	8.69E-08	9.73E-06	2.70E-01	3.09E-09	1.98E-09	NA	**1.20E+00**
4-Amino-2,6-dinitrotoluene	4.22E+00	4.86E-05	8.09E-01	7.60E-08	8.50E-06	2.36E-01	2.70E-09	1.73E-09	NA	**1.05E+00**
2,4,6-Trinitrotoluene	1.15E+01	1.32E-04	2.65E-01	2.07E-07	2.32E-05	7.72E-02	7.37E-09	4.71E-09	NA	**3.42E-01**
Dinitrotoluene, total	7.36E+00	8.47E-05	8.47E-02	1.32E-07	1.48E-05	1.48E-02	4.71E-09	3.01E-09	NA	**9.95E-02**
PCB										
Aroclor 1260	2.15E-01	2.47E-06	NA	2.32E-09	2.60E-07	NA	1.38E-10	8.80E-11	NA	**NA**
Semivolatile Organic Compounds										
Benzo(a)pyrene	4.84E-02	5.57E-07	NA	8.71E-10	9.75E-08	NA	3.10E-11	1.98E-11	NA	**NA**
Benzo(b)fluoranthene	1.27E-01	1.46E-06	NA	2.29E-09	2.56E-07	NA	8.13E-11	5.20E-11	NA	**NA**
Total HI			2.08E+00			5.98E-01			NA	**2.68E+00**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-54

COPCs in Soil Associated with Former Building 142
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO016 AA0427 0 - 1	TNTA-SO016 AA0428AA0429 2 - 3	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)				
Metals				
Lead	4.00E+02	5.88E+02	NA	5.88E+02
Nitroaromatics				
2-Amino-4,6-dinitrotoluene	3.70E-01	ND	3.25E+00	3.25E+00
4-Amino-2,6-dinitrotoluene	3.70E-01	NA	1.69E+00	1.69E+00
Dinitrotoluene, total	7.20E-02	1.46E+00	ND	1.46E+00
PCBs				
Aroclor 1260	2.20E-02	2.48E+00	3.29E-02	2.48E+00
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	ND	3.43E-01	3.43E-01
2,6-Dinitrotoluene	7.20E-02	ND	1.19E-01	1.19E-01

[a] Maximum detected concentration.
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.1-55

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 142, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals																	
Lead	5.88E+02	1.66E-03	1.19E-05	NA	NA	4.70E-07	5.19E-05	3.72E-07	NA	NA	2.06E-04	4.02E-05	2.88E-07	NA	NA	**NA**	**NA**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	3.25E+00	9.18E-06	6.58E-08	1.53E-01	NA	2.60E-08	2.86E-06	2.05E-08	7.95E-02	NA	1.14E-06	2.22E-07	1.59E-09	NA	NA	**2.33E-01**	**NA**
4-Amino-2,6-dinitrotoluene	1.69E+00	4.77E-06	3.42E-08	7.95E-02	NA	1.35E-08	1.49E-06	1.06E-08	4.13E-02	NA	5.90E-07	1.15E-07	8.24E-10	NA	NA	**1.21E-01**	**NA**
Dinitrotoluene, total	1.46E+00	4.13E-06	2.96E-08	4.13E-03	2.01E-08	1.17E-08	1.29E-06	9.22E-09	1.29E-03	6.27E-09	5.11E-07	9.97E-08	7.14E-10	NA	NA	**5.42E-03**	**2.64E-08**
PCBs																	
Aroclor 1260	2.48E+00	7.02E-06	5.03E-08	NA	1.01E-07	1.19E-08	1.31E-06	9.40E-09	NA	1.88E-08	8.68E-07	1.69E-07	1.21E-09	NA	2.43E-09	**NA**	**1.22E-07**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	3.43E-01	9.69E-07	6.94E-09	4.85E-04	4.72E-09	2.74E-09	3.02E-07	2.16E-09	1.51E-04	1.47E-09	1.20E-07	2.34E-08	1.68E-10	NA	NA	**6.36E-04**	**6.19E-09**
2,6-Dinitrotoluene	1.19E-01	3.38E-07	2.42E-09	3.38E-04	1.65E-09	9.56E-10	1.05E-07	7.55E-10	1.05E-04	5.13E-10	4.18E-08	8.16E-09	5.84E-11	NA	NA	**4.43E-04**	**2.16E-09**
Total HI				2.37E-01					1.22E-01					NA		**3.60E-01**	
Total ILCR					1.27E-07					2.71E-08					2.43E-09		**1.57E-07**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-56

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 142, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Metals												
Lead	5.88E+02	2.49E-04	5.80E-04	NA	NA	NA	1.06E-06	2.26E-05	1.01E-05	NA	NA	NA
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	3.25E+00	1.37E-06	3.20E-06	NA	NA	NA	5.84E-08	1.25E-06	5.60E-07	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.69E+00	7.12E-07	1.66E-06	NA	NA	NA	3.03E-08	6.48E-07	2.91E-07	NA	NA	NA
Dinitrotoluene, total	1.46E+00	6.17E-07	1.44E-06	4.20E-07	9.79E-07	1.40E-06	2.63E-08	5.62E-07	2.52E-07	3.8E-07	1.7E-07	5.5E-07
PCBs												
Aroclor 1260	2.48E+00	1.05E-06	2.45E-06	2.10E-06	4.89E-06	6.99E-06	2.68E-08	5.72E-07	2.57E-07	1.1E-06	5.1E-07	1.7E-06
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	3.43E-01	1.45E-07	3.38E-07	9.84E-08	2.30E-07	3.28E-07	6.17E-09	1.32E-07	5.91E-08	9E-08	4E-08	1.3E-07
2,6-Dinitrotoluene	1.19E-01	5.05E-08	1.18E-07	3.43E-08	8.01E-08	1.14E-07	2.15E-09	4.59E-08	2.06E-08	3.1E-08	1.4E-08	4.5E-08
Total ILCR				2.65E-06	6.18E-06	8.83E-06				1.65E-06	7.39E-07	2.39E-06

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-56

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 142, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Metals										
Lead	5.88E+02	3.77E-07	3.54E-08	2.06E-08	NA	NA	NA	**NA**	**NA**	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.25E+00	2.08E-09	1.95E-10	1.14E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	1.69E+00	1.08E-09	1.01E-10	5.91E-11	NA	NA	NA	**NA**	**NA**	**NA**
Dinitrotoluene, total	1.46E+00	9.35E-10	8.78E-11	5.12E-11	NA	NA	NA	**8.02E-07**	**1.15E-06**	**1.95E-06**
PCBs										
Aroclor 1260	2.48E+00	1.59E-09	1.49E-10	8.70E-11	2.98E-10	1.74E-10	4.73E-10	**3.24E-06**	**5.41E-06**	**8.65E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	3.43E-01	2.19E-10	2.06E-11	1.20E-11	NA	NA	NA	**1.88E-07**	**2.70E-07**	**4.58E-07**
2,6-Dinitrotoluene	1.19E-01	7.65E-11	7.19E-12	4.19E-12	NA	NA	NA	**6.56E-08**	**9.41E-08**	**1.60E-07**
Total ILCR					2.98E-10	1.74E-10	4.73E-10	**4.30E-06**	**6.92E-06**	**1.12E-05**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-57

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 142, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Metals										
Lead	5.88E+02	6.77E-03	NA	1.06E-06	1.18E-04	NA	3.77E-07	2.41E-07	NA	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.25E+00	3.73E-05	6.22E-01	5.84E-08	6.53E-06	1.82E-01	2.08E-09	1.33E-09	NA	**8.04E-01**
4-Amino-2,6-dinitrotoluene	1.69E+00	1.94E-05	3.23E-01	3.03E-08	3.39E-06	9.43E-02	1.08E-09	6.90E-10	NA	**4.17E-01**
Dinitrotoluene, total	1.46E+00	1.68E-05	1.68E-02	2.63E-08	2.94E-06	2.94E-03	9.35E-10	5.98E-10	NA	**1.97E-02**
PCBs										
Aroclor 1260	2.48E+00	2.85E-05	NA	2.68E-08	3.00E-06	NA	1.59E-09	1.02E-09	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	3.43E-01	3.94E-06	1.97E-03	6.17E-09	6.90E-07	3.45E-04	2.19E-10	1.40E-10	NA	**2.32E-03**
2,6-Dinitrotoluene	1.19E-01	1.37E-06	1.37E-03	2.15E-09	2.41E-07	2.41E-04	7.65E-11	4.89E-11	NA	**1.62E-03**
Total HI			9.66E-01			2.79E-01			NA	**1.24E+00**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-58

COPCs in Soil Associated with Former Building 143
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO035 AA0431 1.5 - 2.5	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)			
Nitroaromatics			
2-Amino-4,6-dinitrotoluene	3.70E-01	5.01E-01	5.01E-01
4-Amino-2,6-dinitrotoluene	3.70E-01	4.09E-01	4.09E-01
PCBs			
Aroclor 1260	2.20E-02	5.30E-02	5.30E-02
Semivolatile Organic Compounds			
2,4-Dinitrotoluene	7.20E-02	3.01E-01	3.01E-01
2,6-Dinitrotoluene	7.20E-02	3.47E-01	3.47E-01
Benzo(a)anthracene	6.20E-02	2.95E-01	2.95E-01
Benzo(a)pyrene	6.20E-03	2.18E-01	2.18E-01
Benzo(b)fluoranthene	6.20E-02	3.05E-01	3.05E-01
Indeno(1,2,3-cd)pyrene	6.20E-02	9.96E-02	9.96E-02

[a] Maximum detected concentration.

Table B.1-59

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 143, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	5.01E-01	1.42E-06	1.02E-08	2.36E-02	NA	4.01E-09	4.42E-07	3.17E-09	1.23E-02	NA	1.75E-07	3.42E-08	2.45E-10	NA	NA	**3.59E-02**	**NA**
4-Amino-2,6-dinitrotoluene	4.09E-01	1.16E-06	8.29E-09	1.93E-02	NA	3.27E-09	3.61E-07	2.58E-09	1.00E-02	NA	1.43E-07	2.79E-08	2.00E-10	NA	NA	**2.93E-02**	**NA**
PCBs																	
Aroclor 1260	5.30E-02	1.50E-07	1.07E-09	NA	2.15E-09	2.54E-10	2.81E-08	2.01E-10	NA	4.02E-10	1.86E-08	3.62E-09	2.59E-11	NA	5.19E-11	**NA**	**2.60E-09**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	3.01E-01	8.52E-07	6.10E-09	4.26E-04	4.15E-09	2.41E-09	2.66E-07	1.90E-09	1.33E-04	1.29E-09	1.05E-07	2.06E-08	1.47E-10	NA	NA	**5.59E-04**	**5.44E-09**
2,6-Dinitrotoluene	3.47E-01	9.82E-07	7.03E-09	9.82E-04	4.78E-09	2.78E-09	3.06E-07	2.19E-09	3.06E-04	1.49E-09	1.21E-07	2.37E-08	1.70E-10	NA	NA	**1.29E-03**	**6.27E-09**
Benzo(a)anthracene	2.95E-01	8.35E-07	5.98E-09	NA	4.36E-09	2.36E-09	2.60E-07	1.86E-09	NA	2.72E-09	1.03E-07	2.02E-08	1.44E-10	NA	4.47E-11	**NA**	**7.13E-09**
Benzo(a)pyrene	2.18E-01	6.17E-07	4.42E-09	NA	3.23E-08	1.74E-09	1.92E-07	1.38E-09	NA	2.01E-08	7.63E-08	1.49E-08	1.07E-10	NA	3.31E-10	**NA**	**5.27E-08**
Benzo(b)fluoranthene	3.05E-01	8.63E-07	6.18E-09	NA	4.51E-09	2.44E-09	2.69E-07	1.93E-09	NA	2.81E-09	1.07E-07	2.08E-08	1.49E-10	NA	4.63E-11	**NA**	**7.37E-09**
Indeno(1,2,3-cd)pyrene	9.96E-02	2.82E-07	2.02E-09	NA	1.47E-09	7.97E-10	8.79E-08	6.29E-10	NA	9.19E-10	3.49E-08	6.80E-09	4.87E-11	NA	1.51E-11	**NA**	**2.41E-09**
Tota HI				4.43E-02					2.27E-02					NA		**6.71E-02**	
Total ILCR					5.37E-08					2.97E-08					4.89E-10		**8.39E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-60

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 143, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	5.01E-01	2.12E-07	4.94E-07	NA	NA	NA	9.02E-09	1.93E-07	8.65E-08	NA	NA	NA
4-Amino-2,6-dinitrotoluene	4.09E-01	1.73E-07	4.03E-07	NA	NA	NA	7.36E-09	1.57E-07	7.06E-08	NA	NA	NA
PCBs												
Aroclor 1260	5.30E-02	2.24E-08	5.23E-08	4.48E-08	1.05E-07	1.49E-07	5.72E-10	1.22E-08	5.49E-09	2.45E-08	1.10E-08	3.54E-08
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	3.01E-01	1.27E-07	2.97E-07	8.65E-08	2.02E-07	2.88E-07	5.42E-09	1.16E-07	5.20E-08	7.87E-08	3.53E-08	1.14E-07
2,6-Dinitrotoluene	3.47E-01	1.47E-07	3.42E-07	9.97E-08	2.33E-07	3.32E-07	6.25E-09	1.33E-07	5.99E-08	9.08E-08	4.07E-08	1.31E-07
Benzo(a)anthracene	2.95E-01	1.25E-07	2.91E-07	9.10E-08	2.12E-07	3.03E-07	5.31E-09	1.13E-07	5.09E-08	1.66E-07	7.43E-08	2.40E-07
Benzo(a)pyrene	2.18E-01	9.21E-08	2.15E-07	6.73E-07	1.57E-06	2.24E-06	3.92E-09	8.39E-08	3.76E-08	1.22E-06	5.49E-07	1.77E-06
Benzo(b)fluoranthene	3.05E-01	1.29E-07	3.01E-07	9.41E-08	2.20E-07	3.14E-07	5.49E-09	1.17E-07	5.26E-08	1.71E-07	7.69E-08	2.48E-07
Indeno(1,2,3-cd)pyrene	9.96E-02	4.21E-08	9.82E-08	3.07E-08	7.17E-08	1.02E-07	1.79E-09	3.83E-08	1.72E-08	5.59E-08	2.51E-08	8.10E-08
Total ILCR				1.12E-06	2.61E-06	3.73E-06				1.81E-06	8.13E-07	2.62E-06

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-60

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 143, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	5.01E-01	3.21E-10	3.01E-11	1.76E-11	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	4.09E-01	2.62E-10	2.46E-11	1.44E-11	NA	NA	NA	**NA**	**NA**	**NA**
PCBs										
Aroclor 1260	5.30E-02	3.39E-11	3.19E-12	1.86E-12	6.38E-12	3.72E-12	1.01E-11	**6.93E-08**	**1.16E-07**	**1.85E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	3.01E-01	1.93E-10	1.81E-11	1.06E-11	NA	NA	NA	**1.65E-07**	**2.37E-07**	**4.02E-07**
2,6-Dinitrotoluene	3.47E-01	2.22E-10	2.09E-11	1.22E-11	NA	NA	NA	**1.91E-07**	**2.73E-07**	**4.64E-07**
Benzo(a)anthracene	2.95E-01	1.89E-10	1.77E-11	1.04E-11	5.50E-12	3.21E-12	8.71E-12	**2.57E-07**	**2.87E-07**	**5.43E-07**
Benzo(a)pyrene	2.18E-01	1.40E-10	1.31E-11	7.65E-12	4.07E-11	2.37E-11	6.44E-11	**1.90E-06**	**2.12E-06**	**4.02E-06**
Benzo(b)fluoranthene	3.05E-01	1.95E-10	1.84E-11	1.07E-11	5.69E-12	3.32E-12	9.01E-12	**2.65E-07**	**2.96E-07**	**5.62E-07**
Indeno(1,2,3-cd)pyrene	9.96E-02	6.38E-11	5.99E-12	3.50E-12	1.86E-12	1.08E-12	2.94E-12	**8.67E-08**	**9.68E-08**	**1.83E-07**
Total ILCR					6.01E-11	3.51E-11	9.51E-11	**2.93E-06**	**3.43E-06**	**6.36E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-61

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 143, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	5.01E-01	5.76E-06	9.61E-02	9.02E-09	1.01E-06	2.80E-02	3.21E-10	2.05E-10	NA	**1.24E-01**
4-Amino-2,6-dinitrotoluene	4.09E-01	4.71E-06	7.84E-02	7.36E-09	8.24E-07	2.29E-02	2.62E-10	1.67E-10	NA	**1.01E-01**
PCBs										
Aroclor 1260	5.30E-02	6.10E-07	NA	5.72E-10	6.40E-08	NA	3.39E-11	2.17E-11	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	3.01E-01	3.46E-06	1.73E-03	5.42E-09	6.06E-07	3.03E-04	1.93E-10	1.23E-10	NA	**2.03E-03**
2,6-Dinitrotoluene	3.47E-01	3.99E-06	3.99E-03	6.25E-09	6.99E-07	6.99E-04	2.22E-10	1.42E-10	NA	**4.69E-03**
Benzo(a)anthracene	2.95E-01	3.39E-06	NA	5.31E-09	5.94E-07	NA	1.89E-10	1.21E-10	NA	**NA**
Benzo(a)pyrene	2.18E-01	2.51E-06	NA	3.92E-09	4.39E-07	NA	1.40E-10	8.93E-11	NA	**NA**
Benzo(b)fluoranthene	3.05E-01	3.51E-06	NA	5.49E-09	6.14E-07	NA	1.95E-10	1.25E-10	NA	**NA**
Indeno(1,2,3-cd)pyrene	9.96E-02	1.15E-06	NA	1.79E-09	2.01E-07	NA	6.38E-11	4.08E-11	NA	**NA**
Total HI			1.80E-01			5.19E-02			NA	**2.32E-01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-62

COPCs in Soil Associated with Former Building 146
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO081 AA0434AA0435 0.8 - 1.8	TNTA-SO225 AA0480 2 - 3	TNTA-SO080 AA0463 4 - 6	TNTA-SO080 AA0464 8 - 10	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)						
Nitroaromatics						
2-Amino-4,6-dinitrotoluene	3.70E-01	9.23E+00	2.07E+01	3.26E+01	1.22E+00	3.26E+01
4-Amino-2,6-dinitrotoluene	3.70E-01	5.98E+00	7.45E+00	1.60E+01	5.51E-01	1.60E+01
2,4,6-Trinitrotoluene	1.60E+00	1.52E+02	2.05E+02	5.30E+02	9.25E+01	5.30E+02
PCBs						
Aroclor 1260	2.20E-02	6.72E-02	ND	1.52E-01	ND	1.52E-01
Semivolatile Organic Compounds						
2,4-Dinitrotoluene	7.20E-02	ND	1.65E-01	2.96E-01	ND	2.96E-01

[a] Maximum detected concentration.
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.1-63

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 146, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	3.26E+01	9.23E-05	6.61E-07	1.54E+00	NA	2.61E-07	2.88E-05	2.06E-07	7.99E-01	NA	1.14E-05	2.23E-06	1.59E-08	NA	NA	**2.34E+00**	**NA**
4-Amino-2,6-dinitrotoluene	1.60E+01	4.53E-05	3.24E-07	7.55E-01	NA	1.28E-07	1.41E-05	1.01E-07	3.92E-01	NA	5.60E-06	1.09E-06	7.83E-09	NA	NA	**1.15E+00**	**NA**
2,4,6-Trinitrotoluene	5.30E+02	1.50E-03	1.07E-05	3.00E+00	3.22E-07	4.24E-06	4.68E-04	3.35E-06	1.56E+00	1.67E-07	1.86E-04	3.62E-05	2.59E-07	NA	NA	**4.56E+00**	**4.90E-07**
PCBs																	
Aroclor 1260	1.52E-01	4.30E-07	3.08E-09	NA	6.16E-09	7.30E-10	8.04E-08	5.76E-10	NA	1.15E-09	5.32E-08	1.04E-08	7.44E-11	NA	1.49E-10	**NA**	**7.46E-09**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	2.96E-01	8.38E-07	6.00E-09	4.19E-04	4.08E-09	2.37E-09	2.61E-07	1.87E-09	1.31E-04	1.27E-09	1.04E-07	2.02E-08	1.45E-10	NA	NA	**5.49E-04**	**5.35E-09**
Total HI				5.29E+00					2.75E+00					NA		**8.04E+00**	
Total ILCR					3.33E-07					1.70E-07					1.49E-10		**5.03E-07**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; H = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-64

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 146, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	3.26E+01	1.38E-05	3.22E-05	NA	NA	NA	5.87E-07	1.25E-05	5.63E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.60E+01	6.76E-06	1.58E-05	NA	NA	NA	2.88E-07	6.15E-06	2.76E-06	NA	NA	NA
2,4,6-Trinitrotoluene	5.30E+02	2.24E-04	5.23E-04	6.72E-06	1.57E-05	2.24E-05	9.54E-06	2.04E-04	9.15E-05	1.02E-05	4.57E-06	1.48E-05
PCBs												
Aroclor 1260	1.52E-01	6.43E-08	1.50E-07	1.29E-07	3.00E-07	4.28E-07	1.64E-09	3.51E-08	1.57E-08	7.02E-08	3.15E-08	1.02E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	2.96E-01	1.25E-07	2.92E-07	8.51E-08	1.99E-07	2.84E-07	5.33E-09	1.14E-07	5.11E-08	7.74E-08	3.47E-08	1.12E-07
Total ILCR				6.93E-06	1.62E-05	2.31E-05				1.03E-05	4.64E-06	1.50E-05

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-64

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 146, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.26E+01	2.09E-08	1.96E-09	1.14E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	1.60E+01	1.02E-08	9.63E-10	5.62E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	5.30E+02	3.39E-07	3.19E-08	1.86E-08	NA	NA	NA	**1.69E-05**	**2.03E-05**	**3.72E-05**
PCBs										
Aroclor 1260	1.52E-01	9.74E-11	9.15E-12	5.33E-12	1.83E-11	1.07E-11	2.90E-11	**1.99E-07**	**3.31E-07**	**5.30E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.96E-01	1.90E-10	1.78E-11	1.04E-11	NA	NA	NA	**1.63E-07**	**2.33E-07**	**3.96E-07**
Total ILCR					1.83E-11	1.07E-11	2.90E-11	**1.73E-05**	**2.08E-05**	**3.81E-05**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-65

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 146, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-cinitrotoluene	3.26E+01	3.75E-04	6.25E+00	5.87E-07	6.56E-05	1.82E+00	2.09E-08	1.33E-08	NA	**8.08E+00**
4-Amino-2,6-cinitrotoluene	1.60E+01	1.84E-04	3.07E+00	2.88E-07	3.22E-05	8.95E-01	1.02E-08	6.55E-09	NA	**3.96E+00**
2,4,6-Trinitrotoluene	5.30E+02	6.10E-03	1.22E+01	9.54E-06	1.07E-03	3.56E+00	3.39E-07	2.17E-07	NA	**1.58E+01**
PCBs										
Aroclor 1260	1.52E-01	1.75E-06	NA	1.64E-09	1.84E-07	NA	9.74E-11	6.22E-11	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.96E-01	3.41E-06	1.70E-03	5.33E-09	5.96E-07	2.98E-04	1.90E-10	1.21E-10	NA	**2.00E-03**
Total HI			2.15E+01			6.28E+00			NA	**2.78E+01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-66

COPCs in Soil Associated with Former Building 148
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO077 AA0433 0.7 - 1.7	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)			
Nitroaromatics			
2-Amino-4,6-dinitrotoluene	3.70E-01	1.04E+00	1.04E+00
Dinitrotoluene, total	7.20E-02	6.77E-01	6.77E-01
PCB			
Aroclor 1260	2.20E-02	2.40E-01	2.40E-01

[a] Maximum detected concentration.

Table B.1-67

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 148, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	1.04E+00	2.94E-06	2.11E-08	4.91E-02	NA	8.32E-09	9.17E-07	6.57E-09	2.55E-02	NA	3.64E-07	7.10E-08	5.09E-10	NA	NA	**7.45E-02**	**NA**
Dinitrotoluene, total	6.77E-01	1.92E-06	1.37E-08	1.92E-03	9.33E-09	5.42E-09	5.97E-07	4.28E-09	5.97E-04	2.91E-09	2.37E-07	4.62E-08	3.31E-10	NA	NA	**2.51E-03**	**1.22E-08**
PCBs																	
Aroclor 1260	2.40E-01	6.79E-07	4.86E-09	NA	9.73E-09	1.15E-09	1.27E-07	9.10E-10	NA	1.82E-09	8.40E-08	1.64E-08	1.17E-10	NA	2.35E-10	**NA**	**1.18E-08**
Total HI				5.10E-02					2.61E-02					NA		**7.70E-02**	
Total ILCR					1.91E-08					4.73E-09					2.35E-10		**2.40E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-68

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 148, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
4-Amino-2,6-dinitrotoluene	1.04E+00	4.40E-07	1.03E-06	NA	NA	NA	1.87E-08	4.00E-07	1.80E-07	NA	NA	NA
Dinitrotoluene, total	6.77E-01	2.86E-07	6.68E-07	1.95E-07	4.54E-07	6.49E-07	1.22E-08	2.60E-07	1.17E-07	1.77E-07	7.95E-08	2.57E-07
PCBs												
Aroclor 1260	2.40E-01	1.01E-07	2.37E-07	2.03E-07	4.73E-07	6.76E-07	2.59E-09	5.54E-08	2.49E-08	1.11E-07	4.97E-08	1.60E-07
Total ILCR				3.97E-07	9.27E-07	1.32E-06				2.88E-07	1.29E-07	4.17E-07

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-68

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 148, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	1.04E+00	6.66E-10	6.26E-11	3.65E-11	NA	NA	NA	**NA**	**NA**	**NA**
Dinitrotoluene, total	6.77E-01	4.34E-10	4.07E-11	2.38E-11	NA	NA	NA	**3.72E-07**	**5.34E-07**	**9.05E-07**
PCBs										
Aroclor 1260	2.40E-01	1.54E-10	1.44E-11	8.42E-12	2.89E-11	1.68E-11	4.57E-11	**3.14E-07**	**5.23E-07**	**8.37E-07**
Total ILCR					2.89E-11	1.68E-11	4.57E-11	**6.85E-07**	**1.06E-06**	**1.74E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-69

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 148, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	1.04E+00	1.20E-05	1.99E-01	1.87E-08	2.09E-06	5.82E-02	6.66E-10	4.26E-10	NA	**2.58E-01**
Dinitrotoluene, total	6.77E-01	7.79E-06	7.79E-03	1.22E-08	1.36E-06	1.36E-03	4.34E-10	2.77E-10	NA	**9.15E-03**
PCBs										
Aroclor 1260	2.40E-01	2.76E-06	NA	2.59E-09	2.90E-07	NA	1.54E-10	9.83E-11	NA	**NA**
Total HI			2.07E-01			5.95E-02			NA	**2.67E-01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-70

COPCs in Soil Associated with Former Building 182
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO094 AA0437AA0438 2 - 3	TNTA-SO094 AA0465 5 - 7	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)				
PCBs				
Aroclor 1260	2.20E-02	5.26E-02	ND	5.26E-02
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	ND	1.75E+01	1.75E+01
2,6-Dinitrotoluene	7.20E-02	1.05E-01	1.01E+01	1.01E+01

[a] Maximum detected concentration.
ND = Not Detected

Table B.1-71

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 182, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
PCBs																	
Aroclor 1260	5.26E-02	1.49E-07	1.07E-09	NA	2.13E-09	2.52E-10	2.78E-08	1.99E-10	NA	3.98E-10	1.84E-08	3.59E-09	2.57E-11	NA	5.14E-11	**NA**	**2.58E-09**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	1.75E+01	4.95E-05	3.55E-07	2.48E-02	2.41E-07	1.40E-07	1.54E-05	1.11E-07	7.72E-03	7.52E-08	6.13E-06	1.20E-06	8.56E-09	NA	NA	**3.25E-02**	**3.16E-07**
2,6-Dinitrotoluene	1.01E+01	2.86E-05	2.05E-07	2.86E-02	1.39E-07	8.08E-08	8.91E-06	6.38E-08	8.91E-03	4.34E-08	3.54E-06	6.90E-07	4.94E-09	NA	NA	**3.75E-02**	**1.83E-07**
Total HI				5.33E-02					1.66E-02					NA		**7.00E-02**	
Total ILCR					3.83E-07					1.19E-07					5.14E-11		**5.02E-07**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-72

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 182, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
PCBs												
Aroclor 1260	5.26E-02	2.22E-08	5.18E-08	4.44E-08	1.04E-07	1.48E-07	5.68E-10	1.21E-08	5.44E-09	2.43E-08	1.09E-08	3.51E-08
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	1.75E+01	7.40E-06	1.73E-05	5.03E-06	1.17E-05	1.68E-05	3.15E-07	6.73E-06	3.02E-06	4.58E-06	2.05E-06	6.63E-06
2,6-Dinitrotoluene	1.01E+01	4.27E-06	9.96E-06	2.90E-06	6.77E-06	9.68E-06	1.82E-07	3.89E-06	1.74E-06	2.64E-06	1.19E-06	3.83E-06
Total ILCR				7.98E-06	1.86E-05	2.66E-05				7.24E-06	3.25E-06	1.05E-05

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-72

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 182, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
PCBs										
Aroclor 1260	5.26E-02	3.37E-11	3.16E-12	1.84E-12	6.32E-12	3.69E-12	1.00E-11	**6.87E-08**	**1.15E-07**	**1.83E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.75E+01	1.12E-08	1.05E-09	6.14E-10	NA	NA	NA	**9.61E-06**	**1.38E-05**	**2.34E-05**
2,6-Dinitrotoluene	1.01E+01	6.47E-09	6.08E-10	3.54E-10	NA	NA	NA	**5.54E-06**	**7.96E-06**	**1.35E-05**
Total ILCR					6.32E-12	3.69E-12	1.00E-11	**1.52E-05**	**2.19E-05**	**3.71E-05**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-73

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 182, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
PCBs										
Aroclor 1260	5.26E-02	6.05E-07	NA	5.68E-10	6.35E-08	NA	3.37E-11	2.15E-11	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.75E+01	2.01E-04	1.01E-01	3.15E-07	3.52E-05	1.76E-02	1.12E-08	7.17E-09	NA	**1.18E-01**
2,6-Dinitrotoluene	1.01E+01	1.16E-04	1.16E-01	1.82E-07	2.03E-05	2.03E-02	6.47E-09	4.14E-09	NA	**1.37E-01**
Total HI			2.17E-01			3.80E-02			NA	**2.55E-01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-74

COPCs in Soil Associated with Former Building 185
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO399 AA0478 4 - 6	TNTA-SO399 AA0479 8 - 9	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)				
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	2.22E-01	--	2.22E-01
2,6-Dinitrotoluene	7.20E-02	ND	3.42E-01	3.42E-01

[a] Maximum detected concentration.
ND = Not Detected
-- = No result was available from this sample.

Table B.1-75

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 185, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	2.22E-01	6.28E-07	4.50E-09	3.14E-04	3.06E-09	1.78E-09	1.96E-07	1.40E-09	9.79E-05	9.54E-10	7.77E-08	1.52E-08	1.09E-10	NA	NA	**4.12E-04**	**4.01E-09**
2,6-Dinitrotoluene	3.42E-01	9.68E-07	6.93E-09	9.68E-04	4.71E-09	2.74E-09	3.02E-07	2.16E-09	3.02E-04	1.47E-09	1.20E-07	2.34E-08	1.67E-10	NA	NA	**1.27E-03**	**6.18E-09**
Total HI				1.28E-03					4.00E-04					NA		**1.68E-03**	
Total ILCR					7.77E-09					2.42E-09					NA		**1.02E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-76

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 185, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	2.22E-01	9.38E-08	2.19E-07	6.38E-08	1.49E-07	2.13E-07	4.00E-09	8.54E-08	3.83E-08	5.81E-08	2.61E-08	8.41E-08
2,6-Dinitrotoluene	3.42E-01	1.45E-07	3.37E-07	9.83E-08	2.29E-07	3.28E-07	6.16E-09	1.32E-07	5.90E-08	8.95E-08	4.01E-08	1.30E-07
Total ILCR				1.62E-07	3.78E-07	5.40E-07				1.48E-07	6.62E-08	2.14E-07

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incrementa lifetime cancer risk
NA = Not applicable

Table B.1-76

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 185, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.22E-01	1.42E-10	1.34E-11	7.79E-12	NA	NA	NA	**1.22E-07**	**1.75E-07**	**2.97E-07**
2,6-Dinitrotoluene	3.42E-01	2.19E-10	2.06E-11	1.20E-11	NA	NA	NA	**1.88E-07**	**2.70E-07**	**4.57E-07**
Total ILCR					NA	NA	NA	**3.10E-07**	**4.44E-07**	**7.54E-07**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-77

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 185, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.22E-01	2.55E-06	1.28E-03	4.00E-09	4.47E-07	2.24E-04	1.42E-10	9.09E-11	NA	**1.50E-03**
2,6-Dinitrotoluene	3.42E-01	3.94E-06	3.94E-03	6.16E-09	6.89E-07	6.89E-04	2.19E-10	1.40E-10	NA	**4.62E-03**
Total HI			5.21E-03			9.12E-04			NA	**6.12E-03**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-78

COPCs in Soil Associated with Former Building 192
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO276 AA0449 1.5 - 2.5	TNTA-SO279 AA0450 2 - 3	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)				
PCBs				
Aroclor 1260	2.20E-02	NA	1.31E-01	1.31E-01
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	3.16E-01	8.09E+01	8.09E+01
2,6-Dinitrotoluene	7.20E-02	NA	3.20E+03	3.20E+03

[a] Maximum detected concentration.
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.1-79

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Building 192, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
PCBs																	
Aroclor 1260	1.31E-01	3.71E-07	2.66E-09	NA	5.31E-09	6.29E-10	6.93E-08	4.97E-10	NA	9.93E-10	4.59E-08	8.95E-09	6.41E-11	NA	1.28E-10	**NA**	**6.43E-09**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	8.09E+01	2.29E-04	1.64E-06	1.14E-01	1.12E-06	6.47E-07	7.14E-05	5.11E-07	3.57E-02	3.48E-07	2.83E-05	5.53E-06	3.96E-08	NA	NA	**1.50E-01**	**1.46E-06**
2,6-Dinitrotoluene	3.20E+03	9.06E-03	6.49E-05	9.06E+00	4.41E-05	2.56E-05	2.82E-03	2.02E-05	2.82E+00	1.38E-05	1.12E-03	2.19E-04	1.57E-06	NA	NA	**1.19E+01**	**5.79E-05**
Total HI				9.17E+00					2.86E+00					NA		**1.20E+01**	
Total ILCR					4.52E-05					1.41E-05					1.28E-10		**5.93E-05**

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; H = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-80

Cancer Risk: On-Site Resident Exposure to Total Soil
Building 192, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
PCBs												
Aroclor 1260	1.31E-01	5.54E-08	1.29E-07	1.11E-07	2.58E-07	3.69E-07	1.41E-09	3.02E-08	1.36E-08	6.05E-08	2.71E-08	8.76E-08
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	8.09E+01	3.42E-05	7.98E-05	2.33E-05	5.43E-05	7.75E-05	1.46E-06	3.11E-05	1.40E-05	2.12E-05	9.50E-06	3.07E-05
2,6-Dinitrotoluene	3.20E+03	1.35E-03	3.16E-03	9.20E-04	2.15E-03	3.07E-03	5.76E-05	1.23E-03	5.53E-04	8.37E-04	3.76E-04	1.21E-03
Total ILCR				9.43E-04	2.20E-03	3.14E-03				8.58E-04	3.85E-04	1.24E-03

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-80

Cancer Risk: On-Site Resident Exposure to Total Soil
Building 192, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
PCBs										
Aroclor 1260	1.31E-01	8.39E-11	7.88E-12	4.60E-12	1.58E-11	9.20E-12	2.50E-11	**1.71E-07**	**2.86E-07**	**4.57E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.09E+01	5.18E-08	4.87E-09	2.84E-09	NA	NA	NA	**4.44E-05**	**6.38E-05**	**1.08E-04**
2,6-Dinitrotoluene	3.20E+03	2.05E-06	1.93E-07	1.12E-07	NA	NA	NA	**1.76E-03**	**2.52E-03**	**4.28E-03**
Total ILCR					1.58E-11	9.20E-12	2.50E-11	**1.80E-03**	**2.59E-03**	**4.39E-03**

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-81

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Building 192, TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
PCBs										
Aroclor 1260	1.31E-01	1.51E-06	NA	1.41E-09	1.58E-07	NA	8.39E-11	4.60E-12	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.09E+01	9.31E-04	4.65E-01	1.46E-06	1.63E-04	8.15E-02	5.18E-08	2.84E-09	NA	**5.47E-01**
2,6-Dinitrotoluene	3.20E+03	3.68E-02	3.68E+01	5.76E-05	6.45E-03	6.45E+00	2.05E-06	1.12E-07	NA	**4.33E+01**
Total HI			3.73E+01			6.53E+00			NA	**4.38E+01**

COPC = Chemicals of potential concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.1-82

COPCs in Soil Associated with Former Building 195
TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):**	Risk-Based Screening Criterion	TNTA-SO012 AA0426 2 - 3	TNTA-SO012 AA0460 4 - 6	Source Term Concentration [a]
Chemicals of Potential Concern (mg/kg)				
Nitroaromatics				
2,4,6-Trinitrotoluene	1.60E+00	2.59E+02	1.04E+02	2.59E+02
PCBs				
Aroclor 1260	2.20E-02	3.57E-01	ND	3.57E-01
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	8.91E+03	4.77E+01	8.91E+03
2,6-Dinitrotoluene	7.20E-02	1.03E+04	9.69E+01	1.03E+04

[a] Maximum detected concentration.
ND = Not Detected

Table B.1-83

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 195, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2,4,6-Trinitrotoluene	2.59E+02	7.33E-04	5.25E-06	1.47E+00	1.57E-07	2.07E-06	2.28E-04	1.64E-06	7.62E-01	8.18E-08	9.07E-05	1.77E-05	1.27E-07	NA	NA	**2.23E+00**	**2.39E-07**
PCBs																	
Aroclor 1260	3.57E-01	1.01E-06	7.24E-09	NA	1.45E-08	1.71E-09	1.89E-07	1.35E-09	NA	2.71E-09	1.25E-07	2.44E-08	1.75E-10	NA	3.49E-10	**NA**	**1.75E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	8.91E+03	2.52E-02	1.81E-04	1.26E+01	1.23E-04	7.13E-05	7.86E-03	5.63E-05	3.93E+00	3.83E-05	3.12E-03	6.09E-04	4.36E-06	NA	NA	**1.65E+01**	**1.61E-04**
2,6-Dinitrotoluene	1.03E+04	2.91E-02	2.08E-04	2.91E+01	1.42E-04	8.22E-05	9.06E-03	6.49E-05	9.06E+00	4.41E-05	3.60E-03	7.02E-04	5.03E-06	NA	NA	**3.81E+01**	**1.86E-04**
Total HI				4.31E+01					1.38E+01					NA		**5.69E+01**	
Total ILCR					2.65E-04					8.25E-05					3.49E-10		**3.47E-04**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-84

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 195, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Nitroaromatics												
2,4,6-Trinitrotoluene	2.59E+02	1.09E-04	2.55E-04	3.28E-06	7.66E-06	1.09E-05	4.66E-06	9.96E-05	4.47E-05	4.98E-06	2.24E-06	7.22E-06
PCBs												
Aroclor 1260	3.57E-01	1.51E-07	3.52E-07	3.02E-07	7.04E-07	1.01E-06	3.86E-09	8.24E-08	3.70E-08	1.65E-07	7.39E-08	2.39E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	8.91E+03	3.77E-03	8.79E-03	2.56E-03	5.98E-03	8.54E-03	1.60E-04	3.43E-03	1.54E-03	2.33E-03	1.05E-03	3.38E-03
2,6-Dinitrotoluene	1.03E+04	4.34E-03	1.01E-02	2.95E-03	6.89E-03	9.84E-03	1.85E-04	3.95E-03	1.77E-03	2.69E-03	1.21E-03	3.89E-03
Total ILCR				5.52E-03	1.29E-02	1.84E-02				5.02E-03	2.25E-03	7.28E-03

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-84

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 195, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2,4,6-Trinitrotoluene	2.59E+02	1.66E-07	1.56E-08	9.09E-09	NA	NA	NA	**8.27E-06**	**9.90E-06**	**1.82E-05**
PCBs										
Aroclor 1260	3.57E-01	2.29E-10	2.15E-11	1.25E-11	4.30E-11	2.51E-11	6.80E-11	**4.67E-07**	**7.78E-07**	**1.24E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.91E+03	5.71E-06	5.36E-07	3.13E-07	NA	NA	NA	**4.89E-03**	**7.02E-03**	**1.19E-02**
2,6-Dinitrotoluene	1.03E+04	6.58E-06	6.18E-07	3.61E-07	NA	NA	NA	**5.64E-03**	**8.10E-03**	**1.37E-02**
Total ILCR					4.30E-11	2.51E-11	6.80E-11	**1.05E-02**	**1.51E-02**	**2.57E-02**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.1-85

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 195, TNT Area A
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2,4,6-Trinitrotoluene	2.59E+02	2.98E-03	5.96E+00	4.66E-06	5.22E-04	1.74E+00	1.66E-07	1.06E-07	NA	**7.70E+00**
PCBs										
Aroclor 1260	3.57E-01	4.11E-06	NA	3.86E-09	4.31E-07	NA	2.29E-10	1.25E-11	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.91E+03	1.03E-01	5.13E+01	1.60E-04	1.79E-02	8.97E+00	5.71E-06	3.13E-07	NA	**6.02E+01**
2,6-Dinitrotoluene	1.03E+04	1.18E-01	1.18E+02	1.85E-04	2.07E-02	2.07E+01	6.58E-06	3.61E-07	NA	**1.39E+02**
Total HI			1.75E+02			3.14E+01			NA	**2.07E+02**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

APPENDIX B.2

RISK CALCULATIONS TNT AREA C

Table B.2-1

Cancer Risk and Noncancer Hazard: Groundskeeper Exposure to Surface Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

(Page 1 of 2)

		Incidental Ingestion					Dermal Absorption			
Chemical	Source-Term Concentration (mg/kg)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA (mg/cm^2-day)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR
Metals										
Lead	9.34E+02	9.14E-04	3.26E-04	NA	NA	8.41E-08	9.29E-06	3.32E-06	NA	NA
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.80E+01	3.72E-05	1.33E-05	6.20E-01	NA	3.42E-08	3.78E-06	1.35E-06	1.05E-01	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	1.10E-05	3.94E-06	1.84E-01	NA	1.01E-08	1.12E-06	4.01E-07	3.12E-02	NA
1,3-Dinitrobenzene	7.51E-01	7.35E-07	2.62E-07	7.35E-03	NA	6.76E-10	7.47E-08	2.67E-08	9.34E-04	NA
2,4,6-Trinitrotoluene	4.13E+04	4.04E-02	1.44E-02	8.07E+01	4.33E-04	3.71E-05	4.11E-03	1.47E-03	1.37E+01	7.33E-05
PCBs										
Aroclor 1260	4.88E+00	4.77E-06	1.70E-06	NA	3.41E-06	2.63E-09	2.91E-07	1.04E-07	NA	2.08E-07
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	9.85E+00	9.63E-06	3.44E-06	4.82E-03	2.34E-06	8.86E-09	9.80E-07	3.50E-07	4.90E-04	2.38E-07
2,6-Dinitrotoluene	9.52E+00	9.31E-06	3.33E-06	9.31E-03	2.26E-06	8.56E-09	9.47E-07	3.38E-07	9.47E-04	2.30E-07
Benzo(a)anthracene	6.94E+00	6.79E-06	2.43E-06	NA	1.77E-06	6.25E-09	6.91E-07	2.47E-07	NA	3.60E-07
Benzo(a)pyrene	6.33E+00	6.19E-06	2.21E-06	NA	1.61E-05	5.70E-09	6.30E-07	2.25E-07	NA	3.28E-06
Benzo(b)fluoranthene	8.43E+00	8.25E-06	2.95E-06	NA	2.15E-06	7.59E-09	8.39E-07	3.00E-07	NA	4.38E-07
Benzo(k)fluoranthene	2.05E+00	2.00E-06	7.15E-07	NA	5.22E-08	1.84E-09	2.04E-07	7.27E-08	NA	1.06E-08
Chrysene	5.85E+00	5.73E-06	2.04E-06	NA	1.49E-08	5.27E-09	5.82E-07	2.08E-07	NA	1.90E-09
Dibenz(a,h)anthracene	1.03E+00	1.01E-06	3.60E-07	NA	2.63E-06	9.27E-10	1.02E-07	3.66E-08	NA	3.34E-07
Indeno(1,2,3-cd)pyrene	2.05E+00	2.00E-06	7.15E-07	NA	5.22E-07	1.84E-09	2.04E-07	7.27E-08	NA	1.06E-07
Total HI				**8.16E+01**					**1.38E+01**	
Total ILCR					**4.64E-04**					**7.85E-05**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.2-1

Cancer Risk and Noncancer Hazard: Groundskeeper Exposure to Surface Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Concentration in Air (mg/m^3)	Inhalation Noncancer Dose (mg/kg-day)	Inhalation Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals								
Lead	9.34E+02	9.34E-05	1.83E-05	6.53E-06	NA	NA	**NA**	**NA**
Nitroaromatics								
2-Amino-4,6-dinitrotoluene	3.80E+01	3.80E-06	7.44E-07	2.66E-07	NA	NA	**7.25E-01**	**NA**
4-Amino-2,6-dinitrotoluene	1.13E+01	1.13E-06	2.21E-07	7.88E-08	NA	NA	**2.15E-01**	**NA**
1,3-Dinitrobenzene	7.51E-01	7.51E-08	1.47E-08	5.25E-09	NA	NA	**8.28E-03**	**NA**
2,4,6-Trinitrotoluene	4.13E+04	4.13E-03	8.07E-04	2.88E-04	NA	NA	**9.44E+01**	**5.06E-04**
PCBs								
Aroclor 1260	4.88E+00	4.88E-07	9.54E-08	3.41E-08	NA	6.81E-08	**NA**	**3.68E-06**
Semivolatile Organic Compounds								
2,4-Dinitrotoluene	9.85E+00	9.85E-07	1.93E-07	6.88E-08	NA	NA	**5.31E-03**	**2.58E-06**
2,6-Dinitrotoluene	9.52E+00	9.52E-07	1.86E-07	6.65E-08	NA	NA	**1.03E-02**	**2.49E-06**
Benzo(a)anthracene	6.94E+00	6.94E-07	1.36E-07	4.85E-08	NA	1.50E-08	**NA**	**2.15E-06**
Benzo(a)pyrene	6.33E+00	6.33E-07	1.24E-07	4.42E-08	NA	1.37E-07	**NA**	**1.96E-05**
Benzo(b)fluoranthene	8.43E+00	8.43E-07	1.65E-07	5.89E-08	NA	1.83E-08	**NA**	**2.61E-06**
Benzo(k)fluoranthene	2.05E+00	2.05E-07	4.00E-08	1.43E-08	NA	4.43E-10	**NA**	**6.33E-08**
Chrysene	5.85E+00	5.85E-07	1.15E-07	4.09E-08	NA	1.27E-10	**NA**	**1.70E-08**
Dibenz(a,h)anthracene	1.03E+00	1.03E-07	2.02E-08	7.20E-09	NA	2.23E-08	**NA**	**2.98E-06**
Indeno(1,2,3-cd)pyrene	2.05E+00	2.05E-07	4.00E-08	1.43E-08	NA	4.43E-09	**NA**	**6.32E-07**
Total HI					**NA**		**9.54E+01**	
Total ILCR						**2.66E-07**		**5.43E-04**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.2-2

Cancer Risk and Noncancer Hazard: Indoor Worker Exposure to Surface Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR
Metals					
Lead	9.34E+02	4.57E-04	1.63E-04	NA	NA
Nitroaromatics					
2-Amino-4,6-dinitrotoluene	3.80E+01	1.86E-05	6.64E-06	3.10E-01	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	5.51E-06	1.97E-06	9.19E-02	NA
1,3-Dinitrobenzene	7.51E-01	3.67E-07	1.31E-07	3.67E-03	NA
2,4,6-Trinitrotoluene	4.13E+04	2.02E-02	7.21E-03	4.04E+01	2.16E-04
PCBs					
Aroclor 1260	4.88E+00	2.39E-06	8.52E-07	NA	1.70E-06
Semivolatile Organic Compounds					
2,4-Dinitrotoluene	9.85E+00	4.82E-06	1.72E-06	2.41E-03	1.17E-06
2,6-Dinitrotoluene	9.52E+00	4.66E-06	1.66E-06	4.66E-03	1.13E-06
Benzo(a)anthracene	6.94E+00	3.40E-06	1.21E-06	NA	8.85E-07
Benzo(a)pyrene	6.33E+00	3.10E-06	1.11E-06	NA	8.07E-06
Benzo(b)fluoranthene	8.43E+00	4.13E-06	1.47E-06	NA	1.08E-06
Benzo(k)fluoranthene	2.05E+00	1.00E-06	3.58E-07	NA	2.61E-08
Chrysene	5.85E+00	2.86E-06	1.02E-06	NA	7.46E-09
Dibenz(a,h)anthracene	1.03E+00	5.04E-07	1.80E-07	NA	1.31E-06
Indeno(1,2,3-cd)pyrene	2.05E+00	1.00E-06	3.57E-07	NA	2.61E-07
Total HI				**4.08E+01**	
Total ILCR					**2.32E-04**

HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.2-3

Cancer Risk and Noncancer Hazard: Adult Hunter Exposure to Surface Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

(Page 1 of 2)

Chemical	Source-Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm2-day	Dermal Absorption Noncancer Dose (mg/kg-day)	Dermal Absorption Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR
Metals										
Lead	9.34E+02	5.12E-05	2.19E-05	NA	NA	8.41E-08	2.10E-07	8.98E-08	NA	NA
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.80E+01	2.08E-06	8.92E-07	3.47E-02	NA	3.42E-08	8.53E-08	3.65E-08	2.37E-03	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	6.18E-07	2.65E-07	1.03E-02	NA	1.01E-08	2.53E-08	1.08E-08	7.02E-04	NA
1,3-Dinitrobenzene	7.51E-01	4.12E-08	1.76E-08	4.12E-04	NA	6.76E-10	1.69E-09	7.22E-10	2.11E-05	NA
2,4,6-Trinitrotoluene	4.13E+04	2.26E-03	9.69E-04	4.52E+00	2.91E-05	3.71E-05	9.26E-05	3.97E-05	3.09E-01	1.98E-06
PCBs										
Aroclor 1260	4.88E+00	2.67E-07	1.14E-07	NA	2.29E-07	2.63E-09	6.56E-09	2.81E-09	NA	5.63E-09
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	9.85E+00	5.39E-07	2.31E-07	2.70E-04	1.57E-07	8.86E-09	2.21E-08	9.47E-09	1.10E-05	6.44E-09
2,6-Dinitrotoluene	9.52E+00	5.21E-07	2.23E-07	5.21E-04	1.52E-07	8.56E-09	2.14E-08	9.15E-09	2.14E-05	6.22E-09
Benzo(a)anthracene	6.94E+00	3.80E-07	1.63E-07	NA	1.19E-07	6.25E-09	1.56E-08	6.67E-09	NA	9.74E-09
Benzo(a)pyrene	6.33E+00	3.47E-07	1.49E-07	NA	1.09E-06	5.70E-09	1.42E-08	6.09E-09	NA	8.89E-08
Benzo(b)fluoranthene	8.43E+00	4.62E-07	1.98E-07	NA	1.45E-07	7.59E-09	1.89E-08	8.11E-09	NA	1.18E-08
Benzo(k)fluoranthene	2.05E+00	1.12E-07	4.81E-08	NA	3.51E-09	1.84E-09	4.59E-09	1.97E-09	NA	2.87E-10
Chrysene	5.85E+00	3.21E-07	1.37E-07	NA	1.00E-09	5.27E-09	1.31E-08	5.63E-09	NA	5.13E-11
Dibenz(a,h)anthracene	1.03E+00	5.64E-08	2.42E-08	NA	1.77E-07	9.27E-10	2.31E-09	9.90E-10	NA	9.04E-09
Indeno(1,2,3-cd)pyrene	2.05E+00	1.12E-07	4.80E-08	NA	3.51E-08	1.84E-09	4.59E-09	1.97E-09	NA	2.87E-09
Total HI				**4.57E+00**					**3.12E-01**	
Total ILCR					**3.12E-05**					**2.12E-06**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.2-3

Cancer Risk and Noncancer Hazard: Adult Hunter Exposure to Surface Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

(Page 2 of 2)

Chemical	Source-Term Concentration (mg/kg)	Concentration in Plant (mg/kg)	Concentration in Venison (mg/m^3)	Venison Consumption Noncancer Dose (mg/kg-day)	Venison Consumption Cancer Dose (mg/kg-day)	Venison Consumption HQ	Venison Consumption ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals									
Lead	9.34E+02	5.25E+01	2.74E-03	4.88E-07	2.09E-07	NA	NA	**NA**	**NA**
Nitroaromatics									
2-Amino-4,6-dinitrotoluene	3.80E+01	NA	NA	NA	NA	NA	NA	**3.71E-02**	**NA**
4-Amino-2,6-dinitrotoluene	1.13E+01	NA	NA	NA	NA	NA	NA	**1.10E-02**	**NA**
1,3-Dinitrobenzene	7.51E-01	NA	NA	NA	NA	NA	NA	**4.33E-04**	**NA**
2,4,6-Trinitrotoluene	4.13E+04	NA	NA	NA	NA	NA	NA	**4.83E+00**	**3.11E-05**
PCBs									
Aroclor 1260	4.88E+00	2.77E-02	7.62E-04	1.36E-07	5.82E-08	NA	1.16E-07	**NA**	**3.51E-07**
Semivolatile Organic Compounds									
2,4-Dinitrotoluene	9.85E+00	NA	NA	NA	NA	NA	NA	**2.81E-04**	**1.64E-07**
2,6-Dinitrotoluene	9.52E+00	NA	NA	NA	NA	NA	NA	**5.43E-04**	**1.58E-07**
Benzo(a)anthracene	6.94E+00	1.80E-01	3.59E-04	6.40E-08	2.74E-08	NA	2.00E-08	**NA**	**1.49E-07**
Benzo(a)pyrene	6.33E+00	8.47E-02	5.35E-04	9.52E-08	4.08E-08	NA	2.98E-07	**NA**	**1.47E-06**
Benzo(b)fluoranthene	8.43E+00	1.18E-01	6.80E-04	1.21E-07	5.19E-08	NA	3.79E-08	**NA**	**1.94E-07**
Benzo(k)fluoranthene	2.05E+00	3.12E-02	1.56E-04	2.78E-08	1.19E-08	NA	8.71E-10	**NA**	**4.67E-09**
Chrysene	5.85E+00	1.51E-01	3.03E-04	5.40E-08	2.31E-08	NA	1.69E-10	**NA**	**1.22E-09**
Dibenz(a,h)anthracene	1.03E+00	5.55E-03	1.68E-04	2.99E-08	1.28E-08	NA	9.36E-08	**NA**	**2.79E-07**
Indeno(1,2,3-cd)pyrene	2.05E+00	1.56E-02	2.59E-04	4.61E-08	1.98E-08	NA	1.44E-08	**NA**	**5.24E-08**
Total HI						**NA**		**4.88E+00**	
Total ILCR							**5.81E-07**		**3.39E-05**

DA = Dose absorbed per unit body surface area per c
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
mg/cm2-day = Milligrams per square centimeter per c
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
mg/m^3 = Milligrams per cubic meter.
NA = Not applicable.
PCB = Polychlorinated biphenyl.

Table B.2-4

Cancer Risk and Noncancer Hazard: Child Venison Consumer
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source-Term Concentration (mg/kg)	Concentration in Plant (mg/kg)	Concentration in Venison (mg/m^3)	Venison Consumption Noncancer Dose (mg/kg-day)	Venison Consumption Cancer Dose (mg/kg-day)	Venison Consumption HQ	Venison Consumption ILCR
Metals							
Lead	9.34E+02	5.25E+01	2.74E-03	8.77E-07	7.51E-08	NA	NA
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	3.80E+01	NA	NA	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	7.51E-01	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	4.13E+04	NA	NA	NA	NA	NA	NA
PCBs							
Aroclor 1260	4.88E+00	2.77E-02	7.62E-04	2.44E-07	2.09E-08	NA	4.18E-08
Semivolatile Organic Compounds							
2,4-Dinitrotoluene	9.85E+00	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	9.52E+00	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	6.94E+00	1.80E-01	3.59E-04	1.15E-07	9.84E-09	NA	7.19E-09
Benzo(a)pyrene	6.33E+00	8.47E-02	5.35E-04	1.71E-07	1.47E-08	NA	1.07E-07
Benzo(b)fluoranthene	8.43E+00	1.18E-01	6.80E-04	2.17E-07	1.86E-08	NA	1.36E-08
Benzo(k)fluoranthene	2.05E+00	3.12E-02	1.56E-04	5.00E-08	4.28E-09	NA	3.13E-10
Chrysene	5.85E+00	1.51E-01	3.03E-04	9.68E-08	8.30E-09	NA	6.06E-11
Dibenz(a,h)anthracene	1.03E+00	5.55E-03	1.68E-04	5.37E-08	4.60E-09	NA	3.36E-08
Indeno(1,2,3-cd)pyrene	2.05E+00	1.56E-02	2.59E-04	8.27E-08	7.09E-09	NA	5.18E-09
Total HI						**NA**	
Total ILCR							**2.09E-07**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

Table B.2-5

TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio
(Page 1 of 2)

Chemical	Source-Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Dermal Absorption Noncancer Dose (mg/kg-day)	Dermal Absorption Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR
Metals										
Chromium	2.02E+02	5.72E-04	4.09E-06	3.81E-04	NA	1.62E-07	1.78E-05	1.28E-07	1.19E-03	NA
Lead	9.34E+02	2.64E-03	1.89E-05	NA	NA	7.47E-07	8.24E-05	5.90E-07	NA	NA
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.80E+01	1.08E-04	7.70E-07	1.79E+00	NA	3.04E-07	3.35E-05	2.40E-07	9.31E-01	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	3.19E-05	2.28E-07	5.32E-01	NA	9.02E-08	9.94E-06	7.12E-08	2.76E-01	NA
1,3-Dinitrobenzene	7.51E-01	2.13E-06	1.52E-08	2.13E-02	NA	6.01E-09	6.62E-07	4.74E-09	8.28E-03	NA
2-Nitrotoluene	5.08E+01	1.44E-04	1.03E-06	1.44E-02	NA	4.06E-07	4.48E-05	3.21E-07	4.98E-03	NA
4-Nitrotoluene	6.74E+01	1.91E-04	1.37E-06	1.91E-02	NA	5.39E-07	5.95E-05	4.26E-07	6.61E-03	NA
2,4,6-Trinitrotoluene	4.13E+04	1.17E-01	8.36E-04	2.34E+02	2.51E-05	3.30E-04	3.64E-02	2.61E-04	1.21E+02	1.30E-05
PCBs										
Aroclor 1254	7.45E-01	2.11E-06	1.51E-08	1.05E-01	3.02E-08	3.58E-09	3.94E-07	2.82E-09	2.19E-02	5.65E-09
Aroclor 1260	4.88E+00	1.38E-05	9.88E-08	NA	1.98E-07	2.34E-08	2.58E-06	1.85E-08	NA	3.70E-08
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.75E+02	7.78E-04	5.57E-06	3.89E-01	3.79E-06	2.20E-06	2.43E-04	1.74E-06	1.21E-01	1.18E-06
2,6-Dinitrotoluene	1.94E+01	5.48E-05	3.93E-07	5.48E-02	2.67E-07	1.55E-07	1.71E-05	1.22E-07	1.71E-02	8.32E-08
Benzo(a)anthracene	6.94E+00	1.96E-05	1.41E-07	NA	1.03E-07	5.55E-08	6.12E-06	4.38E-08	NA	6.40E-08
Benzo(a)pyrene	6.33E+00	1.79E-05	1.28E-07	NA	9.37E-07	5.06E-08	5.58E-06	4.00E-08	NA	5.84E-07
Benzo(b)fluoranthene	8.43E+00	2.39E-05	1.71E-07	NA	1.25E-07	6.75E-08	7.44E-06	5.33E-08	NA	7.78E-08
Benzo(k)fluoranthene	2.05E+00	5.79E-06	4.15E-08	NA	3.03E-09	1.64E-08	1.81E-06	1.29E-08	NA	1.89E-09
Chrysene	5.85E+00	1.66E-05	1.19E-07	NA	8.66E-10	4.68E-08	5.16E-06	3.70E-08	NA	3.37E-10
Dibenz(a,h)anthracene	1.40E+00	3.96E-06	2.84E-08	NA	2.07E-07	1.12E-08	1.23E-06	8.85E-09	NA	8.07E-08
Indeno(1,2,3-cd)pyrene	2.05E+00	5.79E-06	4.15E-08	NA	3.03E-08	1.64E-08	1.80E-06	1.29E-08	NA	1.89E-08
Total HI				**2.36E+02**					**1.23E+02**	
Total ILCR					**3.08E-05**					**1.52E-05**

DA = dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = not applicable

Table B.2-5

TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio
(Page 2 of 2)

Chemical	Source-Term Concentration (mg/kg)	Concentration in Air (mg/m^3)	Inhalation Noncancer Dose (mg/kg-day)	Inhalation Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	Total HI All Pathways	Total ILCR All Pathways
Metals								
Chromium	2.02E+02	7.07E-05	1.38E-05	9.88E-08	4.76E-01	4.15E-06	4.77E-01	4.15E-06
Lead	9.34E+02	3.27E-04	6.38E-05	4.57E-07	NA	NA	NA	NA
Nitroaromatics								
2-Amino-4,6-dinitrotoluene	3.80E+01	1.33E-05	2.60E-06	1.86E-08	NA	NA	2.72E+00	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	3.94E-06	7.70E-07	5.51E-09	NA	NA	8.08E-01	NA
1,3-Dinitrobenzene	7.51E-01	2.63E-07	5.13E-08	3.67E-10	NA	NA	2.95E-02	NA
2-Nitrotoluene	5.08E+01	1.78E-05	3.47E-06	2.49E-08	NA	NA	1.94E-02	NA
4-Nitrotoluene	6.74E+01	2.36E-05	4.60E-06	3.30E-08	NA	NA	2.57E-02	NA
2,4,6-Trinitrotoluene	4.13E+04	1.44E-02	2.82E-03	2.02E-05	NA	NA	3.55E+02	3.81E-05
PCBs								
Aroclor 1254	7.45E-01	2.61E-07	5.09E-08	3.64E-10	NA	7.29E-10	1.27E-01	3.66E-08
Aroclor 1260	4.88E+00	1.71E-06	3.33E-07	2.39E-09	NA	4.77E-09	NA	2.39E-07
Semivolatile Organic Compounds								
2,4-Dinitrotoluene	2.75E+02	9.63E-05	1.88E-05	1.35E-07	NA	NA	5.10E-01	4.97E-06
2,6-Dinitrotoluene	1.94E+01	6.78E-06	1.32E-06	9.48E-09	NA	NA	7.19E-02	3.50E-07
Benzo(a)anthracene	6.94E+00	2.43E-06	4.74E-07	3.40E-09	NA	1.05E-09	NA	1.68E-07
Benzo(a)pyrene	6.33E+00	2.22E-06	4.32E-07	3.10E-09	NA	9.60E-09	NA	1.53E-06
Benzo(b)fluoranthene	8.43E+00	2.95E-06	5.76E-07	4.13E-09	NA	1.28E-09	NA	2.04E-07
Benzo(k)fluoranthene	2.05E+00	7.16E-07	1.40E-07	1.00E-09	NA	3.10E-11	NA	4.95E-09
Chrysene	5.85E+00	2.05E-06	4.00E-07	2.86E-09	NA	8.87E-12	NA	1.21E-09
Dibenz(a,h)anthracene	1.40E+00	4.90E-07	9.56E-08	6.85E-10	NA	2.12E-09	NA	2.90E-07
Indeno(1,2,3-cd)pyrene	2.05E+00	7.16E-07	1.40E-07	1.00E-09	NA	3.10E-10	NA	4.94E-08
Total HI					**4.76E-01**		**3.60E+02**	
Total ILCR						**4.17E-06**		**5.01E-05**

DA = dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = not applicable

Table B.2-6

Cancer Risk: On-Site Resident Exposure to Total Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion: Adult Cancer Dose (mg/kg-day)	Incidental Ingestion: Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption: Adult Cancer Dose (mg/kg-day)	Dermal Absorption: Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR
Metals											
Chromium	2.02E+02	8.54E-05	1.99E-04	NA	NA	NA	3.64E-07	7.77E-06	3.49E-06	NA	NA
Lead	9.34E+02	3.95E-04	9.21E-04	NA	NA	NA	1.68E-06	3.59E-05	1.61E-05	NA	NA
Nitroaromatics											
2-Amino-4,6-dinitrotoluene	3.80E+01	1.61E-05	3.75E-05	NA	NA	NA	6.84E-07	1.46E-05	6.56E-06	NA	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	4.76E-06	1.11E-05	NA	NA	NA	2.03E-07	4.33E-06	1.95E-06	NA	NA
1,3-Dinitrobenzene	7.51E-01	3.17E-07	7.41E-07	NA	NA	NA	1.35E-08	2.89E-07	1.30E-07	NA	NA
2-Nitrotoluene	5.08E+01	2.15E-05	5.01E-05	NA	NA	NA	9.14E-07	1.95E-05	8.77E-06	NA	NA
4-Nitrotoluene	6.74E+01	2.85E-05	6.65E-05	NA	NA	NA	1.21E-06	2.59E-05	1.16E-05	NA	NA
2,4,6-Trinitrotoluene	4.13E+04	1.74E-02	4.07E-02	5.23E-04	1.22E-03	1.74E-03	7.43E-04	1.59E-02	7.12E-03	7.94E-04	3.56E-04
PCBs											
Aroclor 1254	7.45E-01	3.15E-07	7.35E-07	6.30E-07	1.47E-06	2.10E-06	8.04E-09	1.72E-07	7.71E-08	3.44E-07	1.54E-07
Aroclor 1260	4.88E+00	2.06E-06	4.81E-06	4.12E-06	9.62E-06	1.37E-05	5.27E-08	1.13E-06	5.05E-07	2.25E-06	1.01E-06
Semivolatile Organic Compounds											
2,4-Dinitrotoluene	2.75E+02	1.16E-04	2.71E-04	7.90E-05	1.84E-04	2.63E-04	4.95E-06	1.06E-04	4.75E-05	7.19E-05	3.23E-05
2,6-Dinitrotoluene	1.94E+01	8.19E-06	1.91E-05	5.57E-06	1.30E-05	1.86E-05	3.49E-07	7.45E-06	3.34E-06	5.07E-06	2.27E-06
Benzo(a)anthracene	6.94E+00	2.93E-06	6.84E-06	2.14E-06	5.00E-06	7.14E-06	1.25E-07	2.67E-06	1.20E-06	3.90E-06	1.75E-06
Benzo(a)pyrene	6.33E+00	2.68E-06	6.24E-06	1.95E-05	4.56E-05	6.51E-05	1.14E-07	2.43E-06	1.09E-06	3.55E-05	1.60E-05
Benzo(b)fluoranthene	8.43E+00	3.56E-06	8.32E-06	2.60E-06	6.07E-06	8.67E-06	1.52E-07	3.24E-06	1.46E-06	4.74E-06	2.13E-06
Benzo(k)fluoranthene	2.05E+00	8.65E-07	2.02E-06	6.31E-08	1.47E-07	2.10E-07	3.68E-08	7.87E-07	3.53E-07	1.15E-07	5.16E-08
Chrysene	5.85E+00	2.47E-06	5.77E-06	1.81E-08	4.21E-08	6.02E-08	1.05E-07	2.25E-06	1.01E-06	2.05E-08	9.22E-09
Dibenz(a,h)anthracene	1.40E+00	5.92E-07	1.38E-06	4.32E-06	1.01E-05	1.44E-05	2.52E-08	5.39E-07	2.42E-07	4.91E-06	2.21E-06
Indeno(1,2,3-cd)pyrene	2.05E+00	8.65E-07	2.02E-06	6.31E-07	1.47E-06	2.10E-06	3.68E-08	7.87E-07	3.53E-07	1.15E-06	5.16E-07
Total ILCR				**6.42E-04**	**1.50E-03**	**2.14E-03**				**9.24E-04**	**4.14E-04**

DA = dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = not applicable

Table B.2-6

Cancer Risk: On-Site Resident Exposure to Total Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio
(Page 2 of 3)

Chemical	Source Term Concentration (mg/kg)	On-Site Resident Dermal ILCR
Metals		
Chromium	2.02E+02	NA
Lead	9.34E+02	NA
Nitroaromatics		
2-Amino-4,6-dinitrotoluene	3.80E+01	NA
4-Amino-2,6-dinitrotoluene	1.13E+01	NA
1,3-Dinitrobenzene	7.51E-01	NA
2-Nitrotoluene	5.08E+01	NA
4-Nitrotoluene	6.74E+01	NA
2,4,6-Trinitrotoluene	4.13E+04	1.15E-03
PCBs		
Aroclor 1254	7.45E-01	4.98E-07
Aroclor 1260	4.88E+00	3.26E-06
Semivolatile Organic Compounds		
2,4-Dinitrotoluene	2.75E+02	1.04E-04
2,6-Dinitrotoluene	1.94E+01	7.34E-06
Benzo(a)anthracene	6.94E+00	5.65E-06
Benzo(a)pyrene	6.33E+00	5.15E-05
Benzo(b)fluoranthene	8.43E+00	6.86E-06
Benzo(k)fluoranthene	2.05E+00	1.66E-07
Chrysene	5.85E+00	2.98E-08
Dibenz(a,h)anthracene	1.40E+00	7.12E-06
Indeno(1,2,3-cd)pyrene	2.05E+00	1.66E-06
Total ILCR		**1.34E-03**

DA = dose absorbed per unit body surface area per da
ILCR = Incremental lifetime cancer risk
NA = not applicable

Table B.2-6

Cancer Risk: On-Site Resident Exposure to Total Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio
(Page 3 of 3)

Chemical	Source Term Concentration (mg/kg)	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Metals										
Chromium	2.02E+02	1.29E-07	1.22E-08	7.09E-09	5.10E-07	2.98E-07	8.08E-07	**5.10E-07**	**2.98E-07**	**8.08E-07**
Lead	9.34E+02	5.98E-07	5.62E-08	3.28E-08	NA	NA	NA	**NA**	**NA**	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.80E+01	2.43E-08	2.29E-09	1.33E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	1.13E+01	7.22E-09	6.78E-10	3.96E-10	NA	NA	NA	**NA**	**NA**	**NA**
1,3-Dinitrobenzene	7.51E-01	4.81E-10	4.52E-11	2.64E-11	NA	NA	NA	**NA**	**NA**	**NA**
2-Nitrotoluene	5.08E+01	3.25E-08	3.06E-09	1.78E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Nitrotoluene	6.74E+01	4.32E-08	4.06E-09	2.37E-09	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	4.13E+04	2.64E-05	2.48E-06	1.45E-06	NA	NA	NA	**1.32E-03**	**1.58E-03**	**2.89E-03**
PCBs										
Aroclor 1254	7.45E-01	4.77E-10	4.48E-11	2.61E-11	8.96E-11	5.23E-11	1.42E-10	**9.74E-07**	**1.62E-06**	**2.60E-06**
Aroclor 1260	4.88E+00	3.12E-09	2.93E-10	1.71E-10	5.87E-10	3.42E-10	9.29E-10	**6.37E-06**	**1.06E-05**	**1.70E-05**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.75E+02	1.76E-07	1.65E-08	9.65E-09	NA	NA	NA	**1.51E-04**	**2.17E-04**	**3.68E-04**
2,6-Dinitrotoluene	1.94E+01	1.24E-08	1.17E-09	6.80E-10	NA	NA	NA	**1.06E-05**	**1.53E-05**	**2.59E-05**
Benzo(a)anthracene	6.94E+00	4.45E-09	4.18E-10	2.44E-10	1.29E-10	7.55E-11	2.05E-10	**6.04E-06**	**6.75E-06**	**1.28E-05**
Benzo(a)pyrene	6.33E+00	4.05E-09	3.81E-10	2.22E-10	1.18E-09	6.89E-10	1.87E-09	**5.51E-05**	**6.15E-05**	**1.17E-04**
Benzo(b)fluoranthene	8.43E+00	5.40E-09	5.07E-10	2.96E-10	1.57E-10	9.17E-11	2.49E-10	**7.34E-06**	**8.20E-06**	**1.55E-05**
Benzo(k)fluoranthene	2.05E+00	1.31E-09	1.23E-10	7.18E-11	3.82E-12	2.23E-12	6.04E-12	**1.78E-07**	**1.99E-07**	**3.77E-07**
Chrysene	5.85E+00	3.75E-09	3.52E-10	2.05E-10	1.09E-12	6.37E-13	1.73E-12	**3.86E-08**	**5.13E-08**	**8.99E-08**
Dibenz(a,h)anthracene	1.40E+00	8.97E-10	8.42E-11	4.91E-11	2.61E-10	1.52E-10	4.13E-10	**9.23E-06**	**1.23E-05**	**2.15E-05**
Indeno(1,2,3-cd)pyrene	2.05E+00	1.31E-09	1.23E-10	7.18E-11	3.82E-11	2.23E-11	6.04E-11	**1.78E-06**	**1.99E-06**	**3.77E-06**
Total ILCR					**5.13E-07**	**2.99E-07**	**8.12E-07**	**1.57E-03**	**1.91E-03**	**3.48E-03**

DA = dose absorbed per unit body surface area per da
ILCR = Incremental lifetime cancer risk
NA = not applicable

Table B.2-7

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	Total HI All Pathways
Metals										
Chromium	2.02E+02	2.32E-03	1.55E-03	3.64E-07	4.07E-05	2.71E-03	1.29E-07	8.27E-08	2.85E-03	7.11E-03
Lead	9.34E+02	1.07E-02	NA	1.68E-06	1.88E-04	NA	5.98E-07	3.82E-07	NA	NA
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.80E+01	4.37E-04	7.29E+00	6.84E-07	7.65E-05	2.13E+00	2.43E-08	1.56E-08	NA	9.41E+00
4-Amino-2,6-dinitrotoluene	1.13E+01	1.30E-04	2.16E+00	2.03E-07	2.27E-05	6.30E-01	7.22E-09	4.61E-09	NA	2.79E+00
1,3-Dinitrobenzene	7.51E-01	8.64E-06	8.64E-02	1.35E-08	1.51E-06	1.89E-02	4.81E-10	3.08E-10	NA	1.05E-01
2-Nitrotoluene	5.08E+01	5.85E-04	5.85E-02	9.14E-07	1.02E-04	1.14E-02	3.25E-08	2.08E-08	NA	6.98E-02
4-Nitrotoluene	6.74E+01	7.76E-04	7.76E-02	1.21E-06	1.36E-04	1.51E-02	4.32E-08	2.76E-08	NA	9.26E-02
2,4,6-Trinitrotoluene	4.13E+04	4.75E-01	9.50E+02	7.43E-04	8.31E-02	2.77E+02	2.64E-05	1.69E-05	NA	1.23E+03
PCBs										
Aroclor 1254	7.45E-01	8.57E-06	4.29E-01	8.04E-09	9.00E-07	5.00E-02	4.77E-10	3.05E-10	NA	4.79E-01
Aroclor 1260	4.88E+00	5.61E-05	NA	5.27E-08	5.89E-06	NA	3.12E-09	2.00E-09	NA	NA
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.75E+02	3.16E-03	1.58E+00	4.95E-06	5.54E-04	2.77E-01	1.76E-07	1.13E-07	NA	1.86E+00
2,6-Dinitrotoluene	1.94E+01	2.23E-04	2.23E-01	3.49E-07	3.90E-05	3.90E-02	1.24E-08	7.93E-09	NA	2.62E-01
Benzo(a)anthracene	6.94E+00	7.99E-05	NA	1.25E-07	1.40E-05	NA	4.45E-09	2.84E-09	NA	NA
Benzo(a)pyrene	6.33E+00	7.28E-05	NA	1.14E-07	1.27E-05	NA	4.05E-09	2.59E-09	NA	NA
Benzo(b)fluoranthene	8.43E+00	9.70E-05	NA	1.52E-07	1.70E-05	NA	5.40E-09	3.45E-09	NA	NA
Benzo(k)fluoranthene	2.05E+00	2.35E-05	NA	3.68E-08	4.12E-06	NA	1.31E-09	8.38E-10	NA	NA
Chrysene	5.85E+00	6.73E-05	NA	1.05E-07	1.18E-05	NA	3.75E-09	2.40E-09	NA	NA
Dibenz(a,h)anthracene	1.40E+00	1.61E-05	NA	2.52E-08	2.82E-06	NA	8.97E-10	5.73E-10	NA	NA
Indeno(1,2,3-cd)pyrene	2.05E+00	2.35E-05	NA	3.68E-08	4.12E-06	NA	1.31E-09	8.38E-10	NA	NA
Total HI			**9.61E+02**			**2.80E+02**			**2.85E-03**	**1.24E+03**

HQ = Hazard quotient; HI = Hazard index
DA = Dose absorbed per unit body surface area per day
NA = Not applicable

Table B.2-8

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Surface Water
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/L)	DA (mg/cm^2-day)	Dermal Absorption Noncancer Dose (mg/kg-day)	Dermal Absorption Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR
Metals						
Manganese	3.01E+00	1.20E-05	3.64E-04	2.61E-06	1.55E-01	NA
Nitroaromatics						
Dinitrotoluene, total	7.92E-03	1.20E-07	3.64E-06	2.61E-08	3.64E-03	1.77E-08
Total HI					**1.59E-01**	
Total ILCR						**1.77E-08**

DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
mg/L = Milligrams per liter.
mg/cm2-day = Milligrams per square centimeter per day.
mg/kg-day - Milligrams per kilogram per day.
NA = Not applicable

Table B.2-9

Cancer Risk: On-Site Resident Exposure to Surface Water
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/L)	DA (mg/cm^2-day)	Adult Dermally Absorbed Dose (mg/kg-day)	Child Dermally Absorbed Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Metals							
Manganese	3.01E+00	9.03E-06	3.43E-05	1.54E-05	NA	NA	NA
Nitroaromatics							
Dinitrotoluene, total	7.92E-03	9.03E-08	3.43E-07	1.54E-07	2.33E-07	1.05E-07	3.38E-07
Total ILCR					**2.33E-07**	**1.05E-07**	**3.38E-07**

DA = Dose absorbed per unit body surface area per day.
ILCR = Incremental lifetime cancer risk.
mg/L = Milligrams per liter.

Table B.2-10

Noncancer Hazard: On-Site Resident Child Exposure to Surface Water
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/L)	DA (mg/cm^2-day)	Dermally Absorbed Dose (mg/kg-day)	Dermal HQ
Metals				
Manganese	3.01E+00	9.03E-06	1.80E-04	7.66E-02
Nitroaromatics				
Dinitrotoluene, total	7.92E-03	9.03E-08	1.80E-06	1.80E-03
Total HI				**7.84E-02**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
NA = Not applicable.

Table B.2-11

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Sediment
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Incidental Ingestion Noncancer Dose (mg/kg-day)	Incidental Ingestion Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Noncancer Dose (mg/kg-day)	Dermal Absorption Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	1.12E+01	3.17E-05	2.27E-07	5.28E-01	NA	2.69E-07	8.13E-06	5.82E-08	2.26E-01	NA	**7.54E-01**	**NA**
4-Amino-2,6-dinitrotoluene	1.28E+01	3.62E-05	2.59E-07	6.04E-01	NA	3.07E-07	9.29E-06	6.66E-08	2.58E-01	NA	**8.62E-01**	**NA**
2,4,6-Trinitrotoluene	1.50E+03	4.23E-03	3.03E-05	8.47E+00	9.10E-07	3.59E-05	1.09E-03	7.78E-06	3.62E+00	3.89E-07	**1.21E+01**	**1.30E-06**
PCBs												
Aroclor 1260	7.68E-01	2.17E-06	1.56E-08	NA	3.11E-08	1.11E-08	3.34E-07	2.40E-09	NA	4.79E-09	**NA**	**3.59E-08**
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	2.34E-01	6.63E-07	4.75E-09	3.32E-04	3.23E-09	5.62E-09	1.70E-07	1.22E-09	8.51E-05	8.29E-10	**4.17E-04**	**4.06E-09**
2,6-Dinitrotoluene	1.83E-01	5.18E-07	3.71E-09	5.18E-04	2.52E-09	4.39E-09	1.33E-07	9.52E-10	1.33E-04	6.47E-10	**6.51E-04**	**3.17E-09**
Benzo(a)pyrene	6.99E-02	1.98E-07	1.42E-09	NA	1.03E-08	1.68E-09	5.07E-08	3.63E-10	NA	5.31E-09	**NA**	**1.56E-08**
Total HI				**9.60E+00**					**4.10E+00**		**1.37E+01**	
Total ILCR					**9.57E-07**					**4.01E-07**		**1.36E-06**

DA = Dose absorbed per unit body surface area per day
HI = Hazard index.
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
mg/cm^2-day - Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable
PCB = Polychlorinated biphenyl.

Table B.2-12

Cancer Risk: On-Site Resident Exposure to Sediment
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

(Page 1 of 2)

Chemical	Source Term Concentration (mg/kg)	Adult Ingested Dose (mg/kg-day)	Child Ingested Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR
Nitroaromatics						
2-Amino-4,6-dinitrotoluene	1.12E+01	5.26E-07	1.23E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.28E+01	6.01E-07	1.40E-06	NA	NA	NA
2,4,6-Trinitrotoluene	1.50E+03	7.03E-05	1.64E-04	2.11E-06	4.92E-06	7.03E-06
PCBs						
Aroclor 1260	7.68E-01	3.61E-08	8.41E-08	7.21E-08	1.68E-07	2.40E-07
Semivolatile Organic Compounds						
2,4-Dinitrotoluene	2.34E-01	1.10E-08	2.57E-08	7.49E-09	1.75E-08	2.50E-08
2,6-Dinitrotoluene	1.83E-01	8.59E-09	2.01E-08	5.84E-09	1.36E-08	1.95E-08
Benzo(a)pyrene	6.99E-02	3.28E-09	7.66E-09	2.40E-08	5.59E-08	7.99E-08
Total ILCR				**2.22E-06**	**5.17E-06**	**7.39E-06**

DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable
ND = Not determined.
PCB = Polychlorinated biphenyl.

Table B.2-12

Cancer Risk: On-Site Resident Exposure to Sediment
TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	DA (mg/cm^2-day)	Adult Dermally Absorbed Dose (mg/kg-day)	Child Dermally Absorbed Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR	**Adult Resident Total All Pathways ILCR**	**Child Resident Total All Pathways ILCR**	**On-Site Resident Total All Pathways ILCR**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.12E+01	2.24E-08	4.79E-07	2.15E-07	NA	NA	ND	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	1.28E+01	2.56E-08	5.47E-07	2.45E-07	NA	NA	ND	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	1.50E+03	2.99E-06	6.39E-05	2.87E-05	3.20E-06	1.43E-06	4.63E-06	**5.30E-06**	**6.35E-06**	**1.17E-05**
PCBs										
Aroclor 1260	7.68E-01	9.21E-10	1.97E-08	8.83E-09	3.94E-08	1.77E-08	5.70E-08	**1.11E-07**	**1.86E-07**	**2.97E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.34E-01	4.69E-10	1.00E-08	4.49E-09	6.81E-09	3.06E-09	9.87E-09	**1.43E-08**	**2.05E-08**	**3.48E-08**
2,6-Dinitrotoluene	1.83E-01	3.66E-10	7.82E-09	3.51E-09	5.32E-09	2.39E-09	7.71E-09	**1.12E-08**	**1.60E-08**	**2.72E-08**
Benzo(a)pyrene	6.99E-02	1.40E-10	2.99E-09	1.34E-09	4.36E-08	1.96E-08	6.32E-08	**6.76E-08**	**7.55E-08**	**1.43E-07**
Total ILCR					**3.29E-06**	**1.48E-06**	**4.77E-06**	**5.51E-06**	**6.65E-06**	**1.22E-05**

DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable
ND = Not determined.
PCB = Polychlorinated biphenyl.

Table B.2-13

TNT Area C, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Source Term Concentration (mg/kg)	Child Ingested Dose (mg/kg-day)	Child Resident Oral HQ	DA (mg/cm^2-day)	Child Dermally Absorbed Dose (mg/kg-day)	Child Resident Dermal HQ	**Child Resident Total All Pathways HI**
Nitroaromatics							
2-Amino-4,6-dinitrotoluene	1.12E+01	1.43E-05	2.39E-01	2.24E-08	2.51E-06	6.96E-02	**3.08E-01**
4-Amino-2,6-dinitrotoluene	1.28E+01	1.64E-05	2.73E-01	2.56E-08	2.86E-06	7.96E-02	**3.52E-01**
2,4,6-Trinitrotoluene	1.50E+03	1.91E-03	3.83E+00	2.99E-06	3.35E-04	1.12E+00	**4.94E+00**
PCBs							
Aroclor 1260	7.68E-01	9.82E-07	NA	9.21E-10	1.03E-07	NA	**NA**
Semivolatile Organic Compounds							
2,4-Dinitrotoluene	2.34E-01	3.00E-07	1.50E-04	4.69E-10	5.24E-08	2.62E-05	**1.76E-04**
2,6-Dinitrotoluene	1.83E-01	2.34E-07	2.34E-04	3.66E-10	4.09E-08	4.09E-05	**2.75E-04**
Benzo(a)pyrene	6.99E-02	8.94E-08	NA	1.40E-10	1.56E-08	NA	**NA**
Total HI			**4.34E+00**			**1.26E+00**	**5.60E+00**

DA = Dose absorbed per unit body surface area per day.
HQ = Hazard quotient; HI = Hazard index.
mg/cm^2-day = Milligrams per square centimeter per day.
mg/kg = Milligrams per kilogram.
mg/kg-day = mg/kg per day.
NA = Not applicable
PCB = Polychlorinated biphenyl.

Table B.2-14

COPCs in Soil Associated with Former Building 602
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO134 AB0434AB0436 2.5 - 3.5	TNTC-SO134 AB0465 5 - 7	Source Term Concentration [a]
PCBs				
Aroclor 1254	2.20E-02	2.66E-01	1.76E-01	2.66E-01
Aroclor 1260	2.20E-02	ND	1.35E-01	1.35E-01
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	7.33E-02	ND	7.33E-02

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
ND = Not Detected

Table B.2-15

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 602, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
PCBs																	
Aroclor 1254	2.66E-01	7.53E-07	5.39E-09	3.76E-02	1.08E-08	1.28E-09	1.41E-07	1.01E-09	7.82E-03	2.02E-09	9.31E-08	1.82E-08	1.30E-10	NA	2.60E-10	**4.55E-02**	**1.31E-08**
Aroclor 1260	1.35E-01	3.82E-07	2.74E-09	NA	5.47E-09	6.48E-10	7.15E-08	5.12E-10	NA	1.02E-09	4.73E-08	9.22E-09	6.60E-11	NA	1.32E-10	**NA**	**6.63E-09**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	7.33E-02	2.07E-07	1.48E-09	1.04E-04	1.01E-09	5.86E-10	6.46E-08	4.63E-10	3.23E-05	3.15E-10	2.56E-08	5.00E-09	3.58E-11	NA	NA	**1.36E-04**	**1.32E-09**
Total HI				3.77E-02					7.86E-03					NA		**4.56E-02**	
Total ILCR					1.73E-08					3.36E-09					3.92E-10		**2.10E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-16

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 602, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
PCBs												
Aroclor 1254	2.66E-01	1.12E-07	2.62E-07	2.25E-07	5.25E-07	7.50E-07	2.87E-09	6.14E-08	2.76E-08	1.23E-07	5.51E-08	1.78E-07
Aroclor 1260	1.35E-01	5.71E-08	1.33E-07	1.14E-07	2.66E-07	3.80E-07	1.46E-09	3.12E-08	1.40E-08	6.23E-08	2.80E-08	9.03E-08
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	7.33E-02	3.10E-08	7.22E-08	2.11E-08	4.91E-08	7.02E-08	1.32E-09	2.82E-08	1.26E-08	1.92E-08	8.60E-09	2.78E-08
Total ILCR				3.60E-07	8.40E-07	1.20E-06				2.04E-07	9.17E-08	2.96E-07

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-16

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 602, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
PCBs										
Aroclor 1254	2.66E-01	1.70E-10	1.60E-11	9.34E-12	3.20E-11	1.87E-11	5.07E-11	**3.48E-07**	**5.80E-07**	**9.28E-07**
Aroclor 1260	1.35E-01	8.65E-11	8.12E-12	4.74E-12	1.62E-11	9.48E-12	2.57E-11	**1.76E-07**	**2.94E-07**	**4.71E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	7.33E-02	4.69E-11	4.41E-12	2.57E-12	NA	NA	NA	**4.02E-08**	**5.77E-08**	**9.79E-08**
Total ILCR					4.83E-11	2.82E-11	7.64E-11	**5.64E-07**	**9.32E-07**	**1.50E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-17

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 602, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
PCBs										
Aroclor 1254	2.66E-01	3.06E-06	1.53E-01	2.87E-09	3.21E-07	1.79E-02	1.70E-10	1.09E-10	NA	**1.71E-01**
Aroclor 1260	1.35E-01	1.55E-06	NA	1.46E-09	1.63E-07	NA	8.65E-11	5.53E-11	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	7.33E-02	8.43E-07	4.21E-04	1.32E-09	1.48E-07	7.38E-05	4.69E-11	3.00E-11	NA	**4.95E-04**
Total HI			1.53E-01			1.79E-02			NA	**1.71E-01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-18

COPCs in Soil Associated with Former Building 603
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO123 AB0463 5 - 7	TNTC-SO123 AB0464 8 - 10	Source Term Concentration [a]
Nitroaromatics				
2-Amino-4,6-dinitrotoluene	3.70E-01	3.61E+00	1.03E+01	1.03E+01
4-Amino-2,6-dinitrotoluene	3.70E-01	9.34E-01	8.96E-01	9.34E-01
2,4,6-Trinitrotoluene	1.60E+00	5.26E+00	1.51E+01	1.51E+01
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	6.17E-01	8.19E+00	8.19E+00
2,6-Dinitrotoluene	7.20E-02	7.21E+00	6.83E+00	7.21E+00

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern

Table B.2-19

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 603, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	1.03E+01	2.91E-05	2.09E-07	4.86E-01	NA	8.24E-08	9.09E-06	6.51E-08	2.52E-01	NA	3.61E-06	7.04E-07	5.04E-09	NA	NA	**7.38E-01**	**NA**
4-Amino-2,6-dinitrotoluene	9.34E-01	2.64E-06	1.89E-08	4.41E-02	NA	7.47E-09	8.24E-07	5.90E-09	2.29E-02	NA	3.27E-07	6.38E-08	4.57E-10	NA	NA	**6.69E-02**	**NA**
2,4,6-Trinitrotoluene	1.51E+01	4.27E-05	3.06E-07	8.55E-02	9.18E-09	1.21E-07	1.33E-05	9.54E-08	4.44E-02	4.77E-09	5.29E-06	1.03E-06	7.39E-09	NA	NA	**1.30E-01**	**1.40E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	8.19E+00	2.32E-05	1.66E-07	1.16E-02	1.13E-07	6.55E-08	7.22E-06	5.17E-08	3.61E-03	3.52E-08	2.87E-06	5.59E-07	4.01E-09	NA	NA	**1.52E-02**	**1.48E-07**
2,6-Dinitrotoluene	7.21E+00	2.04E-05	1.46E-07	2.04E-02	9.94E-08	5.77E-08	6.36E-06	4.56E-08	6.36E-03	3.10E-08	2.52E-06	4.92E-07	3.53E-09	NA	NA	**2.68E-02**	**1.30E-07**
Total HI				6.47E-01					3.30E-01					NA		**9.77E-01**	
Total ILCR					2.21E-07					7.09E-08					NA		**2.92E-07**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-20

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 603, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	1.03E+01	4.35E-06	1.02E-05	NA	NA	NA	1.85E-07	3.96E-06	1.78E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	9.34E-01	3.95E-07	9.21E-07	NA	NA	NA	1.68E-08	3.59E-07	1.61E-07	NA	NA	NA
2,4,6-Trinitrotoluene	1.51E+01	6.38E-06	1.49E-05	1.91E-07	4.47E-07	6.38E-07	2.72E-07	5.81E-06	2.61E-06	2.90E-07	1.30E-07	4.21E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	8.19E+00	3.46E-06	8.08E-06	2.35E-06	5.49E-06	7.85E-06	1.47E-07	3.15E-06	1.41E-06	2.14E-06	9.61E-07	3.10E-06
2,6-Dinitrotoluene	7.21E+00	3.05E-06	7.11E-06	2.07E-06	4.84E-06	6.91E-06	1.30E-07	2.77E-06	1.24E-06	1.89E-06	8.46E-07	2.73E-06
Total ILCR				4.62E-06	1.08E-05	1.54E-05				4.32E-06	1.94E-06	6.26E-06

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-20

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 603, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.03E+01	6.60E-09	6.20E-10	3.62E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	9.34E-01	5.98E-10	5.62E-11	3.28E-11	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	1.51E+01	9.67E-09	9.09E-10	5.30E-10	NA	NA	NA	**4.82E-07**	**5.77E-07**	**1.06E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.19E+00	5.25E-09	4.93E-10	2.87E-10	NA	NA	NA	**4.50E-06**	**6.45E-06**	**1.10E-05**
2,6-Dinitrotoluene	7.21E+00	4.62E-09	4.34E-10	2.53E-10	NA	NA	NA	**3.96E-06**	**5.68E-06**	**9.64E-06**
Total ILCR					NA	NA	NA	**8.94E-06**	**1.27E-05**	**2.16E-05**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-21

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 603, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.03E+01	1.19E-04	1.98E+00	1.85E-07	2.07E-05	5.76E-01	6.60E-09	4.22E-09	NA	**2.55E+00**
4-Amino-2,6-dinitrotoluene	9.34E-01	1.07E-05	1.79E-01	1.68E-08	1.88E-06	5.22E-02	5.98E-10	3.82E-10	NA	**2.31E-01**
2,4,6-Trinitrotoluene	1.51E+01	1.74E-04	3.48E-01	2.72E-07	3.04E-05	1.01E-01	9.67E-09	6.18E-09	NA	**4.49E-01**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	8.19E+00	9.42E-05	4.71E-02	1.47E-07	1.65E-05	8.25E-03	5.25E-09	3.35E-09	NA	**5.54E-02**
2,6-Dinitrotoluene	7.21E+00	8.30E-05	8.30E-02	1.30E-07	1.45E-05	1.45E-02	4.62E-09	2.95E-09	NA	**9.75E-02**
Total HI			2.63E+00			7.53E-01			NA	**3.38E+00**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-22

COPCs in Soil Associated with Former Building 606
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO206 AB0447 1 - 2	Source Term Concentration [a]
Nitroaromatics			
2-Amino-4,6-dinitrotoluene	3.70E-01	**6.90E+00**	6.90E+00
4-Amino-2,6-dinitrotoluene	3.70E-01	**4.48E+00**	4.48E+00
2,4,6-Trinitrotoluene	1.60E+00	**3.45E+00**	3.45E+00
PCBs			
Aroclor 1260	2.20E-02	**1.40E-01**	1.40E-01
Semivolatile Organic Compounds			
Benzo(a)pyrene	6.20E-03	**4.49E-02**	4.49E-02
Benzo(b)fluoranthene	6.20E-02	**8.26E-02**	8.26E-02

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern

Table B.2-23

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 606, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	6.90E+00	1.95E-05	1.40E-07	3.25E-01	NA	5.52E-08	6.09E-06	4.36E-08	1.69E-01	NA	2.42E-06	4.71E-07	3.38E-09	NA	NA	**4.95E-01**	**NA**
4-Amino-2,6-dinitrotoluene	4.48E+00	1.27E-05	9.08E-08	2.11E-01	NA	3.58E-08	3.95E-06	2.83E-08	1.10E-01	NA	1.57E-06	3.06E-07	2.19E-09	NA	NA	**3.21E-01**	**NA**
2,4,6-Trinitrotoluene	3.45E+00	9.76E-06	6.99E-08	1.95E-02	2.10E-09	2.76E-08	3.04E-06	2.18E-08	1.01E-02	1.09E-09	1.21E-06	2.36E-07	1.69E-09	NA	NA	**2.97E-02**	**3.19E-09**
PCBs																	
Aroclor 1260	1.40E-01	3.96E-07	2.84E-09	NA	5.68E-09	6.72E-10	7.41E-08	5.31E-10	NA	1.06E-09	4.90E-08	9.56E-09	6.85E-11	NA	1.37E-10	**NA**	**6.87E-09**
Semivolatile Organic Compounds																	
Benzo(a)pyrene	4.49E-02	1.27E-07	9.10E-10	NA	6.64E-09	3.59E-10	3.96E-08	2.84E-10	NA	4.14E-09	1.57E-08	3.07E-09	2.20E-11	NA	6.81E-11	**NA**	**1.09E-08**
Benzo(b)fluoranthene	8.26E-02	2.34E-07	1.67E-09	NA	1.22E-09	6.61E-10	7.29E-08	5.22E-10	NA	7.62E-10	2.89E-08	5.64E-09	4.04E-11	NA	1.25E-11	**NA**	**2.00E-09**
Total HI				5.56E-01					2.89E-01					NA		**8.45E-01**	
Total ILCR					1.56E-08					7.06E-09					2.18E-10		**2.29E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-24

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 606, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	6.90E+00	2.92E-06	6.81E-06	NA	NA	NA	1.24E-07	2.65E-06	1.19E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	4.48E+00	1.89E-06	4.42E-06	NA	NA	NA	8.06E-08	1.72E-06	7.73E-07	NA	NA	NA
2,4,6-Trinitrotoluene	3.45E+00	1.46E-06	3.40E-06	4.37E-08	1.02E-07	1.46E-07	6.21E-08	1.33E-06	5.95E-07	6.64E-08	2.98E-08	9.61E-08
PCBs												
Aroclor 1260	1.40E-01	5.92E-08	1.38E-07	1.18E-07	2.76E-07	3.95E-07	1.51E-09	3.23E-08	1.45E-08	6.46E-08	2.90E-08	9.36E-08
Semivolatile Organic Compounds												
Benzo(a)pyrene	4.49E-02	1.90E-08	4.43E-08	1.39E-07	3.23E-07	4.62E-07	8.08E-10	1.73E-08	7.75E-09	2.52E-07	1.13E-07	3.65E-07
Benzo(b)fluoranthene	8.26E-02	3.49E-08	8.15E-08	2.55E-08	5.95E-08	8.50E-08	1.49E-09	3.18E-08	1.43E-08	4.64E-08	2.08E-08	6.72E-08
Total ILCR				3.26E-07	7.61E-07	1.09E-06				4.30E-07	1.93E-07	6.22E-07

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-24

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 606, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	6.90E+00	4.42E-09	4.15E-10	2.42E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	4.48E+00	2.87E-09	2.70E-10	1.57E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	3.45E+00	2.21E-09	2.08E-10	1.21E-10	NA	NA	NA	**1.10E-07**	**1.32E-07**	**2.42E-07**
PCBs										
Aroclor 1260	1.40E-01	8.97E-11	8.42E-12	4.91E-12	1.68E-11	9.83E-12	2.67E-11	**1.83E-07**	**3.05E-07**	**4.88E-07**
Semivolatile Organic Compounds										
Benzo(a)pyrene	4.49E-02	2.88E-11	2.70E-12	1.58E-12	8.37E-12	4.89E-12	1.33E-11	**3.91E-07**	**4.36E-07**	**8.27E-07**
Benzo(b)fluoranthene	8.26E-02	5.29E-11	4.97E-12	2.90E-12	1.54E-12	8.99E-13	2.44E-12	**7.19E-08**	**8.03E-08**	**1.52E-07**
Total ILCR					2.68E-11	1.56E-11	4.24E-11	**7.56E-07**	**9.54E-07**	**1.71E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-25

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 606, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	6.90E+00	7.94E-05	1.32E+00	1.24E-07	1.39E-05	3.86E-01	4.42E-09	2.83E-09	NA	**1.71E+00**
4-Amino-2,6-dinitrotoluene	4.48E+00	5.16E-05	8.59E-01	8.06E-08	9.02E-06	2.51E-01	2.87E-09	1.83E-09	NA	**1.11E+00**
2,4,6-Trinitrotoluene	3.45E+00	3.97E-05	7.94E-02	6.21E-08	6.95E-06	2.32E-02	2.21E-09	1.41E-09	NA	**1.03E-01**
PCBs										
Aroclor 1260	1.40E-01	1.61E-06	NA	1.51E-09	1.69E-07	NA	8.97E-11	5.73E-11	NA	**NA**
Semivolatile Organic Compounds										
Benzo(a)pyrene	4.49E-02	5.17E-07	NA	8.08E-10	9.04E-08	NA	2.88E-11	1.84E-11	NA	**NA**
Benzo(b)fluoranthene	8.26E-02	9.50E-07	NA	1.49E-09	1.66E-07	NA	5.29E-11	3.38E-11	NA	**NA**
Total HI			2.26E+00			6.60E-01			NA	**2.92E+00**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-26

COPCs in Soil Associated with Former Building 611
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO383 AB0470 4 - 6	Source Term Concentration [a]
PCBs			
Aroclor 1260	2.20E-02	2.44E-02	2.44E-02

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern

Table B.2-27

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 611, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
PCBs																	
Aroclor 1260	2.44E-02	6.90E-08	4.95E-10	NA	9.89E-10	1.17E-10	1.29E-08	9.25E-11	NA	1.85E-10	8.54E-09	1.67E-09	1.19E-11	NA	2.39E-11	**NA**	**1.20E-09**
Total HI				NA					NA					NA		**NA**	
Total ILCR					9.89E-10					1.85E-10					2.39E-11		**1.20E-09**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-28

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 611, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
PCBs												
Aroclor 1260	2.44E-02	1.03E-08	2.41E-08	2.06E-08	4.81E-08	6.88E-08	2.64E-10	5.63E-09	2.53E-09	1.13E-08	5.05E-09	1.63E-08
Total ILCR				2.06E-08	4.81E-08	6.88E-08				1.13E-08	5.05E-09	1.63E-08

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk

Table B.2-28

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 611, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
PCBs										
Aroclor 1260	2.44E-02	1.56E-11	1.47E-12	8.56E-13	2.94E-12	1.71E-12	4.65E-12	**3.19E-08**	**5.32E-08**	**8.51E-08**
Total ILCR					2.94E-12	1.71E-12	4.65E-12	**3.19E-08**	**5.32E-08**	**8.51E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk

Table B.2-29

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 611, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
PCBs										
Aroclor 1260	2.44E-02	2.81E-07	NA	2.64E-10	2.95E-08	NA	1.56E-11	9.99E-12	NA	**NA**
Total HI			NA			NA			NA	**NA**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-30

COPCs in Soil Associated with Former Building 616
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO107 AB0432 0 - 1	TNTC-SO252 AB0449FDAB0451 0.5 - 1.5	TNTC-SO100 AB0476 2 - 3	TNTC-SO107 AB0433 3 - 4	TNTC-SO252 AB0473 4 - 6	TNTC-SO252 AB0474 8 - 10	Source Term Concentration [a]
Nitroaromatics								
2-Amino-4,6-dinitrotoluene	3.70E-01	ND	3.79E+00	6.44E+00	NA	NA	ND	6.44E+00
4-Amino-2,6-dinitrotoluene	3.70E-01	ND	3.85E+00	ND	NA	ND	ND	3.85E+00
2,4,6-Trinitrotoluene	1.60E+00	NA	8.17E+02	2.23E+03	4.73E+01	NA	ND	2.23E+03
PCBs								
Aroclor 1260	2.20E-02	8.80E-02	4.37E-01	2.60E-01	3.00E-02	ND	ND	4.37E-01
Semivolatile Organic Compounds								
2,4-Dinitrotoluene	7.20E-02	ND	1.47E+00	4.96E-01	ND	ND	ND	1.47E+00
Benzo(a)anthracene	6.20E-02	2.69E-01	ND	ND	ND	ND	ND	2.69E-01
Benzo(a)pyrene	6.20E-03	3.05E-01	ND	ND	ND	ND	ND	3.05E-01
Benzo(b)fluoranthene	6.20E-02	4.43E-01	ND	ND	ND	ND	ND	4.43E-01
Dibenz(a,h)anthracene	6.20E-03	8.17E-02	ND	ND	ND	ND	ND	8.17E-02
Indeno(1,2,3-cd)pyrene	6.20E-02	2.10E-01	ND	ND	ND	ND	ND	2.10E-01

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.2-31

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 616, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	6.44E+00	1.82E-05	1.31E-07	3.04E-01	NA	5.15E-08	5.68E-06	4.07E-08	1.58E-01	NA	2.25E-06	4.40E-07	3.15E-09	NA	NA	**4.62E-01**	**NA**
4-Amino-2,6-dinitrotoluene	3.85E+00	1.09E-05	7.79E-08	1.81E-01	NA	3.08E-08	3.39E-06	2.43E-08	9.42E-02	NA	1.35E-06	2.63E-07	1.88E-09	NA	NA	**2.76E-01**	**NA**
2,4,6-Trinitrotoluene	2.23E+03	6.30E-03	4.51E-05	1.26E+01	1.35E-06	1.78E-05	1.96E-03	1.41E-05	6.55E+00	7.03E-07	7.79E-04	1.52E-04	1.09E-06	NA	NA	**1.91E+01**	**2.06E-06**
PCBs																	
Aroclor 1260	4.37E-01	1.24E-06	8.86E-09	NA	1.77E-08	2.10E-09	2.31E-07	1.66E-09	NA	3.31E-09	1.53E-07	2.98E-08	2.14E-10	NA	4.28E-10	**NA**	**2.15E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	1.47E+00	4.17E-06	2.98E-08	2.08E-03	2.03E-08	1.18E-08	1.30E-06	9.30E-09	6.49E-04	6.32E-09	5.15E-07	1.01E-07	7.20E-10	NA	NA	**2.73E-03**	**2.66E-08**
Benzo(a)anthracene	2.69E-01	7.61E-07	5.45E-09	NA	3.98E-09	2.15E-09	2.37E-07	1.70E-09	NA	2.48E-09	9.42E-08	1.84E-08	1.32E-10	NA	4.08E-11	**NA**	**6.50E-09**
Benzo(a)pyrene	3.05E-01	8.63E-07	6.18E-09	NA	4.51E-08	2.44E-09	2.69E-07	1.93E-09	NA	2.81E-08	1.07E-07	2.08E-08	1.49E-10	NA	4.63E-10	**NA**	**7.37E-08**
Benzo(b)fluoranthene	4.43E-01	1.25E-06	8.98E-09	NA	6.55E-09	3.54E-09	3.91E-07	2.80E-09	NA	4.09E-09	1.55E-07	3.03E-08	2.17E-10	NA	6.72E-11	**NA**	**1.07E-08**
Dibenz(a,h)anthracene	8.17E-02	2.31E-07	1.66E-09	NA	1.21E-08	6.54E-10	7.21E-08	5.16E-10	NA	4.71E-09	2.86E-08	5.58E-09	4.00E-11	NA	1.24E-10	**NA**	**1.69E-08**
Indeno(1,2,3-cd)pyrene	2.10E-01	5.94E-07	4.26E-09	NA	3.11E-09	1.68E-09	1.85E-07	1.33E-09	NA	1.94E-09	7.35E-08	1.43E-08	1.03E-10	NA	3.18E-11	**NA**	**5.08E-09**
Total HI				1.31E+01					6.80E+00					NA		**1.99E+01**	
Total ILCR					1.46E-06					7.54E-07					1.15E-09		**2.22E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-32

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 616, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	6.44E+00	2.72E-06	6.35E-06	NA	NA	NA	1.16E-07	2.48E-06	1.11E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	3.85E+00	1.63E-06	3.79E-06	NA	NA	NA	6.92E-08	1.48E-06	6.64E-07	NA	NA	NA
2,4,6-Trinitrotoluene	2.23E+03	9.41E-04	2.20E-03	2.82E-05	6.59E-05	9.41E-05	4.01E-05	8.56E-04	3.84E-04	4.28E-05	1.92E-05	6.20E-05
PCBs												
Aroclor 1260	4.37E-01	1.85E-07	4.31E-07	3.69E-07	8.62E-07	1.23E-06	4.72E-09	1.01E-07	4.53E-08	2.02E-07	9.05E-08	2.92E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	1.47E+00	6.22E-07	1.45E-06	4.23E-07	9.87E-07	1.41E-06	2.65E-08	5.66E-07	2.54E-07	3.85E-07	1.73E-07	5.58E-07
Benzo(a)anthracene	2.69E-01	1.14E-07	2.65E-07	8.30E-08	1.94E-07	2.77E-07	4.84E-09	1.03E-07	4.64E-08	1.51E-07	6.78E-08	2.19E-07
Benzo(a)pyrene	3.05E-01	1.29E-07	3.01E-07	9.41E-07	2.20E-06	3.14E-06	5.49E-09	1.17E-07	5.26E-08	1.71E-06	7.69E-07	2.48E-06
Benzo(b)fluoranthene	4.43E-01	1.87E-07	4.37E-07	1.37E-07	3.19E-07	4.56E-07	7.97E-09	1.70E-07	7.65E-08	2.49E-07	1.12E-07	3.60E-07
Dibenz(a,h)anthracene	8.17E-02	3.45E-08	8.06E-08	2.52E-07	5.88E-07	8.40E-07	1.47E-09	3.14E-08	1.41E-08	2.87E-07	1.29E-07	4.15E-07
Indeno(1,2,3-cd)pyrene	2.10E-01	8.88E-08	2.07E-07	6.48E-08	1.51E-07	2.16E-07	3.78E-09	8.08E-08	3.62E-08	1.18E-07	5.29E-08	1.71E-07
Total ILCR				3.05E-05	7.12E-05	1.02E-04				4.59E-05	2.06E-05	6.65E-05

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-32

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 616, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	6.44E+00	4.12E-09	3.87E-10	2.26E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	3.85E+00	2.46E-09	2.31E-10	1.35E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	2.23E+03	1.43E-06	1.34E-07	7.81E-08	NA	NA	NA	**7.10E-05**	**8.51E-05**	**1.56E-04**
PCBs										
Aroclor 1260	4.37E-01	2.80E-10	2.63E-11	1.53E-11	5.26E-11	3.07E-11	8.33E-11	**5.71E-07**	**9.53E-07**	**1.52E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.47E+00	9.43E-10	8.86E-11	5.17E-11	NA	NA	NA	**8.08E-07**	**1.16E-06**	**1.97E-06**
Benzo(a)anthracene	2.69E-01	1.72E-10	1.62E-11	9.44E-12	5.02E-12	2.93E-12	7.94E-12	**2.34E-07**	**2.61E-07**	**4.96E-07**
Benzo(a)pyrene	3.05E-01	1.95E-10	1.84E-11	1.07E-11	5.69E-11	3.32E-11	9.01E-11	**2.65E-06**	**2.96E-06**	**5.62E-06**
Benzo(b)fluoranthene	4.43E-01	2.84E-10	2.67E-11	1.55E-11	8.26E-12	4.82E-12	1.31E-11	**3.85E-07**	**4.31E-07**	**8.16E-07**
Dibenz(a,h)anthracene	8.17E-02	5.23E-11	4.92E-12	2.87E-12	1.52E-11	8.89E-12	2.41E-11	**5.39E-07**	**7.17E-07**	**1.26E-06**
Indeno(1,2,3-cd)pyrene	2.10E-01	1.35E-10	1.26E-11	7.37E-12	3.92E-12	2.28E-12	6.20E-12	**1.83E-07**	**2.04E-07**	**3.87E-07**
Total ILCR					1.42E-10	8.28E-11	2.25E-10	**7.64E-05**	**9.18E-05**	**1.68E-04**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-33

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 616, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	6.44E+00	7.41E-05	1.24E+00	1.16E-07	1.30E-05	3.60E-01	4.12E-09	2.64E-09	NA	**1.60E+00**
4-Amino-2,6-dinitrotoluene	3.85E+00	4.42E-05	7.37E-01	6.92E-08	7.74E-06	2.15E-01	2.46E-09	1.57E-09	NA	**9.52E-01**
2,4,6-Trinitrotoluene	2.23E+03	2.56E-02	5.12E+01	4.01E-05	4.48E-03	1.49E+01	1.43E-06	9.11E-07	NA	**6.62E+01**
PCBs										
Aroclor 1260	4.37E-01	5.03E-06	NA	4.72E-09	5.28E-07	NA	2.80E-10	1.79E-10	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.47E+00	1.69E-05	8.47E-03	2.65E-08	2.96E-06	1.48E-03	9.43E-10	6.03E-10	NA	**9.95E-03**
Benzo(a)anthracene	2.69E-01	3.10E-06	NA	4.84E-09	5.42E-07	NA	1.72E-10	1.10E-10	NA	**NA**
Benzo(a)pyrene	3.05E-01	3.51E-06	NA	5.49E-09	6.14E-07	NA	1.95E-10	1.25E-10	NA	**NA**
Benzo(b)fluoranthene	4.43E-01	5.10E-06	NA	7.97E-09	8.92E-07	NA	2.84E-10	1.81E-10	NA	**NA**
Dibenz(a,h)anthracene	8.17E-02	9.40E-07	NA	1.47E-09	1.65E-07	NA	5.23E-11	3.35E-11	NA	**NA**
Indeno(1,2,3-cd)pyrene	2.10E-01	2.42E-06	NA	3.78E-09	4.23E-07	NA	1.35E-10	8.60E-11	NA	**NA**
Total HI			5.32E+01			1.55E+01			NA	**6.87E+01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-34

COPCs in Soil Associated with Former Building 626
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO074 AB0431 2.5 - 3.5	Source Term Concentration [a]
Nitroaromatics			
2-Amino-4,6-dinitrotoluene	3.70E-01	2.67E+00	2.67E+00
4-Amino-2,6-dinitrotoluene	3.70E-01	7.84E-01	7.84E-01
PCBs			
Aroclor 1260	2.20E-02	1.50E-01	1.50E-01
Semivolatile Organic Compounds			
Benzo(a)anthracene	6.20E-02	1.35E-01	1.35E-01
Benzo(a)pyrene	6.20E-03	5.36E-02	5.36E-02
Benzo(b)fluoranthene	6.20E-02	1.16E-01	1.16E-01

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern

Table B.2-35

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 626, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	2.67E+00	7.56E-06	5.41E-08	1.26E-01	NA	2.14E-08	2.36E-06	1.69E-08	6.54E-02	NA	9.35E-07	1.82E-07	1.31E-09	NA	NA	**1.91E-01**	**NA**
4-Amino-2,6-dinitrotoluene	7.84E-01	2.22E-06	1.59E-08	3.70E-02	NA	6.27E-09	6.92E-07	4.95E-09	1.92E-02	NA	2.74E-07	5.36E-08	3.84E-10	NA	NA	**5.62E-02**	**NA**
PCBs																	
Aroclor 1260	1.50E-01	4.24E-07	3.04E-09	NA	6.08E-09	7.20E-10	7.94E-08	5.69E-10	NA	1.14E-09	5.25E-08	1.02E-08	7.34E-11	NA	1.47E-10	**NA**	**7.36E-09**
Semivolatile Organic Compounds																	
Benzo(a)anthracene	1.35E-01	3.82E-07	2.74E-09	NA	2.00E-09	1.08E-09	1.19E-07	8.53E-10	NA	1.25E-09	4.73E-08	9.22E-09	6.60E-11	NA	2.05E-11	**NA**	**3.26E-09**
Benzo(a)pyrene	5.36E-02	1.52E-07	1.09E-09	NA	7.93E-09	4.29E-10	4.73E-08	3.39E-10	NA	4.94E-09	1.88E-08	3.66E-09	2.62E-11	NA	8.13E-11	**NA**	**1.30E-08**
Benzo(b)fluoranthene	1.16E-01	3.28E-07	2.35E-09	NA	1.72E-09	9.28E-10	1.02E-07	7.33E-10	NA	1.07E-09	4.06E-08	7.92E-09	5.68E-11	NA	1.76E-11	**NA**	**2.80E-09**
Total HI				1.63E-01					8.46E-02					NA		**2.48E-01**	
Total ILCR					1.77E-08					8.40E-09					2.66E-10		**2.64E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-36

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 626, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	2.67E+00	1.13E-06	2.63E-06	NA	NA	NA	4.81E-08	1.03E-06	4.61E-07	NA	NA	NA
4-Amino-2,6-dinitrotoluene	7.84E-01	3.31E-07	7.73E-07	NA	NA	NA	1.41E-08	3.02E-07	1.35E-07	NA	NA	NA
PCBs												
Aroclor 1260	1.50E-01	6.34E-08	1.48E-07	1.27E-07	2.96E-07	4.23E-07	1.62E-09	3.46E-08	1.55E-08	6.92E-08	3.11E-08	1.00E-07
Semivolatile Organic Compounds												
Benzo(a)anthracene	1.35E-01	5.71E-08	1.33E-07	4.17E-08	9.72E-08	1.39E-07	2.43E-09	5.19E-08	2.33E-08	7.58E-08	3.40E-08	1.10E-07
Benzo(a)pyrene	5.36E-02	2.27E-08	5.29E-08	1.65E-07	3.86E-07	5.51E-07	9.65E-10	2.06E-08	9.25E-09	3.01E-07	1.35E-07	4.36E-07
Benzo(b)fluoranthene	1.16E-01	4.90E-08	1.14E-07	3.58E-08	8.35E-08	1.19E-07	2.09E-09	4.46E-08	2.00E-08	6.51E-08	2.92E-08	9.44E-08
Total ILCR				3.70E-07	8.63E-07	1.23E-06				5.11E-07	2.29E-07	7.41E-07

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-36

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 626, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	2.67E+00	1.71E-09	1.61E-10	9.37E-11	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	7.84E-01	5.02E-10	4.72E-11	2.75E-11	NA	NA	NA	**NA**	**NA**	**NA**
PCBs										
Aroclor 1260	1.50E-01	9.61E-11	9.02E-12	5.26E-12	1.80E-11	1.05E-11	2.86E-11	**1.96E-07**	**3.27E-07**	**5.23E-07**
Semivolatile Organic Compounds										
Benzo(a)anthracene	1.35E-01	8.65E-11	8.12E-12	4.74E-12	2.52E-12	1.47E-12	3.99E-12	**1.17E-07**	**1.31E-07**	**2.49E-07**
Benzo(a)pyrene	5.36E-02	3.43E-11	3.22E-12	1.88E-12	1.00E-11	5.83E-12	1.58E-11	**4.66E-07**	**5.21E-07**	**9.87E-07**
Benzo(b)fluoranthene	1.16E-01	7.43E-11	6.98E-12	4.07E-12	2.16E-12	1.26E-12	3.43E-12	**1.01E-07**	**1.13E-07**	**2.14E-07**
Total ILCR					3.27E-11	1.91E-11	5.18E-11	**8.81E-07**	**1.09E-06**	**1.97E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-37

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 626, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	2.67E+00	3.07E-05	5.12E-01	4.81E-08	5.38E-06	1.49E-01	1.71E-09	1.09E-09	NA	**6.61E-01**
4-Amino-2,6-dinitrotoluene	7.84E-01	9.02E-06	1.50E-01	1.41E-08	1.58E-06	4.39E-02	5.02E-10	3.21E-10	NA	**1.94E-01**
PCBs										
Aroclor 1260	1.50E-01	1.73E-06	NA	1.62E-09	1.81E-07	NA	9.61E-11	6.14E-11	NA	**NA**
Semivolatile Organic Compounds										
Benzo(a)anthracene	1.35E-01	1.55E-06	NA	2.43E-09	2.72E-07	NA	8.65E-11	5.53E-11	NA	**NA**
Benzo(a)pyrene	5.36E-02	6.17E-07	NA	9.65E-10	1.08E-07	NA	3.43E-11	2.19E-11	NA	**NA**
Benzo(b)fluoranthene	1.16E-01	1.33E-06	NA	2.09E-09	2.34E-07	NA	7.43E-11	4.75E-11	NA	**NA**
Total HI			6.62E-01			1.93E-01			NA	**8.56E-01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-38

COPCs in Soil Associated with Former Building 629
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO066 AB0427FDAB0429 0 - 1	TNTC-SO065 AB0475 2.5 - 3.5	TNTC-SO066 AB0430 2.5 - 3.5	TNTC-SO066 AB0461 5 - 7	TNTC-SO066 AB0462 8 - 10	Source Term Concentration [a]
Metals							
Lead	4.00E+02	NA	NA	7.61E+02	NA	--	7.61E+02
Nitroaromatics							
2-Nitrotoluene	3.70E+01	--	ND	NA	5.08E+01	NA	5.08E+01
4-Nitrotoluene	3.70E+01	--	ND	ND	6.74E+01	NA	6.74E+01
2,4,6-Trinitrotoluene	1.60E+00	NA	ND	3.80E+01	5.19E+00	NA	3.80E+01
PCBs							
Aroclor 1254	2.20E-02	--	9.69E-01	ND	ND	ND	9.69E-01
Aroclor 1260	2.20E-02	4.88E+00	1.58E+00	2.09E+00	1.60E-01	1.03E-01	4.88E+00
Semivolatile Organic Compounds							
2,4-Dinitrotoluene	7.20E-02	2.30E-01	NA	4.31E+01	1.70E+02	1.32E+01	1.70E+02
2,6-Dinitrotoluene	7.20E-02	NA	ND	6.92E+00	6.55E+01	6.83E+00	6.55E+01
Benzo(a)pyrene	6.20E-03	ND	4.30E-02	ND	ND	ND	4.30E-02

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected
-- = No result was available from this sample.

Table B.2-39

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 629, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals																	
Lead	7.61E+02	2.15E-03	1.54E-05	NA	NA	6.09E-07	6.71E-05	4.81E-07	NA	NA	2.66E-04	5.20E-05	3.72E-07	NA	NA	**NA**	**NA**
Nitroaromatics																	
2-Nitrotoluene	5.08E+01	1.44E-04	1.03E-06	1.44E-02	NA	4.06E-07	4.48E-05	3.21E-07	4.98E-03	NA	1.78E-05	3.47E-06	2.49E-08	NA	NA	**1.94E-02**	**NA**
4-Nitrotoluene	6.74E+01	1.91E-04	1.37E-06	1.91E-02	NA	5.39E-07	5.95E-05	4.26E-07	6.61E-03	NA	2.36E-05	4.60E-06	3.30E-08	NA	NA	**2.57E-02**	**NA**
2,4,6-Trinitrotoluene	3.80E+01	1.08E-04	7.70E-07	2.15E-01	2.31E-08	3.04E-07	3.35E-05	2.40E-07	1.12E-01	1.20E-08	1.33E-05	2.60E-06	1.86E-08	NA	NA	**3.27E-01**	**3.51E-08**
PCBs																	
Aroclor 1254	9.69E-01	2.74E-06	1.96E-08	1.37E-01	3.93E-08	4.65E-09	5.13E-07	3.67E-09	2.85E-02	7.35E-09	3.39E-07	6.62E-08	4.74E-10	NA	9.48E-10	**1.66E-01**	**4.76E-08**
Aroclor 1260	4.88E+00	1.38E-05	9.88E-08	NA	1.98E-07	2.34E-08	2.58E-06	1.85E-08	NA	3.70E-08	1.71E-06	3.33E-07	2.39E-09	NA	4.77E-09	**NA**	**2.39E-07**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	1.70E+02	4.81E-04	3.45E-06	2.41E-01	2.34E-06	1.36E-06	1.50E-04	1.07E-06	7.50E-02	7.30E-07	5.95E-05	1.16E-05	8.32E-08	NA	NA	**3.16E-01**	**3.07E-06**
2,6-Dinitrotoluene	6.55E+01	1.85E-04	1.33E-06	1.85E-01	9.03E-07	5.24E-07	5.78E-05	4.14E-07	5.78E-02	2.81E-07	2.29E-05	4.47E-06	3.20E-08	NA	NA	**2.43E-01**	**1.18E-06**
Benzo(a)pyrene	4.30E-02	1.22E-07	8.72E-10	NA	6.36E-09	3.44E-10	3.79E-08	2.72E-10	NA	3.97E-09	1.51E-08	2.94E-09	2.10E-11	NA	6.52E-11	**NA**	**1.04E-08**
Total HI				8.12E-01					2.85E-01					NA		**1.10E+00**	
Total ILCR					3.51E-06					1.07E-06					5.78E-09		**4.59E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-40

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 629, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Metals												
Lead	7.61E+02	3.22E-04	7.51E-04	NA	NA	NA	1.37E-06	2.93E-05	1.31E-05	NA	NA	NA
Nitroaromatics												
2-Nitrotoluene	5.08E+01	2.15E-05	5.01E-05	NA	NA	NA	9.14E-07	1.95E-05	8.77E-06	NA	NA	NA
4-Nitrotoluene	6.74E+01	2.85E-05	6.65E-05	NA	NA	NA	1.21E-06	2.59E-05	1.16E-05	NA	NA	NA
2,4,6-Trinitrotoluene	3.80E+01	1.61E-05	3.75E-05	4.82E-07	1.12E-06	1.61E-06	6.84E-07	1.46E-05	6.56E-06	7.31E-07	3.28E-07	1.06E-06
PCBs												
Aroclor 1254	9.69E-01	4.10E-07	9.56E-07	8.19E-07	1.91E-06	2.73E-06	1.05E-08	2.24E-07	1.00E-07	4.47E-07	2.01E-07	6.48E-07
Aroclor 1260	4.88E+00	2.06E-06	4.81E-06	4.12E-06	9.62E-06	1.37E-05	5.27E-08	1.13E-06	5.05E-07	2.25E-06	1.01E-06	3.26E-06
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	1.70E+02	7.19E-05	1.68E-04	4.89E-05	1.14E-04	1.63E-04	3.06E-06	6.54E-05	2.93E-05	4.45E-05	2.00E-05	6.44E-05
2,6-Dinitrotoluene	6.55E+01	2.77E-05	6.46E-05	1.88E-05	4.39E-05	6.28E-05	1.18E-06	2.52E-05	1.13E-05	1.71E-05	7.69E-06	2.48E-05
Benzo(a)pyrene	4.30E-02	1.82E-08	4.24E-08	1.33E-07	3.10E-07	4.42E-07	7.74E-10	1.65E-08	7.42E-09	2.41E-07	1.08E-07	3.50E-07
Total ILCR				7.32E-05	1.71E-04	2.44E-04				6.53E-05	2.93E-05	9.46E-05

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-40

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 629, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Metals										
Lead	7.61E+02	4.87E-07	4.58E-08	2.67E-08	NA	NA	NA	**NA**	**NA**	**NA**
Nitroaromatics										
2-Nitrotoluene	5.08E+01	3.25E-08	3.06E-09	1.78E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Nitrotoluene	6.74E+01	4.32E-08	4.06E-09	2.37E-09	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	3.80E+01	2.43E-08	2.29E-09	1.33E-09	NA	NA	NA	**1.21E-06**	**1.45E-06**	**2.67E-06**
PCBs										
Aroclor 1254	9.69E-01	6.21E-10	5.83E-11	3.40E-11	1.17E-10	6.80E-11	1.85E-10	**1.27E-06**	**2.11E-06**	**3.38E-06**
Aroclor 1260	4.88E+00	3.12E-09	2.93E-10	1.71E-10	5.87E-10	3.42E-10	9.29E-10	**6.37E-06**	**1.06E-05**	**1.70E-05**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.70E+02	1.09E-07	1.02E-08	5.97E-09	NA	NA	NA	**9.33E-05**	**1.34E-04**	**2.27E-04**
2,6-Dinitrotoluene	6.55E+01	4.20E-08	3.94E-09	2.30E-09	NA	NA	NA	**3.60E-05**	**5.16E-05**	**8.76E-05**
Benzo(a)pyrene	4.30E-02	2.75E-11	2.59E-12	1.51E-12	8.02E-12	4.68E-12	1.27E-11	**3.74E-07**	**4.18E-07**	**7.92E-07**
Total ILCR					7.11E-10	4.15E-10	1.13E-09	**1.39E-04**	**2.00E-04**	**3.39E-04**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-41

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 629, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Metals										
Lead	7.61E+02	8.76E-03	NA	1.37E-06	1.53E-04	NA	4.87E-07	3.12E-07	NA	**NA**
Nitroaromatics										
2-Nitrotoluene	5.08E+01	5.85E-04	5.85E-02	9.14E-07	1.02E-04	1.14E-02	3.25E-08	2.08E-08	NA	**6.98E-02**
4-Nitrotoluene	6.74E+01	7.76E-04	7.76E-02	1.21E-06	1.36E-04	1.51E-02	4.32E-08	2.76E-08	NA	**9.26E-02**
2,4,6-Trinitrotoluene	3.80E+01	4.37E-04	8.75E-01	6.84E-07	7.65E-05	2.55E-01	2.43E-08	1.56E-08	NA	**1.13E+00**
PCBs										
Aroclor 1254	9.69E-01	1.12E-05	5.58E-01	1.05E-08	1.17E-06	6.50E-02	6.21E-10	3.97E-10	NA	**6.23E-01**
Aroclor 1260	4.88E+00	5.61E-05	NA	5.27E-08	5.89E-06	NA	3.12E-09	2.00E-09	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.70E+02	1.96E-03	9.78E-01	3.06E-06	3.42E-04	1.71E-01	1.09E-07	6.96E-08	NA	**1.15E+00**
2,6-Dinitrotoluene	6.55E+01	7.54E-04	7.54E-01	1.18E-06	1.32E-04	1.32E-01	4.20E-08	2.68E-08	NA	**8.86E-01**
Benzo(a)pyrene	4.30E-02	4.95E-07	NA	7.74E-10	8.66E-08	NA	2.75E-11	1.76E-11	NA	**NA**
Total HI			3.30E+00			6.50E-01			NA	**3.95E+00**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-42

COPCs in Soil Associated with Former Building 657
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO222 AB0468 3 - 5	Source Term Concentration [a]
PCBs			
Aroclor 1260	2.20E-02	6.13E-02	6.13E-02
Semivolatile Organic Compounds			
Benzo(a)anthracene	6.20E-02	2.89E-01	2.89E-01
Benzo(a)pyrene	6.20E-03	3.56E-01	3.56E-01
Benzo(b)fluoranthene	6.20E-02	4.92E-01	4.92E-01
Dibenz(a,h)anthracene	6.20E-03	1.23E-01	1.23E-01
Indeno(1,2,3-cd)pyrene	6.20E-02	2.70E-01	2.70E-01

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern

Table B.2-43

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 657, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
PCBs																	
Aroclor 1260	6.13E-02	1.73E-07	1.24E-09	NA	2.48E-09	2.94E-10	3.24E-08	2.32E-10	NA	4.65E-10	2.15E-08	4.19E-09	3.00E-11	NA	6.00E-11	**NA**	**3.01E-09**
Semivolatile Organic Compounds																	
Benzo(a)anthracene	2.89E-01	8.18E-07	5.86E-09	NA	4.28E-09	2.31E-09	2.55E-07	1.83E-09	NA	2.67E-09	1.01E-07	1.97E-08	1.41E-10	NA	4.38E-11	**NA**	**6.99E-09**
Benzo(a)pyrene	3.56E-01	1.01E-06	7.22E-09	NA	5.27E-08	2.85E-09	3.14E-07	2.25E-09	NA	3.28E-08	1.25E-07	2.43E-08	1.74E-10	NA	5.40E-10	**NA**	**8.61E-08**
Benzo(b)fluoranthene	4.92E-01	1.39E-06	9.97E-09	NA	7.28E-09	3.94E-09	4.34E-07	3.11E-09	NA	4.54E-09	1.72E-07	3.36E-08	2.41E-10	NA	7.46E-11	**NA**	**1.19E-08**
Dibenz(a,h)anthracene	1.23E-01	3.48E-07	2.49E-09	NA	1.82E-08	9.84E-10	1.09E-07	7.77E-10	NA	7.09E-09	4.31E-08	8.40E-09	6.02E-11	NA	1.87E-10	**NA**	**2.55E-08**
Indeno(1,2,3-cd)pyrene	2.70E-01	7.64E-07	5.47E-09	NA	3.99E-09	2.16E-09	2.38E-07	1.71E-09	NA	2.49E-09	9.45E-08	1.84E-08	1.32E-10	NA	4.09E-11	**NA**	**6.53E-09**
Total HI				NA					NA					NA		**NA**	
Total ILCR					8.89E-08					5.01E-08					9.46E-10		**1.40E-07**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-44

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 657, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
PCBs												
Aroclor 1260	6.13E-02	2.59E-08	6.05E-08	5.18E-08	1.21E-07	1.73E-07	6.62E-10	1.41E-08	6.35E-09	2.83E-08	1.27E-08	4.10E-08
Semivolatile Organic Compounds												
Benzo(a)anthracene	2.89E-01	1.22E-07	2.85E-07	8.92E-08	2.08E-07	2.97E-07	5.20E-09	1.11E-07	4.99E-08	1.62E-07	7.28E-08	2.35E-07
Benzo(a)pyrene	3.56E-01	1.50E-07	3.51E-07	1.10E-06	2.56E-06	3.66E-06	6.41E-09	1.37E-07	6.14E-08	2.00E-06	8.97E-07	2.90E-06
Benzo(b)fluoranthene	4.92E-01	2.08E-07	4.85E-07	1.52E-07	3.54E-07	5.06E-07	8.86E-09	1.89E-07	8.49E-08	2.76E-07	1.24E-07	4.00E-07
Dibenz(a,h)anthracene	1.23E-01	5.20E-08	1.21E-07	3.80E-07	8.86E-07	1.27E-06	2.21E-09	4.73E-08	2.12E-08	4.32E-07	1.94E-07	6.25E-07
Indeno(1,2,3-cd)pyrene	2.70E-01	1.14E-07	2.66E-07	8.33E-08	1.94E-07	2.78E-07	4.86E-09	1.04E-07	4.66E-08	1.52E-07	6.80E-08	2.20E-07
Total ILCR				1.85E-06	4.33E-06	6.18E-06				3.05E-06	1.37E-06	4.42E-06

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk

Table B.2-44

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 657, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
PCBs										
Aroclor 1260	6.13E-02	3.93E-11	3.69E-12	2.15E-12	7.38E-12	4.30E-12	1.17E-11	**8.01E-08**	**1.34E-07**	**2.14E-07**
Semivolatile Organic Compounds										
Benzo(a)anthracene	2.89E-01	1.85E-10	1.74E-11	1.01E-11	5.39E-12	3.14E-12	8.53E-12	**2.51E-07**	**2.81E-07**	**5.32E-07**
Benzo(a)pyrene	3.56E-01	2.28E-10	2.14E-11	1.25E-11	6.64E-11	3.87E-11	1.05E-10	**3.10E-06**	**3.46E-06**	**6.56E-06**
Benzo(b)fluoranthene	4.92E-01	3.15E-10	2.96E-11	1.73E-11	9.18E-12	5.35E-12	1.45E-11	**4.28E-07**	**4.78E-07**	**9.06E-07**
Dibenz(a,h)anthracene	1.23E-01	7.88E-11	7.40E-12	4.32E-12	2.29E-11	1.34E-11	3.63E-11	**8.11E-07**	**1.08E-06**	**1.89E-06**
Indeno(1,2,3-cd)pyrene	2.70E-01	1.73E-10	1.62E-11	9.48E-12	5.04E-12	2.94E-12	7.97E-12	**2.35E-07**	**2.62E-07**	**4.97E-07**
Total ILCR					1.16E-10	6.79E-11	1.84E-10	**4.90E-06**	**5.69E-06**	**1.06E-05**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk

Table B.2-45

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 657, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
PCBs										
Aroclor 1260	6.13E-02	7.05E-07	NA	6.62E-10	7.41E-08	NA	3.93E-11	2.51E-11	NA	**NA**
Semivolatile Organic Compounds										
Benzo(a)anthracene	2.89E-01	3.33E-06	NA	5.20E-09	5.82E-07	NA	1.85E-10	1.18E-10	NA	**NA**
Benzo(a)pyrene	3.56E-01	4.10E-06	NA	6.41E-09	7.17E-07	NA	2.28E-10	1.46E-10	NA	**NA**
Benzo(b)fluoranthene	4.92E-01	5.66E-06	NA	8.86E-09	9.91E-07	NA	3.15E-10	2.01E-10	NA	**NA**
Dibenz(a,h)anthracene	1.23E-01	1.42E-06	NA	2.21E-09	2.48E-07	NA	7.88E-11	5.04E-11	NA	**NA**
Indeno(1,2,3-cd)pyrene	2.70E-01	3.11E-06	NA	4.86E-09	5.44E-07	NA	1.73E-10	1.11E-10	NA	**NA**
Total HI			NA			NA			NA	**NA**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-46

COPCs in Soil Associated with Former Building 681
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO397 AB0471 4 - 6	Source Term Concentration [a]
Nitroaromatics			
4-Amino-2,6-dinitrotoluene	3.70E-01	9.46E-01	9.46E-01
PCBs			
Aroclor 1260	2.20E-02	5.92E-02	5.92E-02
Semivolatile Organic Compounds			
2,4-Dinitrotoluene	7.20E-02	7.40E-01	7.40E-01
2,6-Dinitrotoluene	7.20E-02	1.17E-01	1.17E-01
Benzo(a)pyrene	6.20E-03	3.61E-02	3.61E-02

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern

Table B.2-47

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 681, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
4-Amino-2,6-dinitrotoluene	9.46E-01	2.68E-06	1.92E-08	4.46E-02	NA	7.57E-09	8.34E-07	5.98E-09	2.32E-02	NA	3.31E-07	6.46E-08	4.63E-10	NA	NA	**6.78E-02**	**NA**
PCBs																	
Aroclor 1260	5.92E-02	1.68E-07	1.20E-09	NA	2.40E-09	2.84E-10	3.13E-08	2.24E-10	NA	4.49E-10	2.07E-08	4.04E-09	2.90E-11	NA	5.79E-11	**NA**	**2.91E-09**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	7.40E-01	2.09E-06	1.50E-08	1.05E-03	1.02E-08	5.92E-09	6.53E-07	4.68E-09	3.26E-04	3.18E-09	2.59E-07	5.05E-08	3.62E-10	NA	NA	**1.37E-03**	**1.34E-08**
2,6-Dinitrotoluene	1.17E-01	3.31E-07	2.37E-09	3.31E-04	1.61E-09	9.36E-10	1.03E-07	7.39E-10	1.03E-04	5.03E-10	4.10E-08	7.99E-09	5.72E-11	NA	NA	**4.34E-04**	**2.12E-09**
Benzo(a)pyrene	3.61E-02	1.02E-07	7.32E-10	NA	5.34E-09	2.89E-10	3.18E-08	2.28E-10	NA	3.33E-09	1.26E-08	2.47E-09	1.77E-11	NA	5.48E-11	**NA**	**8.73E-09**
Total HI				4.60E-02					2.36E-02					NA		**6.96E-02**	
Total ILCR					1.96E-08					7.46E-09					1.13E-10		**2.71E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-48

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 681, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
4-Amino-2,6-dinitrotoluene	9.46E-01	4.00E-07	9.33E-07	NA	NA	NA	1.70E-08	3.64E-07	1.63E-07	NA	NA	NA
PCBs												
Aroclor 1260	5.92E-02	2.50E-08	5.84E-08	5.00E-08	1.17E-07	1.67E-07	6.39E-10	1.37E-08	6.13E-09	2.73E-08	1.23E-08	3.96E-08
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	7.40E-01	3.13E-07	7.30E-07	2.13E-07	4.96E-07	7.09E-07	1.33E-08	2.85E-07	1.28E-07	1.94E-07	8.69E-08	2.80E-07
2,6-Dinitrotoluene	1.17E-01	4.95E-08	1.15E-07	3.36E-08	7.85E-08	1.12E-07	2.11E-09	4.50E-08	2.02E-08	3.06E-08	1.37E-08	4.43E-08
Benzo(a)pyrene	3.61E-02	1.53E-08	3.56E-08	1.11E-07	2.60E-07	3.71E-07	6.50E-10	1.39E-08	6.23E-09	2.03E-07	9.10E-08	2.94E-07
Total ILCR				4.08E-07	9.51E-07	1.36E-06				4.54E-07	2.04E-07	6.58E-07

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-48

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 681, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	9.46E-01	6.06E-10	5.69E-11	3.32E-11	NA	NA	NA	**NA**	**NA**	**NA**
PCBs										
Aroclor 1260	5.92E-02	3.79E-11	3.56E-12	2.08E-12	7.12E-12	4.16E-12	1.13E-11	**7.74E-08**	**1.29E-07**	**2.06E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	7.40E-01	4.74E-10	4.45E-11	2.60E-11	NA	NA	NA	**4.06E-07**	**5.83E-07**	**9.89E-07**
2,6-Dinitrotoluene	1.17E-01	7.49E-11	7.04E-12	4.11E-12	NA	NA	NA	**6.42E-08**	**9.22E-08**	**1.56E-07**
Benzo(a)pyrene	3.61E-02	2.31E-11	2.17E-12	1.27E-12	6.73E-12	3.93E-12	1.07E-11	**3.14E-07**	**3.51E-07**	**6.65E-07**
Total ILCR					1.39E-11	8.08E-12	2.19E-11	**8.62E-07**	**1.16E-06**	**2.02E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-49

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 681, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	9.46E-01	1.09E-05	1.81E-01	1.70E-08	1.90E-06	5.29E-02	6.06E-10	3.87E-10	NA	**2.34E-01**
PCBs										
Aroclor 1260	5.92E-02	6.81E-07	NA	6.39E-10	7.15E-08	NA	3.79E-11	2.42E-11	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	7.40E-01	8.52E-06	4.26E-03	1.33E-08	1.49E-06	7.45E-04	4.74E-10	3.03E-10	NA	**5.00E-03**
2,6-Dinitrotoluene	1.17E-01	1.35E-06	1.35E-03	2.11E-09	2.36E-07	2.36E-04	7.49E-11	4.79E-11	NA	**1.58E-03**
Benzo(a)pyrene	3.61E-02	4.15E-07	NA	6.50E-10	7.27E-08	NA	2.31E-11	1.48E-11	NA	**NA**
Total HI			1.87E-01			5.39E-02			NA	**2.41E-01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-50

COPCs in Soil Associated with Former Building 682
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO165 AB0442 1.5 - 2.5	TNTC-SO280 AB0452FDAB0454 0.25 - 1.25	TNTC-SO311 AB0455 0.5 - 1.5	Source Term Concentration [a]
Metals					
Lead	4.00E+02	NA	NA	7.21E+02	7.21E+02
Nitroaromatics					
2-Amino-4,6-dinitrotoluene	3.70E-01	1.19E+01	ND	9.48E-01	1.19E+01
4-Amino-2,6-dinitrotoluene	3.70E-01	7.28E+00	ND	5.88E-01	7.28E+00
2,4,6-Trinitrotoluene	1.60E+00	1.34E+03	4.13E+04	NA	4.13E+04
PCBs					
Aroclor 1260	2.20E-02	5.09E-01	9.92E-01	1.62E-01	9.92E-01
Semivolatile Organic Compounds					
2,4-Dinitrotoluene	7.20E-02	1.06E+01	9.85E+00	1.72E+00	1.06E+01
2,6-Dinitrotoluene	7.20E-02	2.88E+00	6.42E+00	4.28E-01	6.42E+00

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.2-51

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 682, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals																	
Lead	7.21E+02	2.04E-03	1.46E-05	NA	NA	5.77E-07	6.36E-05	4.56E-07	NA	NA	2.52E-04	4.92E-05	3.53E-07	NA	NA	**NA**	**NA**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	1.19E+01	3.37E-05	2.41E-07	5.61E-01	NA	9.52E-08	1.05E-05	7.52E-08	2.92E-01	NA	4.17E-06	8.13E-07	5.82E-09	NA	NA	**8.53E-01**	**NA**
4-Amino-2,6-dinitrotoluene	7.28E+00	2.06E-05	1.48E-07	3.43E-01	NA	5.82E-08	6.42E-06	4.60E-08	1.78E-01	NA	2.55E-06	4.97E-07	3.56E-09	NA	NA	**5.22E-01**	**NA**
2,4,6-Trinitrotoluene	4.13E+04	1.17E-01	8.36E-04	2.34E+02	2.51E-05	3.30E-04	3.64E-02	2.61E-04	1.21E+02	1.30E-05	1.44E-02	2.82E-03	2.02E-05	NA	NA	**3.55E+02**	**3.81E-05**
PCBs																	
Aroclor 1260	9.92E-01	2.81E-06	2.01E-08	NA	4.02E-08	4.76E-09	5.25E-07	3.76E-09	NA	7.52E-09	3.47E-07	6.77E-08	4.85E-10	NA	9.70E-10	**NA**	**4.87E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	1.06E+01	3.00E-05	2.15E-07	1.50E-02	1.46E-07	8.48E-08	9.35E-06	6.70E-08	4.68E-03	4.55E-08	3.71E-06	7.24E-07	5.19E-09	NA	NA	**1.97E-02**	**1.92E-07**
2,6-Dinitrotoluene	6.42E+00	1.82E-05	1.30E-07	1.82E-02	8.85E-08	5.14E-08	5.66E-06	4.06E-08	5.66E-03	2.76E-08	2.25E-06	4.39E-07	3.14E-09	NA	NA	**2.38E-02**	**1.16E-07**
Total HI				2.34E+02					1.22E+02					NA		**3.56E+02**	
Total ILCR					2.54E-05					1.31E-05					9.70E-10		**3.85E-05**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-52

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 682, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Metals												
Lead	7.21E+02	3.05E-04	7.11E-04	NA	NA	NA	1.30E-06	2.77E-05	1.24E-05	NA	NA	NA
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	1.19E+01	5.03E-06	1.17E-05	NA	NA	NA	2.14E-07	4.58E-06	2.05E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	7.28E+00	3.08E-06	7.18E-06	NA	NA	NA	1.31E-07	2.80E-06	1.26E-06	NA	NA	NA
2,4,6-Trinitrotoluene	4.13E+04	1.74E-02	4.07E-02	5.23E-04	1.22E-03	1.74E-03	7.43E-04	1.59E-02	7.12E-03	7.94E-04	3.56E-04	1.15E-03
PCBs												
Aroclor 1260	9.92E-01	4.19E-07	9.78E-07	8.38E-07	1.96E-06	2.79E-06	1.07E-08	2.29E-07	1.03E-07	4.58E-07	2.05E-07	6.63E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	1.06E+01	4.48E-06	1.05E-05	3.05E-06	7.11E-06	1.02E-05	1.91E-07	4.08E-06	1.83E-06	2.77E-06	1.24E-06	4.02E-06
2,6-Dinitrotoluene	6.42E+00	2.71E-06	6.33E-06	1.85E-06	4.31E-06	6.15E-06	1.16E-07	2.47E-06	1.11E-06	1.68E-06	7.54E-07	2.43E-06
Total ILCR				5.29E-04	1.23E-03	1.76E-03				7.98E-04	3.58E-04	1.16E-03

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-52

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 682, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Metals										
Lead	7.21E+02	4.62E-07	4.34E-08	2.53E-08	NA	NA	NA	**NA**	**NA**	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.19E+01	7.62E-09	7.16E-10	4.18E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	7.28E+00	4.66E-09	4.38E-10	2.56E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	4.13E+04	2.64E-05	2.48E-06	1.45E-06	NA	NA	NA	**1.32E-03**	**1.58E-03**	**2.89E-03**
PCBs										
Aroclor 1260	9.92E-01	6.35E-10	5.97E-11	3.48E-11	1.19E-10	6.96E-11	1.89E-10	**1.30E-06**	**2.16E-06**	**3.46E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.06E+01	6.79E-09	6.38E-10	3.72E-10	NA	NA	NA	**5.82E-06**	**8.35E-06**	**1.42E-05**
2,6-Dinitrotoluene	6.42E+00	4.11E-09	3.86E-10	2.25E-10	NA	NA	NA	**3.52E-06**	**5.06E-06**	**8.58E-06**
Total ILCR					1.19E-10	6.96E-11	1.89E-10	**1.33E-03**	**1.59E-03**	**2.92E-03**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-53

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 682, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Metals										
Lead	7.21E+02	8.30E-03	NA	1.30E-06	1.45E-04	NA	4.62E-07	2.95E-07	NA	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.19E+01	1.37E-04	2.28E+00	2.14E-07	2.40E-05	6.66E-01	7.62E-09	4.87E-09	NA	**2.95E+00**
4-Amino-2,6-dinitrotoluene	7.28E+00	8.38E-05	1.40E+00	1.31E-07	1.47E-05	4.07E-01	4.66E-09	2.98E-09	NA	**1.80E+00**
2,4,6-Trinitrotoluene	4.13E+04	4.75E-01	9.50E+02	7.43E-04	8.31E-02	2.77E+02	2.64E-05	1.69E-05	NA	**1.23E+03**
PCBs										
Aroclor 1260	9.92E-01	1.14E-05	NA	1.07E-08	1.20E-06	NA	6.35E-10	4.06E-10	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.06E+01	1.22E-04	6.10E-02	1.91E-07	2.13E-05	1.07E-02	6.79E-09	4.34E-09	NA	**7.17E-02**
2,6-Dinitrotoluene	6.42E+00	7.39E-05	7.39E-02	1.16E-07	1.29E-05	1.29E-02	4.11E-09	2.63E-09	NA	**8.68E-02**
Total HI			9.53E+02			2.78E+02			NA	**1.23E+03**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-54

COPCs in Soil Associated with Former Building 683
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO171 AB0466 4 - 6	TNTC-SO171 AB0467 8 - 10	Source Term Concentration [a]
Nitroaromatics				
2-Amino-4,6-dinitrotoluene	3.70E-01	ND	6.47E-01	6.47E-01
4-Amino-2,6-dinitrotoluene	3.70E-01	ND	3.76E+00	3.76E+00
2,4,6-Trinitrotoluene	1.60E+00	4.48E+02	1.73E+02	4.48E+02
PCBs				
Aroclor 1260	2.20E-02	7.68E-02	1.06E-01	1.06E-01
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	2.75E+02	2.41E+01	2.75E+02
2,6-Dinitrotoluene	7.20E-02	2.38E+01	1.68E+00	2.38E+01

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
ND = Not Detected

Table B.2-55

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 683, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	6.47E-01	1.83E-06	1.31E-08	3.05E-02	NA	5.18E-09	5.71E-07	4.09E-09	1.59E-02	NA	2.26E-07	4.42E-08	3.17E-10	NA	NA	**4.64E-02**	**NA**
4-Amino-2,6-dinitrotoluene	3.76E+00	1.06E-05	7.62E-08	1.77E-01	NA	3.01E-08	3.32E-06	2.38E-08	9.21E-02	NA	1.32E-06	2.57E-07	1.84E-09	NA	NA	**2.69E-01**	**NA**
2,4,6-Trinitrotoluene	4.48E+02	1.27E-03	9.08E-06	2.54E+00	2.72E-07	3.58E-06	3.95E-04	2.83E-06	1.32E+00	1.42E-07	1.57E-04	3.06E-05	2.19E-07	NA	NA	**3.85E+00**	**4.14E-07**
PCBs																	
Aroclor 1260	1.06E-01	3.00E-07	2.15E-09	NA	4.30E-09	5.09E-10	5.61E-08	4.02E-10	NA	8.04E-10	3.71E-08	7.24E-09	5.19E-11	NA	1.04E-10	**NA**	**5.20E-09**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	2.75E+02	7.78E-04	5.57E-06	3.89E-01	3.79E-06	2.20E-06	2.43E-04	1.74E-06	1.21E-01	1.18E-06	9.63E-05	1.88E-05	1.35E-07	NA	NA	**5.10E-01**	**4.97E-06**
2,6-Dinitrotoluene	2.38E+01	6.73E-05	4.82E-07	6.73E-02	3.28E-07	1.90E-07	2.10E-05	1.50E-07	2.10E-02	1.02E-07	8.33E-06	1.63E-06	1.16E-08	NA	NA	**8.83E-02**	**4.30E-07**
Total HI				3.20E+00					1.57E+00					NA		**4.77E+00**	
Total ILCR					4.39E-06					1.43E-06					1.04E-10		**5.82E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-56

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 683, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	6.47E-01	2.73E-07	6.38E-07	NA	NA	NA	1.16E-08	2.49E-07	1.12E-07	NA	NA	NA
4-Amino-2,6-dinitrotoluene	3.76E+00	1.59E-06	3.71E-06	NA	NA	NA	6.77E-08	1.45E-06	6.49E-07	NA	NA	NA
2,4,6-Trinitrotoluene	4.48E+02	1.89E-04	4.42E-04	5.68E-06	1.33E-05	1.89E-05	8.06E-06	1.72E-04	7.73E-05	8.62E-06	3.87E-06	1.25E-05
PCBs												
Aroclor 1260	1.06E-01	4.48E-08	1.05E-07	8.96E-08	2.09E-07	2.99E-07	1.14E-09	2.45E-08	1.10E-08	4.89E-08	2.20E-08	7.09E-08
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	2.75E+02	1.16E-04	2.71E-04	7.90E-05	1.84E-04	2.63E-04	4.95E-06	1.06E-04	4.75E-05	7.19E-05	3.23E-05	1.04E-04
2,6-Dinitrotoluene	2.38E+01	1.01E-05	2.35E-05	6.84E-06	1.60E-05	2.28E-05	4.28E-07	9.15E-06	4.11E-06	6.23E-06	2.79E-06	9.02E-06
Total ILCR				9.17E-05	2.14E-04	3.06E-04				8.68E-05	3.90E-05	1.26E-04

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-56

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 683, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	6.47E-01	4.14E-10	3.89E-11	2.27E-11	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	3.76E+00	2.41E-09	2.26E-10	1.32E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	4.48E+02	2.87E-07	2.70E-08	1.57E-08	NA	NA	NA	**1.43E-05**	**1.71E-05**	**3.14E-05**
PCBs										
Aroclor 1260	1.06E-01	6.79E-11	6.38E-12	3.72E-12	1.28E-11	7.44E-12	2.02E-11	**1.39E-07**	**2.31E-07**	**3.70E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.75E+02	1.76E-07	1.65E-08	9.65E-09	NA	NA	NA	**1.51E-04**	**2.17E-04**	**3.68E-04**
2,6-Dinitrotoluene	2.38E+01	1.52E-08	1.43E-09	8.35E-10	NA	NA	NA	**1.31E-05**	**1.88E-05**	**3.18E-05**
Total ILCR					1.28E-11	7.44E-12	2.02E-11	**1.78E-04**	**2.53E-04**	**4.31E-04**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-57

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 683, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	6.47E-01	7.44E-06	1.24E-01	1.16E-08	1.30E-06	3.62E-02	4.14E-10	2.65E-10	NA	**1.60E-01**
4-Amino-2,6-dinitrotoluene	3.76E+00	4.33E-05	7.21E-01	6.77E-08	7.57E-06	2.10E-01	2.41E-09	1.54E-09	NA	**9.31E-01**
2,4,6-Trinitrotoluene	4.48E+02	5.16E-03	1.03E+01	8.06E-06	9.02E-04	3.01E+00	2.87E-07	1.83E-07	NA	**1.33E+01**
PCBs										
Aroclor 1260	1.06E-01	1.22E-06	NA	1.14E-09	1.28E-07	NA	6.79E-11	4.34E-11	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.75E+02	3.16E-03	1.58E+00	4.95E-06	5.54E-04	2.77E-01	1.76E-07	1.13E-07	NA	**1.86E+00**
2,6-Dinitrotoluene	2.38E+01	2.74E-04	2.74E-01	4.28E-07	4.79E-05	4.79E-02	1.52E-08	9.75E-09	NA	**3.22E-01**
Total HI			1.30E+01			3.58E+00			NA	**1.66E+01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-58

COPCs in Soil Associated with Former Building 686
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO151 AB0438 0 - 1	TNTC-SO325 AB0478 1 - 2	TNTC-SO151 AB0439 1.3 - 2.3	Source Term Concentration [a]
Metals					
Lead	4.00E+02	**6.21E+02**	NA	NA	6.21E+02
Nitroaromatics					
2-Amino-4,6-dinitrotoluene	3.70E-01	**9.41E+00**	**1.14E+01**	**4.80E+00**	1.14E+01
4-Amino-2,6-dinitrotoluene	3.70E-01	**1.08E+01**	**2.45E+00**	ND	1.08E+01
2,4,6-Trinitrotoluene	1.60E+00	**5.07E+03**	**3.37E+01**	**2.59E+03**	5.07E+03
PCBs					
Aroclor 1260	2.20E-02	**2.11E+00**	**5.42E-02**	**1.02E+00**	2.11E+00
Semivolatile Organic Compounds					
2,4-Dinitrotoluene	7.20E-02	**1.65E+00**	NA	ND	1.65E+00
Benzo(a)anthracene	6.20E-02	**6.94E+00**	ND	ND	6.94E+00
Benzo(a)pyrene	6.20E-03	**6.33E+00**	ND	ND	6.33E+00
Benzo(b)fluoranthene	6.20E-02	**9.05E+00**	ND	ND	9.05E+00
Benzo(k)fluoranthene	6.20E-01	**3.02E+00**	ND	ND	3.02E+00
Chrysene	6.20E+00	**6.28E+00**	ND	ND	6.28E+00
Dibenz(a,h)anthracene	6.20E-03	**1.03E+00**	ND	ND	1.03E+00
Indeno(1,2,3-cd)pyrene	6.20E-02	**2.91E+00**	ND	ND	2.91E+00

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.2-59

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 686, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals																	
Lead	6.21E+02	1.76E-03	1.26E-05	NA	NA	4.97E-07	5.48E-05	3.92E-07	NA	NA	2.17E-04	4.24E-05	3.04E-07	NA	NA	**NA**	**NA**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	1.14E+01	3.23E-05	2.31E-07	5.38E-01	NA	9.12E-08	1.01E-05	7.20E-08	2.79E-01	NA	3.99E-06	7.79E-07	5.58E-09	NA	NA	**8.17E-01**	**NA**
4-Amino-2,6-dinitrotoluene	1.08E+01	3.06E-05	2.19E-07	5.09E-01	NA	8.64E-08	9.53E-06	6.82E-08	2.65E-01	NA	3.78E-06	7.38E-07	5.28E-09	NA	NA	**7.74E-01**	**NA**
2,4,6-Trinitrotoluene	5.07E+03	1.43E-02	1.03E-04	2.87E+01	3.08E-06	4.05E-05	4.47E-03	3.20E-05	1.49E+01	1.60E-06	1.77E-03	3.46E-04	2.48E-06	NA	NA	**4.36E+01**	**4.68E-06**
PCBs																	
Aroclor 1260	2.11E+00	5.97E-06	4.28E-08	NA	8.55E-08	1.01E-08	1.12E-06	8.00E-09	NA	1.60E-08	7.39E-07	1.44E-07	1.03E-09	NA	2.06E-09	**NA**	**1.04E-07**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	1.65E+00	4.67E-06	3.34E-08	2.33E-03	2.27E-08	1.32E-08	1.46E-06	1.04E-08	7.28E-04	7.09E-09	5.78E-07	1.13E-07	8.07E-10	NA	NA	**3.06E-03**	**2.98E-08**
Benzo(a)anthracene	6.94E+00	1.96E-05	1.41E-07	NA	1.03E-07	5.55E-08	6.12E-06	4.38E-08	NA	6.40E-08	2.43E-06	4.74E-07	3.40E-09	NA	1.05E-09	**NA**	**1.68E-07**
Benzo(a)pyrene	6.33E+00	1.79E-05	1.28E-07	NA	9.37E-07	5.06E-08	5.58E-06	4.00E-08	NA	5.84E-07	2.22E-06	4.32E-07	3.10E-09	NA	9.60E-09	**NA**	**1.53E-06**
Benzo(b)fluoranthene	9.05E+00	2.56E-05	1.83E-07	NA	1.34E-07	7.24E-08	7.98E-06	5.72E-08	NA	8.35E-08	3.17E-06	6.18E-07	4.43E-09	NA	1.37E-09	**NA**	**2.19E-07**
Benzo(k)fluoranthene	3.02E+00	8.55E-06	6.12E-08	NA	4.47E-09	2.42E-08	2.66E-06	1.91E-08	NA	2.79E-09	1.06E-06	2.06E-07	1.48E-09	NA	4.58E-11	**NA**	**7.30E-09**
Chrysene	6.28E+00	1.78E-05	1.27E-07	NA	9.29E-10	5.02E-08	5.54E-06	3.97E-08	NA	3.62E-10	2.20E-06	4.29E-07	3.07E-09	NA	9.52E-12	**NA**	**1.30E-09**
Dibenz(a,h)anthracene	1.03E+00	2.91E-06	2.09E-08	NA	1.52E-07	8.24E-09	9.09E-07	6.51E-09	NA	5.94E-08	3.61E-07	7.04E-08	5.04E-10	NA	1.56E-09	**NA**	**2.13E-07**
Indeno(1,2,3-cd)pyrene	2.91E+00	8.23E-06	5.90E-08	NA	4.31E-08	2.33E-08	2.57E-06	1.84E-08	NA	2.68E-08	1.02E-06	1.99E-07	1.42E-09	NA	4.41E-10	**NA**	**7.03E-08**
Total HI				2.97E+01					1.54E+01					NA		**4.52E+01**	
Total ILCR					4.56E-06					2.44E-06					1.61E-08		**7.02E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-60

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 686, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Metals												
Lead	6.21E+02	2.62E-04	6.12E-04	NA	NA	NA	1.12E-06	2.39E-05	1.07E-05	NA	NA	NA
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	1.14E+01	4.82E-06	1.12E-05	NA	NA	NA	2.05E-07	4.39E-06	1.97E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.08E+01	4.57E-06	1.07E-05	NA	NA	NA	1.94E-07	4.15E-06	1.86E-06	NA	NA	NA
2,4,6-Trinitrotoluene	5.07E+03	2.14E-03	5.00E-03	6.43E-05	1.50E-04	2.14E-04	9.12E-05	1.95E-03	8.75E-04	9.75E-05	4.37E-05	1.41E-04
PCBs												
Aroclor 1260	2.11E+00	8.92E-07	2.08E-06	1.78E-06	4.16E-06	5.95E-06	2.28E-08	4.87E-07	2.19E-07	9.74E-07	4.37E-07	1.41E-06
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	1.65E+00	6.97E-07	1.63E-06	4.74E-07	1.11E-06	1.58E-06	2.97E-08	6.35E-07	2.85E-07	4.32E-07	1.94E-07	6.25E-07
Benzo(a)anthracene	6.94E+00	2.93E-06	6.84E-06	2.14E-06	5.00E-06	7.14E-06	1.25E-07	2.67E-06	1.20E-06	3.90E-06	1.75E-06	5.65E-06
Benzo(a)pyrene	6.33E+00	2.68E-06	6.24E-06	1.95E-05	4.56E-05	6.51E-05	1.14E-07	2.43E-06	1.09E-06	3.55E-05	1.60E-05	5.15E-05
Benzo(b)fluoranthene	9.05E+00	3.83E-06	8.93E-06	2.79E-06	6.52E-06	9.31E-06	1.63E-07	3.48E-06	1.56E-06	5.08E-06	2.28E-06	7.36E-06
Benzo(k)fluoranthene	3.02E+00	1.28E-06	2.98E-06	9.32E-08	2.17E-07	3.11E-07	5.44E-08	1.16E-06	5.21E-07	1.70E-07	7.61E-08	2.46E-07
Chrysene	6.28E+00	2.65E-06	6.19E-06	1.94E-08	4.52E-08	6.46E-08	1.13E-07	2.42E-06	1.08E-06	2.20E-08	9.89E-09	3.19E-08
Dibenz(a,h)anthracene	1.03E+00	4.35E-07	1.02E-06	3.18E-06	7.42E-06	1.06E-05	1.85E-08	3.96E-07	1.78E-07	3.62E-06	1.62E-06	5.24E-06
Indeno(1,2,3-cd)pyrene	2.91E+00	1.23E-06	2.87E-06	8.98E-07	2.10E-06	2.99E-06	5.24E-08	1.12E-06	5.02E-07	1.63E-06	7.33E-07	2.37E-06
Total ILCR				9.52E-05	2.22E-04	3.17E-04				1.49E-04	6.68E-05	2.16E-04

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-60

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 686, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Metals										
Lead	6.21E+02	3.98E-07	3.74E-08	2.18E-08	NA	NA	NA	**NA**	**NA**	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.14E+01	7.30E-09	6.86E-10	4.00E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	1.08E+01	6.92E-09	6.50E-10	3.79E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	5.07E+03	3.25E-06	3.05E-07	1.78E-07	NA	NA	NA	**1.62E-04**	**1.94E-04**	**3.55E-04**
PCBs										
Aroclor 1260	2.11E+00	1.35E-09	1.27E-10	7.41E-11	2.54E-10	1.48E-10	4.02E-10	**2.76E-06**	**4.60E-06**	**7.36E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.65E+00	1.06E-09	9.93E-11	5.79E-11	NA	NA	NA	**9.06E-07**	**1.30E-06**	**2.21E-06**
Benzo(a)anthracene	6.94E+00	4.45E-09	4.18E-10	2.44E-10	1.29E-10	7.55E-11	2.05E-10	**6.04E-06**	**6.75E-06**	**1.28E-05**
Benzo(a)pyrene	6.33E+00	4.05E-09	3.81E-10	2.22E-10	1.18E-09	6.89E-10	1.87E-09	**5.51E-05**	**6.15E-05**	**1.17E-04**
Benzo(b)fluoranthene	9.05E+00	5.80E-09	5.45E-10	3.18E-10	1.69E-10	9.85E-11	2.67E-10	**7.88E-06**	**8.80E-06**	**1.67E-05**
Benzo(k)fluoranthene	3.02E+00	1.93E-09	1.82E-10	1.06E-10	5.63E-12	3.29E-12	8.92E-12	**2.63E-07**	**2.94E-07**	**5.56E-07**
Chrysene	6.28E+00	4.02E-09	3.78E-10	2.20E-10	1.17E-12	6.83E-13	1.85E-12	**4.14E-08**	**5.51E-08**	**9.65E-08**
Dibenz(a,h)anthracene	1.03E+00	6.60E-10	6.20E-11	3.62E-11	1.92E-10	1.12E-10	3.04E-10	**6.79E-06**	**9.04E-06**	**1.58E-05**
Indeno(1,2,3-cd)pyrene	2.91E+00	1.86E-09	1.75E-10	1.02E-10	5.43E-11	3.17E-11	8.59E-11	**2.53E-06**	**2.83E-06**	**5.36E-06**
Total ILCR					1.99E-09	1.16E-09	3.14E-09	**2.44E-04**	**2.89E-04**	**5.33E-04**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-61

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 686, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Metals										
Lead	6.21E+02	7.15E-03	NA	1.12E-06	1.25E-04	NA	3.98E-07	2.54E-07	NA	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.14E+01	1.31E-04	2.19E+00	2.05E-07	2.30E-05	6.38E-01	7.30E-09	4.67E-09	NA	**2.82E+00**
4-Amino-2,6-dinitrotoluene	1.08E+01	1.24E-04	2.07E+00	1.94E-07	2.17E-05	6.04E-01	6.92E-09	4.42E-09	NA	**2.68E+00**
2,4,6-Trinitrotoluene	5.07E+03	5.83E-02	1.17E+02	9.12E-05	1.02E-02	3.40E+01	3.25E-06	2.07E-06	NA	**1.51E+02**
PCBs										
Aroclor 1260	2.11E+00	2.43E-05	NA	2.28E-08	2.55E-06	NA	1.35E-09	8.64E-10	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.65E+00	1.90E-05	9.49E-03	2.97E-08	3.32E-06	1.66E-03	1.06E-09	6.76E-10	NA	**1.12E-02**
Benzo(a)anthracene	6.94E+00	7.99E-05	NA	1.25E-07	1.40E-05	NA	4.45E-09	2.84E-09	NA	**NA**
Benzo(a)pyrene	6.33E+00	7.28E-05	NA	1.14E-07	1.27E-05	NA	4.05E-09	2.59E-09	NA	**NA**
Benzo(b)fluoranthene	9.05E+00	1.04E-04	NA	1.63E-07	1.82E-05	NA	5.80E-09	3.71E-09	NA	**NA**
Benzo(k)fluoranthene	3.02E+00	3.48E-05	NA	5.44E-08	6.08E-06	NA	1.93E-09	1.24E-09	NA	**NA**
Chrysene	6.28E+00	7.23E-05	NA	1.13E-07	1.26E-05	NA	4.02E-09	2.57E-09	NA	**NA**
Dibenz(a,h)anthracene	1.03E+00	1.19E-05	NA	1.85E-08	2.07E-06	NA	6.60E-10	4.22E-10	NA	**NA**
Indeno(1,2,3-cd)pyrene	2.91E+00	3.35E-05	NA	5.24E-08	5.86E-06	NA	1.86E-09	1.19E-09	NA	**NA**
Total HI			1.21E+02			3.53E+01			NA	**1.56E+02**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-62

COPCs in Soil Associated with Former Building 689
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO001 AB0426 0 - 1	TNTC-SO150 AB0437 0.33 - 1	TNTC-SO001 AB0460 4 - 6	Source Term Concentration [a]
Nitroaromatics					
2-Amino-4,6-dinitrotoluene	3.70E-01	3.76E+00	3.80E+01	ND	3.80E+01
4-Amino-2,6-dinitrotoluene	3.70E-01	6.93E+00	1.46E+01	4.36E-01	1.46E+01
2,4,6-Trinitrotoluene	1.60E+00	4.76E+00	5.11E+01	1.96E+00	5.11E+01
PCBs					
Aroclor 1260	2.20E-02	1.42E+00	1.37E+00	1.83E-01	1.42E+00
Semivolatile Organic Compounds					
2,4-Dinitrotoluene	7.20E-02	1.01E+00	ND	6.89E-01	1.01E+00
2,6-Dinitrotoluene	7.20E-02	4.58E-01	ND	9.77E-02	4.58E-01
Benzo(a)anthracene	6.20E-02	7.53E-02	3.32E+00	NA	3.32E+00
Benzo(a)pyrene	6.20E-03	7.87E-02	3.63E+00	4.13E-02	3.63E+00
Benzo(b)fluoranthene	6.20E-02	1.76E-01	4.82E+00	ND	4.82E+00
Benzo(k)fluoranthene	6.20E-01	ND	1.65E+00	ND	1.65E+00
Dibenz(a,h)anthracene	6.20E-03	ND	6.01E-01	ND	6.01E-01
Indeno(1,2,3-cd)pyrene	6.20E-02	ND	1.89E+00	ND	1.89E+00

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.2-63

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 689, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	3.80E+01	1.08E-04	7.70E-07	1.79E+00	NA	3.04E-07	3.35E-05	2.40E-07	9.31E-01	NA	1.33E-05	2.60E-06	1.86E-08	NA	NA	**2.72E+00**	**NA**
4-Amino-2,6-dinitrotoluene	1.46E+01	4.13E-05	2.96E-07	6.89E-01	NA	1.17E-07	1.29E-05	9.22E-08	3.58E-01	NA	5.11E-06	9.97E-07	7.14E-09	NA	NA	**1.05E+00**	**NA**
2,4,6-Trinitrotoluene	5.11E+01	1.45E-04	1.04E-06	2.89E-01	3.11E-08	4.09E-07	4.51E-05	3.23E-07	1.50E-01	1.61E-08	1.79E-05	3.49E-06	2.50E-08	NA	NA	**4.39E-01**	**4.72E-08**
PCBs																	
Aroclor 1260	1.42E+00	4.02E-06	2.88E-08	NA	5.76E-08	6.82E-09	7.52E-07	5.38E-09	NA	1.08E-08	4.97E-07	9.70E-08	6.95E-10	NA	1.39E-09	**NA**	**6.97E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	1.01E+00	2.86E-06	2.05E-08	1.43E-03	1.39E-08	8.08E-09	8.91E-07	6.38E-09	4.45E-04	4.34E-09	3.54E-07	6.90E-08	4.94E-10	NA	NA	**1.87E-03**	**1.83E-08**
2,6-Dinitrotoluene	4.58E-01	1.30E-06	9.28E-09	1.30E-03	6.31E-09	3.66E-09	4.04E-07	2.89E-09	4.04E-04	1.97E-09	1.60E-07	3.13E-08	2.24E-10	NA	NA	**1.70E-03**	**8.28E-09**
Benzo(a)anthracene	3.32E+00	9.40E-06	6.73E-08	NA	4.91E-08	2.66E-08	2.93E-06	2.10E-08	NA	3.06E-08	1.16E-06	2.27E-07	1.62E-09	NA	5.04E-10	**NA**	**8.03E-08**
Benzo(a)pyrene	3.63E+00	1.03E-05	7.36E-08	NA	5.37E-07	2.90E-08	3.20E-06	2.29E-08	NA	3.35E-07	1.27E-06	2.48E-07	1.78E-09	NA	5.51E-09	**NA**	**8.77E-07**
Benzo(b)fluoranthene	4.82E+00	1.36E-05	9.77E-08	NA	7.13E-08	3.86E-08	4.25E-06	3.05E-08	NA	4.45E-08	1.69E-06	3.29E-07	2.36E-09	NA	7.31E-10	**NA**	**1.17E-07**
Benzo(k)fluoranthene	1.65E+00	4.67E-06	3.34E-08	NA	2.44E-09	1.32E-08	1.46E-06	1.04E-08	NA	1.52E-09	5.78E-07	1.13E-07	8.07E-10	NA	2.50E-11	**NA**	**3.99E-09**
Dibenz(a,h)anthracene	6.01E-01	1.70E-06	1.22E-08	NA	8.89E-08	4.81E-09	5.30E-07	3.80E-09	NA	3.46E-08	2.10E-07	4.11E-08	2.94E-10	NA	9.11E-10	**NA**	**1.24E-07**
Indeno(1,2,3-cd)pyrene	1.89E+00	5.35E-06	3.83E-08	NA	2.80E-08	1.51E-08	1.67E-06	1.19E-08	NA	1.74E-08	6.62E-07	1.29E-07	9.25E-10	NA	2.87E-10	**NA**	**4.57E-08**
Total HI				2.77E+00					1.44E+00					NA		**4.21E+00**	
Total ILCR					8.86E-07					4.97E-07					9.35E-09		**1.39E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-64

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 689, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	3.80E+01	1.61E-05	3.75E-05	NA	NA	NA	6.84E-07	1.46E-05	6.56E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.46E+01	6.17E-06	1.44E-05	NA	NA	NA	2.63E-07	5.62E-06	2.52E-06	NA	NA	NA
2,4,6-Trinitrotoluene	5.11E+01	2.16E-05	5.04E-05	6.48E-07	1.51E-06	2.16E-06	9.20E-07	1.97E-05	8.82E-06	9.83E-07	4.41E-07	1.42E-06
PCBs												
Aroclor 1260	1.42E+00	6.00E-07	1.40E-06	1.20E-06	2.80E-06	4.00E-06	1.53E-08	3.28E-07	1.47E-07	6.55E-07	2.94E-07	9.50E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	1.01E+00	4.27E-07	9.96E-07	2.90E-07	6.77E-07	9.68E-07	1.82E-08	3.89E-07	1.74E-07	2.64E-07	1.19E-07	3.83E-07
2,6-Dinitrotoluene	4.58E-01	1.94E-07	4.52E-07	1.32E-07	3.07E-07	4.39E-07	8.24E-09	1.76E-07	7.91E-08	1.20E-07	5.38E-08	1.74E-07
Benzo(a)anthracene	3.32E+00	1.40E-06	3.27E-06	1.02E-06	2.39E-06	3.41E-06	5.98E-08	1.28E-06	5.73E-07	1.86E-06	8.37E-07	2.70E-06
Benzo(a)pyrene	3.63E+00	1.53E-06	3.58E-06	1.12E-05	2.61E-05	3.73E-05	6.53E-08	1.40E-06	6.27E-07	2.04E-05	9.15E-06	2.95E-05
Benzo(b)fluoranthene	4.82E+00	2.04E-06	4.75E-06	1.49E-06	3.47E-06	4.96E-06	8.68E-08	1.85E-06	8.32E-07	2.71E-06	1.21E-06	3.92E-06
Benzo(k)fluoranthene	1.65E+00	6.97E-07	1.63E-06	5.09E-08	1.19E-07	1.70E-07	2.97E-08	6.35E-07	2.85E-07	9.27E-08	4.16E-08	1.34E-07
Dibenz(a,h)anthracene	6.01E-01	2.54E-07	5.93E-07	1.85E-06	4.33E-06	6.18E-06	1.08E-08	2.31E-07	1.04E-07	2.11E-06	9.47E-07	3.06E-06
Indeno(1,2,3-cd)pyrene	1.89E+00	7.99E-07	1.86E-06	5.83E-07	1.36E-06	1.94E-06	3.40E-08	7.27E-07	3.26E-07	1.06E-06	4.76E-07	1.54E-06
Total ILCR				1.85E-05	4.31E-05	6.16E-05				3.02E-05	1.36E-05	4.38E-05

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-64

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 689, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.80E+01	2.43E-08	2.29E-09	1.33E-09	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	1.46E+01	9.35E-09	8.78E-10	5.12E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	5.11E+01	3.27E-08	3.07E-09	1.79E-09	NA	NA	NA	**1.63E-06**	**1.95E-06**	**3.58E-06**
PCBs										
Aroclor 1260	1.42E+00	9.10E-10	8.54E-11	4.98E-11	1.71E-10	9.97E-11	2.71E-10	**1.86E-06**	**3.10E-06**	**4.95E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.01E+00	6.47E-10	6.08E-11	3.54E-11	NA	NA	NA	**5.54E-07**	**7.96E-07**	**1.35E-06**
2,6-Dinitrotoluene	4.58E-01	2.93E-10	2.76E-11	1.61E-11	NA	NA	NA	**2.51E-07**	**3.61E-07**	**6.12E-07**
Benzo(a)anthracene	3.32E+00	2.13E-09	2.00E-10	1.17E-10	6.19E-11	3.61E-11	9.80E-11	**2.89E-06**	**3.23E-06**	**6.12E-06**
Benzo(a)pyrene	3.63E+00	2.33E-09	2.18E-10	1.27E-10	6.77E-10	3.95E-10	1.07E-09	**3.16E-05**	**3.53E-05**	**6.69E-05**
Benzo(b)fluoranthene	4.82E+00	3.09E-09	2.90E-10	1.69E-10	8.99E-11	5.24E-11	1.42E-10	**4.19E-06**	**4.69E-06**	**8.88E-06**
Benzo(k)fluoranthene	1.65E+00	1.06E-09	9.93E-11	5.79E-11	3.08E-12	1.80E-12	4.87E-12	**1.44E-07**	**1.60E-07**	**3.04E-07**
Dibenz(a,h)anthracene	6.01E-01	3.85E-10	3.62E-11	2.11E-11	1.12E-10	6.54E-11	1.77E-10	**3.96E-06**	**5.27E-06**	**9.24E-06**
Indeno(1,2,3-cd)pyrene	1.89E+00	1.21E-09	1.14E-10	6.63E-11	3.53E-11	2.06E-11	5.58E-11	**1.64E-06**	**1.84E-06**	**3.48E-06**
Total ILCR					1.15E-09	6.71E-10	1.82E-09	**4.87E-05**	**5.67E-05**	**1.05E-04**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-65

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 689, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	3.80E+01	4.37E-04	7.29E+00	6.84E-07	7.65E-05	2.13E+00	2.43E-08	1.56E-08	NA	**9.41E+00**
4-Amino-2,6-dinitrotoluene	1.46E+01	1.68E-04	2.80E+00	2.63E-07	2.94E-05	8.17E-01	9.35E-09	5.98E-09	NA	**3.62E+00**
2,4,6-Trinitrotoluene	5.11E+01	5.88E-04	1.18E+00	9.20E-07	1.03E-04	3.43E-01	3.27E-08	2.09E-08	NA	**1.52E+00**
PCBs										
Aroclor 1260	1.42E+00	1.63E-05	NA	1.53E-08	1.72E-06	NA	9.10E-10	5.81E-10	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	1.01E+00	1.16E-05	5.81E-03	1.82E-08	2.03E-06	1.02E-03	6.47E-10	4.14E-10	NA	**6.83E-03**
2,6-Dinitrotoluene	4.58E-01	5.27E-06	5.27E-03	8.24E-09	9.22E-07	9.22E-04	2.93E-10	1.88E-10	NA	**6.19E-03**
Benzo(a)anthracene	3.32E+00	3.82E-05	NA	5.98E-08	6.69E-06	NA	2.13E-09	1.36E-09	NA	**NA**
Benzo(a)pyrene	3.63E+00	4.18E-05	NA	6.53E-08	7.31E-06	NA	2.33E-09	1.49E-09	NA	**NA**
Benzo(b)fluoranthene	4.82E+00	5.55E-05	NA	8.68E-08	9.71E-06	NA	3.09E-09	1.97E-09	NA	**NA**
Benzo(k)fluoranthene	1.65E+00	1.90E-05	NA	2.97E-08	3.32E-06	NA	1.06E-09	6.76E-10	NA	**NA**
Dibenz(a,h)anthracene	6.01E-01	6.92E-06	NA	1.08E-08	1.21E-06	NA	3.85E-10	2.46E-10	NA	**NA**
Indeno(1,2,3-cd)pyrene	1.89E+00	2.17E-05	NA	3.40E-08	3.81E-06	NA	1.21E-09	7.74E-10	NA	**NA**
Total HI			1.13E+01			3.29E+00			NA	**1.46E+01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-66

COPCs in Soil Associated with Former Building 692
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO241 AB0469 4 - 6	TNTC-SO320 AB0477 1.5 - 2.5	TNTC-SO241 AB0448 1 - 2	Source Term Concentration [a]
Nitroaromatics					
2-Amino-4,6-dinitrotoluene	3.70E-01	9.11E-01	6.23E+00	1.73E+01	1.73E+01
4-Amino-2,6-dinitrotoluene	3.70E-01	5.89E-01	2.60E+00	1.15E+01	1.15E+01
2,4,6-Trinitrotoluene	1.60E+00	NA	3.87E+01	9.00E+02	9.00E+02
PCBs					
Aroclor 1260	2.20E-02	NA	2.37E-02	5.17E-01	5.17E-01
Semivolatile Organic Compounds					
2,4-Dinitrotoluene	7.20E-02	NA	1.76E-01	5.68E+00	5.68E+00
2,6-Dinitrotoluene	7.20E-02	ND	3.86E-01	1.07E+01	1.07E+01

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.2-67

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 692, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	1.73E+01	4.90E-05	3.51E-07	8.16E-01	NA	1.38E-07	1.53E-05	1.09E-07	4.24E-01	NA	6.06E-06	1.18E-06	8.46E-09	NA	NA	**1.24E+00**	**NA**
4-Amino-2,6-dinitrotoluene	1.15E+01	3.25E-05	2.33E-07	5.42E-01	NA	9.20E-08	1.01E-05	7.27E-08	2.82E-01	NA	4.03E-06	7.86E-07	5.63E-09	NA	NA	**8.24E-01**	**NA**
2,4,6-Trinitrotoluene	9.00E+02	2.55E-03	1.82E-05	5.09E+00	5.47E-07	7.20E-06	7.94E-04	5.69E-06	2.65E+00	2.84E-07	3.15E-04	6.15E-05	4.40E-07	NA	NA	**7.74E+00**	**8.32E-07**
PCBs																	
Aroclor 1260	5.17E-01	1.46E-06	1.05E-08	NA	2.10E-08	2.48E-09	2.74E-07	1.96E-09	NA	3.92E-09	1.81E-07	3.53E-08	2.53E-10	NA	5.06E-10	**NA**	**2.54E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	5.68E+00	1.61E-05	1.15E-07	8.04E-03	7.83E-08	4.54E-08	5.01E-06	3.59E-08	2.51E-03	2.44E-08	1.99E-06	3.88E-07	2.78E-09	NA	NA	**1.05E-02**	**1.03E-07**
2,6-Dinitrotoluene	1.07E+01	3.03E-05	2.17E-07	3.03E-02	1.47E-07	8.56E-08	9.44E-06	6.76E-08	9.44E-03	4.60E-08	3.75E-06	7.31E-07	5.23E-09	NA	NA	**3.97E-02**	**1.93E-07**
Total HI				6.49E+00					3.36E+00					NA		**9.85E+00**	
Total ILCR					7.94E-07					3.59E-07					5.06E-10		**1.15E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-68

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 692, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	1.73E+01	7.31E-06	1.71E-05	NA	NA	NA	3.11E-07	6.65E-06	2.99E-06	NA	NA	NA
4-Amino-2,6-dinitrotoluene	1.15E+01	4.86E-06	1.13E-05	NA	NA	NA	2.07E-07	4.42E-06	1.98E-06	NA	NA	NA
2,4,6-Trinitrotoluene	9.00E+02	3.80E-04	8.88E-04	1.14E-05	2.66E-05	3.80E-05	1.62E-05	3.46E-04	1.55E-04	1.73E-05	7.77E-06	2.51E-05
PCBs												
Aroclor 1260	5.17E-01	2.19E-07	5.10E-07	4.37E-07	1.02E-06	1.46E-06	5.58E-09	1.19E-07	5.35E-08	2.39E-07	1.07E-07	3.46E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	5.68E+00	2.40E-06	5.60E-06	1.63E-06	3.81E-06	5.44E-06	1.02E-07	2.18E-06	9.80E-07	1.49E-06	6.67E-07	2.15E-06
2,6-Dinitrotoluene	1.07E+01	4.52E-06	1.06E-05	3.08E-06	7.18E-06	1.03E-05	1.93E-07	4.12E-06	1.85E-06	2.80E-06	1.26E-06	4.05E-06
Total ILCR				1.66E-05	3.86E-05	5.52E-05				2.18E-05	9.80E-06	3.16E-05

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-68

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 692, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.73E+01	1.11E-08	1.04E-09	6.07E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	1.15E+01	7.37E-09	6.92E-10	4.04E-10	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	9.00E+02	5.76E-07	5.41E-08	3.16E-08	NA	NA	NA	**2.87E-05**	**3.44E-05**	**6.31E-05**
PCBs										
Aroclor 1260	5.17E-01	3.31E-10	3.11E-11	1.81E-11	6.22E-11	3.63E-11	9.85E-11	**6.76E-07**	**1.13E-06**	**1.80E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	5.68E+00	3.64E-09	3.42E-10	1.99E-10	NA	NA	NA	**3.12E-06**	**4.48E-06**	**7.59E-06**
2,6-Dinitrotoluene	1.07E+01	6.85E-09	6.44E-10	3.76E-10	NA	NA	NA	**5.87E-06**	**8.43E-06**	**1.43E-05**
Total ILCR					6.22E-11	3.63E-11	9.85E-11	**3.84E-05**	**4.84E-05**	**8.68E-05**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-69

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 692, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.73E+01	1.99E-04	3.32E+00	3.11E-07	3.48E-05	9.68E-01	1.11E-08	7.08E-09	NA	**4.29E+00**
4-Amino-2,6-dinitrotoluene	1.15E+01	1.32E-04	2.21E+00	2.07E-07	2.32E-05	6.43E-01	7.37E-09	4.71E-09	NA	**2.85E+00**
2,4,6-Trinitrotoluene	9.00E+02	1.04E-02	2.07E+01	1.62E-05	1.81E-03	6.04E+00	5.76E-07	3.69E-07	NA	**2.68E+01**
PCBs										
Aroclor 1260	5.17E-01	5.95E-06	NA	5.58E-09	6.25E-07	NA	3.31E-10	2.12E-10	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	5.68E+00	6.54E-05	3.27E-02	1.02E-07	1.14E-05	5.72E-03	3.64E-09	2.33E-09	NA	**3.84E-02**
2,6-Dinitrotoluene	1.07E+01	1.23E-04	1.23E-01	1.93E-07	2.15E-05	2.15E-02	6.85E-09	4.38E-09	NA	**1.45E-01**
Total HI			2.64E+01			7.68E+00			NA	**3.41E+01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-70

COPCs in Soil Associated with Former Building 693
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO173 AB0443 1 - 2	TNTC-SO407 AB0472 8 - 10	Source Term Concentration [a]
Nitroaromatics				
2-Amino-4,6-dinitrotoluene	3.70E-01	1.28E+00	4.33E-01	1.28E+00
4-Amino-2,6-dinitrotoluene	3.70E-01	2.26E+00	NA	2.26E+00
2,4,6-Trinitrotoluene	1.60E+00	8.07E+00	NA	8.07E+00
PCBs				
Aroclor 1260	2.20E-02	3.66E-02	4.05E-02	4.05E-02
Semivolatile Organic Compounds				
2,4-Dinitrotoluene	7.20E-02	9.16E-02	ND	9.16E-02

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected

Table B.2-71

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 693, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	1.28E+00	3.62E-06	2.59E-08	6.04E-02	NA	1.02E-08	1.13E-06	8.09E-09	3.14E-02	NA	4.48E-07	8.74E-08	6.26E-10	NA	NA	**9.17E-02**	**NA**
4-Amino-2,6-dinitrotoluene	2.26E+00	6.40E-06	4.58E-08	1.07E-01	NA	1.81E-08	1.99E-06	1.43E-08	5.54E-02	NA	7.91E-07	1.54E-07	1.11E-09	NA	NA	**1.62E-01**	**NA**
2,4,6-Trinitrotoluene	8.07E+00	2.28E-05	1.64E-07	4.57E-02	4.91E-09	6.46E-08	7.12E-06	5.10E-08	2.37E-02	2.55E-09	2.82E-06	5.51E-07	3.95E-09	NA	NA	**6.94E-02**	**7.46E-09**
PCBs																	
Aroclor 1260	4.05E-02	1.15E-07	8.21E-10	NA	1.64E-09	1.94E-10	2.14E-08	1.54E-10	NA	3.07E-10	1.42E-08	2.77E-09	1.98E-11	NA	3.96E-11	**NA**	**1.99E-09**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	9.16E-02	2.59E-07	1.86E-09	1.30E-04	1.26E-09	7.33E-10	8.08E-08	5.79E-10	4.04E-05	3.94E-10	3.21E-08	6.26E-09	4.48E-11	NA	NA	**1.70E-04**	**1.66E-09**
Total HI				2.13E-01					1.11E-01					NA		**3.23E-01**	
Total ILCR					7.81E-09					3.25E-09					3.96E-11		**1.11E-08**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-72

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 693, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

COPC (mg/kg)	Source Term Concentration	Incidental Ingestion Adult Cancer Dose (mg/kg-day)	Incidental Ingestion Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	Total On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Dermal Absorption Adult Cancer Dose (mg/kg-day)	Dermal Absorption Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	Total On-Site Resident Dermal ILCR
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	1.28E+00	5.41E-07	1.26E-06	NA	NA	NA	2.30E-08	4.92E-07	2.21E-07	NA	NA	NA
4-Amino-2,6-dinitrotoluene	2.26E+00	9.55E-07	2.23E-06	NA	NA	NA	4.07E-08	8.69E-07	3.90E-07	NA	NA	NA
2,4,6-Trinitrotoluene	8.07E+00	3.41E-06	7.96E-06	1.02E-07	2.39E-07	3.41E-07	1.45E-07	3.10E-06	1.39E-06	1.55E-07	6.96E-08	2.25E-07
PCBs												
Aroclor 1260	4.05E-02	1.71E-08	3.99E-08	3.42E-08	7.99E-08	1.14E-07	4.37E-10	9.35E-09	4.19E-09	1.87E-08	8.39E-09	2.71E-08
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	9.16E-02	3.87E-08	9.03E-08	2.63E-08	6.14E-08	8.78E-08	1.65E-09	3.52E-08	1.58E-08	2.40E-08	1.08E-08	3.47E-08
Total ILCR				1.63E-07	3.80E-07	5.43E-07				1.98E-07	8.88E-08	2.87E-07

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-72

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 693, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.28E+00	8.20E-10	7.70E-11	4.49E-11	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	2.26E+00	1.45E-09	1.36E-10	7.93E-11	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	8.07E+00	5.17E-09	4.86E-10	2.83E-10	NA	NA	NA	**2.58E-07**	**3.08E-07**	**5.66E-07**
PCBs										
Aroclor 1260	4.05E-02	2.59E-11	2.44E-12	1.42E-12	4.87E-12	2.84E-12	7.72E-12	**5.29E-08**	**8.83E-08**	**1.41E-07**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	9.16E-02	5.87E-11	5.51E-12	3.21E-12	NA	NA	NA	**5.03E-08**	**7.22E-08**	**1.22E-07**
Total ILCR					4.87E-12	2.84E-12	7.72E-12	**3.61E-07**	**4.69E-07**	**8.30E-07**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-73

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 693, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	1.28E+00	1.47E-05	2.45E-01	2.30E-08	2.58E-06	7.16E-02	8.20E-10	5.24E-10	NA	**3.17E-01**
4-Amino-2,6-dinitrotoluene	2.26E+00	2.60E-05	4.33E-01	4.07E-08	4.55E-06	1.26E-01	1.45E-09	9.25E-10	NA	**5.60E-01**
2,4,6-Trinitrotoluene	8.07E+00	9.29E-05	1.86E-01	1.45E-07	1.63E-05	5.42E-02	5.17E-09	3.30E-09	NA	**2.40E-01**
PCBs										
Aroclor 1260	4.05E-02	4.66E-07	NA	4.37E-10	4.89E-08	NA	2.59E-11	1.66E-11	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	9.16E-02	1.05E-06	5.27E-04	1.65E-09	1.84E-07	9.22E-05	5.87E-11	3.75E-11	NA	**6.19E-04**
Total HI			8.65E-01			2.52E-01			NA	**1.12E+00**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

Table B.2-74

COPCs in Soil Associated with Former Building 696
TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

Sample Location: **Sample Number:** **Sample Depth (feet):** COPC (mg/kg)	Risk-Based Screening Criterion	TNTC-SO192 AB0445 0 - 1	TNTC-SO190 AB0444 1 - 2	TNTC-SO192 AB0446 2 - 2.5	TNTC-SO327 AB0479 2 - 3	Source Term Concentration [a]
Metals						
Chromium	2.10E+01	--	--	2.02E+02	NA	2.02E+02
Lead	4.00E+02	9.34E+02	NA	NA	NA	9.34E+02
Nitroaromatics						
2-Amino-4,6-dinitrotoluene	3.70E-01	5.14E+00	1.24E+00	3.27E+00	3.02E+00	5.14E+00
4-Amino-2,6-dinitrotoluene	3.70E-01	6.62E+00	9.90E-01	4.76E+00	2.20E+00	6.62E+00
1,3-Dinitrobenzene	6.10E-01	7.51E-01	ND	ND	ND	7.51E-01
2,4,6-Trinitrotoluene	1.60E+00	8.78E+02	NA	2.51E+02	9.91E+00	8.78E+02
PCBs						
Aroclor 1260	2.20E-02	3.73E-01	ND	3.00E-01	NA	3.73E-01
Semivolatile Organic Compounds						
2,4-Dinitrotoluene	7.20E-02	2.41E+00	ND	1.64E+00	ND	2.41E+00
Benzo(a)anthracene	6.20E-02	1.00E+00	6.48E-02	1.11E+01	ND	1.11E+01
Benzo(a)pyrene	6.20E-03	7.04E-01	5.96E-02	8.20E+00	ND	8.20E+00
Benzo(b)fluoranthene	6.20E-02	9.29E-01	1.02E-01	1.02E+01	ND	1.02E+01
Benzo(k)fluoranthene	6.20E-01	ND	ND	4.38E+00	ND	4.38E+00
Chrysene	6.20E+00	NA	NA	8.74E+00	ND	8.74E+00
Dibenz(a,h)anthracene	6.20E-03	ND	ND	1.40E+00	ND	1.40E+00
Indeno(1,2,3-cd)pyrene	6.20E-02	ND	ND	3.64E+00	ND	3.64E+00

[a] Maximum detected concentration.
COPC = Chemical of Potential Concern
NA = Not Applicable (detected concentration did not exceed RBSC)
ND = Not Detected
-- = No result was available from this sample.

Table B.2-75

Cancer Risk and Noncancer Hazard: Construction Worker Exposure to Total Soil
Former Building 696, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

		Incidental Ingestion					Dermal Absorption					Inhalation					
COPC (mg/kg)	Source Term Concentration	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Oral HQ	Oral ILCR	DA mg/cm^2-day	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Dermal HQ	Dermal ILCR	Concentration in Air (mg/m^3)	Noncancer Dose (mg/kg-day)	Cancer Dose (mg/kg-day)	Inhalation HQ	Inhalation ILCR	**Total HI All Pathways**	**Total ILCR All Pathways**
Metals																	
Chromium	2.02E+02	5.72E-04	4.09E-06	3.81E-04	NA	1.62E-07	1.78E-05	1.28E-07	1.19E-03	NA	7.07E-05	1.38E-05	9.88E-08	4.76E-01	4.15E-06	**4.77E-01**	**4.15E-06**
Lead	9.34E+02	2.64E-03	1.89E-05	NA	NA	7.47E-07	8.24E-05	5.90E-07	NA	NA	3.27E-04	6.38E-05	4.57E-07	NA	NA	**NA**	**NA**
Nitroaromatics																	
2-Amino-4,6-dinitrotoluene	5.14E+00	1.45E-05	1.04E-07	2.42E-01	NA	4.11E-08	4.53E-06	3.25E-08	1.26E-01	NA	1.80E-06	3.51E-07	2.51E-09	NA	NA	**3.68E-01**	**NA**
4-Amino-2,6-dinitrotoluene	6.62E+00	1.87E-05	1.34E-07	3.12E-01	NA	5.30E-08	5.84E-06	4.18E-08	1.62E-01	NA	2.32E-06	4.52E-07	3.24E-09	NA	NA	**4.74E-01**	**NA**
1,3-Dinitrobenzene	7.51E-01	2.13E-06	1.52E-08	2.13E-02	NA	6.01E-09	6.62E-07	4.74E-09	8.28E-03	NA	2.63E-07	5.13E-08	3.67E-10	NA	NA	**2.95E-02**	**NA**
2,4,6-Trinitrotoluene	8.78E+02	2.48E-03	1.78E-05	4.97E+00	5.34E-07	7.02E-06	7.75E-04	5.55E-06	2.58E+00	2.77E-07	3.07E-04	6.00E-05	4.30E-07	NA	NA	**7.55E+00**	**8.11E-07**
PCBs																	
Aroclor 1260	3.73E-01	1.06E-06	7.56E-09	NA	1.51E-08	1.79E-09	1.97E-07	1.41E-09	NA	2.83E-09	1.31E-07	2.55E-08	1.82E-10	NA	3.65E-10	**NA**	**1.83E-08**
Semivolatile Organic Compounds																	
2,4-Dinitrotoluene	2.41E+00	6.82E-06	4.88E-08	3.41E-03	3.32E-08	1.93E-08	2.13E-06	1.52E-08	1.06E-03	1.04E-08	8.44E-07	1.65E-07	1.18E-09	NA	NA	**4.47E-03**	**4.36E-08**
Benzo(a)anthracene	1.11E+01	3.14E-05	2.25E-07	NA	1.64E-07	8.88E-08	9.79E-06	7.01E-08	NA	1.02E-07	3.89E-06	7.58E-07	5.43E-09	NA	1.68E-09	**NA**	**2.68E-07**
Benzo(a)pyrene	8.20E+00	2.32E-05	1.66E-07	NA	1.21E-06	6.56E-08	7.23E-06	5.18E-08	NA	7.56E-07	2.87E-06	5.60E-07	4.01E-09	NA	1.24E-08	**NA**	**1.98E-06**
Benzo(b)fluoranthene	1.02E+01	2.89E-05	2.07E-07	NA	1.51E-07	8.16E-08	9.00E-06	6.44E-08	NA	9.41E-08	3.57E-06	6.97E-07	4.99E-09	NA	1.55E-09	**NA**	**2.47E-07**
Benzo(k)fluoranthene	4.38E+00	1.24E-05	8.88E-08	NA	6.48E-09	3.50E-08	3.86E-06	2.77E-08	NA	4.04E-09	1.53E-06	2.99E-07	2.14E-09	NA	6.64E-11	**NA**	**1.06E-08**
Chrysene	8.74E+00	2.47E-05	1.77E-07	NA	1.29E-09	6.99E-08	7.71E-06	5.52E-08	NA	5.04E-10	3.06E-06	5.97E-07	4.28E-09	NA	1.33E-11	**NA**	**1.81E-09**
Dibenz(a,h)anthracene	1.40E+00	3.96E-06	2.84E-08	NA	2.07E-07	1.12E-08	1.23E-06	8.85E-09	NA	8.07E-08	4.90E-07	9.56E-08	6.85E-10	NA	2.12E-09	**NA**	**2.90E-07**
Indeno(1,2,3-cd)pyrene	3.64E+00	1.03E-05	7.38E-08	NA	5.39E-08	2.91E-08	3.21E-06	2.30E-08	NA	3.36E-08	1.27E-06	2.49E-07	1.78E-09	NA	5.52E-10	**NA**	**8.80E-08**
Total HI				5.55E+00					2.88E+00					4.76E-01		**8.91E+00**	
Total ILCR					2.38E-06					1.36E-06					4.17E-06		**7.91E-06**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-76

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 696, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 1 of 2)

		Incidental Ingestion				Total		Dermal Absorption				Total
COPC (mg/kg)	Source Term Concentration	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Oral ILCR	Child Resident Oral ILCR	On-Site Resident Oral ILCR	DA (mg/cm^2-day)	Adult Cancer Dose (mg/kg-day)	Child Cancer Dose (mg/kg-day)	Adult Resident Dermal ILCR	Child Resident Dermal ILCR	On-Site Resident Dermal ILCR
Metals												
Chromium	2.02E+02	8.54E-05	1.99E-04	NA	NA	NA	3.64E-07	7.77E-06	3.49E-06	NA	NA	NA
Lead	9.34E+02	3.95E-04	9.21E-04	NA	NA	NA	1.68E-06	3.59E-05	1.61E-05	NA	NA	NA
Nitroaromatics												
2-Amino-4,6-dinitrotoluene	5.14E+00	2.17E-06	5.07E-06	NA	NA	NA	9.25E-08	1.98E-06	8.87E-07	NA	NA	NA
4-Amino-2,6-dinitrotoluene	6.62E+00	2.80E-06	6.53E-06	NA	NA	NA	1.19E-07	2.55E-06	1.14E-06	NA	NA	NA
1,3-Dinitrobenzene	7.51E-01	3.17E-07	7.41E-07	NA	NA	NA	1.35E-08	2.89E-07	1.30E-07	NA	NA	NA
2,4,6-Trinitrotoluene	8.78E+02	3.71E-04	8.66E-04	1.11E-05	2.60E-05	3.71E-05	1.58E-05	3.38E-04	1.52E-04	1.69E-05	7.58E-06	2.45E-05
PCBs												
Aroclor 1260	3.73E-01	1.58E-07	3.68E-07	3.15E-07	7.36E-07	1.05E-06	4.03E-09	8.61E-08	3.86E-08	1.72E-07	7.73E-08	2.49E-07
Semivolatile Organic Compounds												
2,4-Dinitrotoluene	2.41E+00	1.02E-06	2.38E-06	6.93E-07	1.62E-06	2.31E-06	4.34E-08	9.27E-07	4.16E-07	6.30E-07	2.83E-07	9.13E-07
Benzo(a)anthracene	1.11E+01	4.69E-06	1.09E-05	3.43E-06	7.99E-06	1.14E-05	2.00E-07	4.27E-06	1.92E-06	6.23E-06	2.80E-06	9.03E-06
Benzo(a)pyrene	8.20E+00	3.47E-06	8.09E-06	2.53E-05	5.90E-05	8.43E-05	1.48E-07	3.15E-06	1.42E-06	4.61E-05	2.07E-05	6.67E-05
Benzo(b)fluoranthene	1.02E+01	4.31E-06	1.01E-05	3.15E-06	7.34E-06	1.05E-05	1.84E-07	3.92E-06	1.76E-06	5.73E-06	2.57E-06	8.30E-06
Benzo(k)fluoranthene	4.38E+00	1.85E-06	4.32E-06	1.35E-07	3.15E-07	4.51E-07	7.88E-08	1.68E-06	7.56E-07	2.46E-07	1.10E-07	3.56E-07
Chrysene	8.74E+00	3.69E-06	8.62E-06	2.70E-08	6.29E-08	8.99E-08	1.57E-07	3.36E-06	1.51E-06	3.07E-08	1.38E-08	4.44E-08
Dibenz(a,h)anthracene	1.40E+00	5.92E-07	1.38E-06	4.32E-06	1.01E-05	1.44E-05	2.52E-08	5.39E-07	2.42E-07	4.91E-06	2.21E-06	7.12E-06
Indeno(1,2,3-cd)pyrene	3.64E+00	1.54E-06	3.59E-06	1.12E-06	2.62E-06	3.74E-06	6.55E-08	1.40E-06	6.28E-07	2.04E-06	9.17E-07	2.96E-06
Total ILCR				4.96E-05	1.16E-04	1.65E-04				8.29E-05	3.72E-05	1.20E-04

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-76

Cancer Risk: On-Site Resident Exposure to Total Soil
Former Building 696, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio
(Page 2 of 2)

COPC (mg/kg)	Source Term Concentration	Concentration In Air (mg/m^3)	Inhalation of Dust: Adult Cancer Dose (mg/kg-day)	Inhalation of Dust: Child Cancer Dose (mg/kg-day)	Adult Resident Inhalation ILCR	Child Resident Inhalation ILCR	Total On-Site Resident Inhalation ILCR	**Adult Resident Total ILCR All Pathways**	**Child Resident Total ILCR All Pathways**	**On-Site Resident Total ILCR - All Pathways**
Metals										
Chromium	2.02E+02	1.29E-07	1.22E-08	7.09E-09	5.10E-07	2.98E-07	8.08E-07	**5.10E-07**	**2.98E-07**	**8.08E-07**
Lead	9.34E+02	5.98E-07	5.62E-08	3.28E-08	NA	NA	NA	**NA**	**NA**	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	5.14E+00	3.29E-09	3.09E-10	1.80E-10	NA	NA	NA	**NA**	**NA**	**NA**
4-Amino-2,6-dinitrotoluene	6.62E+00	4.24E-09	3.98E-10	2.32E-10	NA	NA	NA	**NA**	**NA**	**NA**
1,3-Dinitrobenzene	7.51E-01	4.81E-10	4.52E-11	2.64E-11	NA	NA	NA	**NA**	**NA**	**NA**
2,4,6-Trinitrotoluene	8.78E+02	5.62E-07	5.28E-08	3.08E-08	NA	NA	NA	**2.80E-05**	**3.36E-05**	**6.16E-05**
PCBs										
Aroclor 1260	3.73E-01	2.39E-10	2.24E-11	1.31E-11	4.49E-11	2.62E-11	7.11E-11	**4.88E-07**	**8.13E-07**	**1.30E-06**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.41E+00	1.54E-09	1.45E-10	8.46E-11	NA	NA	NA	**1.32E-06**	**1.90E-06**	**3.22E-06**
Benzo(a)anthracene	1.11E+01	7.11E-09	6.68E-10	3.90E-10	2.07E-10	1.21E-10	3.28E-10	**9.66E-06**	**1.08E-05**	**2.04E-05**
Benzo(a)pyrene	8.20E+00	5.25E-09	4.93E-10	2.88E-10	1.53E-09	8.92E-10	2.42E-09	**7.14E-05**	**7.97E-05**	**1.51E-04**
Benzo(b)fluoranthene	1.02E+01	6.53E-09	6.14E-10	3.58E-10	1.90E-10	1.11E-10	3.01E-10	**8.88E-06**	**9.91E-06**	**1.88E-05**
Benzo(k)fluoranthene	4.38E+00	2.81E-09	2.64E-10	1.54E-10	8.17E-12	4.77E-12	1.29E-11	**3.81E-07**	**4.26E-07**	**8.07E-07**
Chrysene	8.74E+00	5.60E-09	5.26E-10	3.07E-10	1.63E-12	9.51E-13	2.58E-12	**5.76E-08**	**7.67E-08**	**1.34E-07**
Dibenz(a,h)anthracene	1.40E+00	8.97E-10	8.42E-11	4.91E-11	2.61E-10	1.52E-10	4.13E-10	**9.23E-06**	**1.23E-05**	**2.15E-05**
Indeno(1,2,3-cd)pyrene	3.64E+00	2.33E-09	2.19E-10	1.28E-10	6.79E-11	3.96E-11	1.07E-10	**3.17E-06**	**3.54E-06**	**6.71E-06**
Total ILCR					5.13E-07	2.99E-07	8.12E-07	**1.33E-04**	**1.53E-04**	**2.86E-04**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
ILCR = Incremental lifetime cancer risk
NA = Not applicable

Table B.2-77

Noncancer Hazard: On-Site Resident Child Exposure to Total Soil
Former Building 696, TNT Area C
Former Plum Brook Ordnance Works, Sandusky, Ohio

COPC (mg/kg)	Source Term Concentration	Ingested Noncancer Dose (mg/kg-day)	Oral HQ	DA (mg/cm^2-day)	Dermally Absorbed Noncancer Dose (mg/kg-day)	Dermal HQ	Concentration In Air (mg/m^3)	Inhalation of Dust Noncancer Dose (mg/kg-day)	Inhalation HQ	**Total HI All Pathways**
Metals										
Chromium	2.02E+02	2.32E-03	1.55E-03	3.64E-07	4.07E-05	2.71E-03	1.29E-07	8.27E-08	2.85E-03	**7.11E-03**
Lead	9.34E+02	1.07E-02	NA	1.68E-06	1.88E-04	NA	5.98E-07	3.82E-07	NA	**NA**
Nitroaromatics										
2-Amino-4,6-dinitrotoluene	5.14E+00	5.91E-05	9.86E-01	9.25E-08	1.04E-05	2.88E-01	3.29E-09	2.10E-09	NA	**1.27E+00**
4-Amino-2,6-dinitrotoluene	6.62E+00	7.62E-05	1.27E+00	1.19E-07	1.33E-05	3.70E-01	4.24E-09	2.71E-09	NA	**1.64E+00**
1,3-Dinitrobenzene	7.51E-01	8.64E-06	8.64E-02	1.35E-08	1.51E-06	1.89E-02	4.81E-10	3.08E-10	NA	**1.05E-01**
2,4,6-Trinitrotoluene	8.78E+02	1.01E-02	2.02E+01	1.58E-05	1.77E-03	5.89E+00	5.62E-07	3.60E-07	NA	**2.61E+01**
PCBs										
Aroclor 1260	3.73E-01	4.29E-06	NA	4.03E-09	4.51E-07	NA	2.39E-10	1.53E-10	NA	**NA**
Semivolatile Organic Compounds										
2,4-Dinitrotoluene	2.41E+00	2.77E-05	1.39E-02	4.34E-08	4.85E-06	2.43E-03	1.54E-09	9.87E-10	NA	**1.63E-02**
Benzo(a)anthracene	1.11E+01	1.28E-04	NA	2.00E-07	2.24E-05	NA	7.11E-09	4.55E-09	NA	**NA**
Benzo(a)pyrene	8.20E+00	9.44E-05	NA	1.48E-07	1.65E-05	NA	5.25E-09	3.36E-09	NA	**NA**
Benzo(b)fluoranthene	1.02E+01	1.17E-04	NA	1.84E-07	2.05E-05	NA	6.53E-09	4.18E-09	NA	**NA**
Benzo(k)fluoranthene	4.38E+00	5.04E-05	NA	7.88E-08	8.82E-06	NA	2.81E-09	1.79E-09	NA	**NA**
Chrysene	8.74E+00	1.01E-04	NA	1.57E-07	1.76E-05	NA	5.60E-09	3.58E-09	NA	**NA**
Dibenz(a,h)anthracene	1.40E+00	1.61E-05	NA	2.52E-08	2.82E-06	NA	8.97E-10	5.73E-10	NA	**NA**
Indeno(1,2,3-cd)pyrene	3.64E+00	4.19E-05	NA	6.55E-08	7.33E-06	NA	2.33E-09	1.49E-09	NA	**NA**
Total HI			2.26E+01			6.58E+00			2.85E-03	**2.91E+01**

COPC = Chemical of Potential Concern
DA = Dose absorbed per unit body surface area per day
HQ = Hazard quotient; HI = Hazard index
NA = Not applicable

APPENDIX C

TOXICOLOGICAL PROFILES FOR THE CHEMICALS OF POTENTIAL CONCERN

TOXICOLOGICAL PROFILES
FOR THE CHEMICALS OF POTENTIAL CONCERN
TNT AREA A & C

INTRODUCTION

Toxicological profiles are presented for each chemical for which documentation of chemical-specific values is required. The doubly hyphenated number in parentheses following the chemical name is its unique Chemical Abstract Service (CAS) registration number. The CAS number may be located in the profile title, or, in the case of multiple isomers or members of a chemical class, in the introductory text or the table that provides the physical properties.

Toxicological profiles contain brief descriptions of the nature of the adverse effects associated with the chemical. It is important to note that a discussion of adverse effects without a discussion of dose is incomplete and potentially misleading, because virtually any chemical may be toxic at some dose, and many chemicals (e.g., nutritionally required minerals, vitamins, amino acids, etc.) enhance human health at some low dose. An ever growing and compelling body of evidence suggests that many environmental contaminants also enhance health at low doses (Hart and Frame, 1996).

When sufficient data are available, the EPA Integrated Risk Information System (IRIS) presents the EPA's verified chronic toxicity values for threshold, or noncancer, effects, and for cancer risk (EPA, 2001). The toxicity values for noncancer effects include a reference dose (RfD) expressed in milligrams per kilogram per day (mg/kg-day) for chronic oral exposure, and a reference concentration (RfC), in milligrams per cubic meter (mg/m^3), for chronic inhalation exposure. The inhalation RfC in units of mg/m^3 may be converted to an equivalent inhalation RfD by assuming continuous chronic exposure of humans with a body weight of 70 kg and an inhalation rate of 20 m^3/day. In other words, the RfC expressed as mg/m^3 is multiplied by the inhalation rate of 20 m^3/day, and the result is divided by the body weight of 70 kg to yield an inhalation RfD expressed as mg/kg-day.

RfDs and RfCs are usually derived from empirical benchmark doses (BMD) or concentrations called no-observed-effect levels (NOEL) or no-observed-adverse-effect levels (NOAEL) from animal toxicity or human epidemiology studies. If the data do not permit identifying a NOEL or NOAEL, a lowest-observed-adverse-effect level (LOAEL) or lowest-effect level (LEL) may be used. A frank-effect level (FEL), e.g., mortality, shortened life span or serious physiologic, neurologic or behavioral disturbances, is generally considered an inappropriate benchmark from which to develop an RfD or RfC. Some RfD and RfC derivations employ a BMD that is a statistically estimated dose for humans at which some low proportion of the population may experience some minimally adverse effect. A BMD at which 10 percent of the population may be expected to respond is expressed as BMD_{10}. The RfD or RfC is derived by dividing the benchmark level (e.g., NOAEL or BMD_{10}) by a series of uncertainty and modifying factors, which collectively are designated the uncertainty factor (UF).

For cancer effects, IRIS presents a verified EPA cancer weight-of-evidence group classification that reflects qualitatively the likelihood that the chemical is carcinogenic to humans. IRIS also presents a slope factor (SF) for oral exposure, expressed as the risk per mg/kg-day ingested dose, and a unit risk factor (URF) for inhalation exposure, expressed as the risk per microgram per cubic meter ($\mu g/m^3$) in ambient air. These quantitative estimates are generally provided for chemicals in EPA weight-of-evidence Groups A and B and C, if the data are adequate. The SF or URF is usually estimated as an upper bound on the slope of the dose- or concentration-response curve from animal toxicity or human epidemiology studies. The inhalation URF in units of risk per $\mu g/m^3$ may be converted to an equivalent inhalation SF in units of risk per mg/kg-day by assuming continuous lifetime exposure of humans with a body weight to 70 kg and an inhalation rate of 20 m^3/day. In other words, the URF expressed as risk per $\mu g/m^3$ is divided by the inhalation rate of 20 m^3/day, and multiplied by the assumed body weight of 70 kg and a conversion factor of 1000 $\mu g/mg$.

Toxicity values are not estimated for acute toxicity and acute exposure is not evaluated in the risk assessment. Nonetheless, the levels associated with acute lethality and data regarding the effects of acute exposure to levels higher than ordinarily observed in chronic environmental exposure provide additional perspective regarding the toxicity of the chemical. Therefore, information regarding acute toxicity, when available, is included in the profiles. Lethality data for laboratory animals are generally expressed as the oral dose associated with lethality of 50 percent of an exposed population (LD_{50}) or the concentration in air associated with lethality of 50 percent of an exposed population (LC_{50}). Occasionally the dose associated with lethality in a low percentage of an exposed population (LD_{LO}) is presented.

The toxicity profiles also provide documentation for physical constants that are important for chemical transport modeling, such as molecular weight (MW) in grams per mole (g/mole), the log of the octanol/water partition coefficient (log K_{ow}), Henry's law constant (H) in atmosphere-cubic meter/mole (atm-m^3/mole), the soil/water partition coefficient (K_d) in liters per kilogram (L/kg) for metals, the log of the soil/organic carbon partition coefficient (log K_{oc}) (unitless) for organic chemicals, diffusivity in air (D_a) in square centimeters per second (cm^2/s), diffusivity in water (D_w) in cm^2/s, vapor pressure (VP) in atmospheres (atm), and solubility in water (S) in milligrams per liter (mg/L). In addition, organic chemicals are designated as volatile organic compounds (VOC) or semivolatile organic compounds (SVOC) based on their propensity to volatilize from environmental media. Chemicals designated as VOCs generally have a MW less than 200 g/mole and H greater than 1E-5 atm-m^3/mole (EPA, 1991).

The physical constants generally are taken from the most reliable source (i.e., the source that provides the highest level of documentation). Values for interrelated properties are usually taken from the same source (e.g., H is often estimated from VP and S; therefore, the same source is generally used for all three property values). When one source provides several values for a given property, professional judgement is used to select the most appropriate. Obvious outliers may be dropped from consideration. The average or the midpoint of a range of values may be selected. K_d values for metals and K_{oc} values for ionizing organic compound are based on a default pH of 6.8 (EPA, 1996) if the data are available. VP, S and H values are limited to those provided for normal ambient temperatures (0 to 30°C), but the temperatures reported in the

original sources are not presented in the toxicity profile, nor is any attempt made to extrapolate K, VP or S to any default temperature.

When values for H were not located, they were calculated as follows, provided the requisite information was available (EPA, 1998):

$$H = \frac{VP \cdot MW}{S}$$

where:

H	=	Henry's law constant (atm-m^3/mole, calculated)
VP	=	vapor pressure (atm)
MW	=	molecular weight (g/mole)
S	=	solubility in water (mg/L).

When values for D_a were not located, they were calculated as follows (EPA, 1998):

$$D_a = \frac{1.9}{MW^{2/3}}$$

where:

D_a	=	diffusivity in air (cm^2/s, calculated)
MW	=	molecular weight (g/mole).

When values for D_w were not located, they were calculated as follows (EPA, 1998):

$$D_w = \frac{22E-5}{MW^{2/3}}$$

where:

D_w	=	diffusivity in water (cm^2/s, calculated)
MW	=	molecular weight (g/mole).

When values for K_{oc} were not located, they were calculated as follows for phthalates and polyaromatic aromatic hydrocarbons (PAH) provided log K_{ow} was available (EPA, 1998):

$$\log K_{oc} = 0.97 \log K_{ow} - 0.094$$

where:

K_{oc}	=	soil/organic carbon partition coefficient (unitless, calculated)
K_{ow}	=	octanol/water partition coefficient (unitless).

K_{oc} for other organic chemicals was calculated as follows provided log K_{ow} was available (EPA, 1998):

$$\log K_{oc} = 0.78 \log K_{ow} + 0.151$$

where:

K_{oc}	=	soil/organic carbon partition coefficient (unitless, calculated)
K_{ow}	=	octanol/water partition coefficient (unitless).

The toxicity profiles also present the predominant sources of release to the environment as well as a qualitative description of the fate of the chemical in air, surface water and sediment, and soil. No attempt is made to present quantitative data because environmental fate is usually highly dependent on climatic conditions and the characteristics of the medium to which the chemical is released, which may differ from location to location and change from time to time. The source and fate information may provide perspective regarding the likelihood that the chemical's presence is related to site activities, that the chemical will migrate across media, or that the chemical will persist at toxicologically significant levels.

Biotransfer factors are provided for chemicals for which food-chain pathways may be significant, which includes many inorganic chemicals and those organic chemicals that are highly lipophilic and persist in the environment. High lipophilicity is indicated by a log K_{ow} greater than 3 (Lyman et al., 1990). Lipophilicity enhances partitioning to biomedia and passage across biological membranes. Persistence in the environment is evidence that the chemical might resist biotransformation and, therefore, remain in edible tissues at toxicologically significant concentrations. VOCs tend to be mobile and labile (i.e., subject to rapid and extensive biotransformation and excretion), and generally do not participate significantly in food-chain pathways. Therefore, biotransfer factors are not estimated for VOCs. Some of the SVOCs, however, are highly lipophilic. They may persist or yield metabolites that are significant toxicants in their own right. For example, the organochlorine pesticide DDT is metabolized by mammals to DDE, which is similar in carcinogenic potency to the parent compound. Biotransfer factors are generally estimated for SVOCs that have log K_{ow} values greater than 3.

The biotransfer factors of interest are water-to-fish bioconcentration factors (BCF) or biota-sediment accumulation factors (BSAF), soil-to-plant biotransfer factors (Bp), cattle ingestion-to-beef factors (Bb) and cattle ingestion-to-milk factors (Bm). Separate soil-to-plant biotransfer factors are available for the reproductive parts of plants (e.g., fruits, seeds) and the vegetative parts of plants (e.g., stems, leaves) for inorganic and some organic chemicals. Soil-to-plant factors for the reproductive parts of plants are designated Bpr; soil-to-plant factors for the vegetative parts of plants are designated Bpv.

BCF values are adopted from empirical data when the data are clearly the best choice (i.e., similar results in multiple species of fin fish). When the empirical data are few or inconsistent, BCFs for inorganic chemicals are taken from various sources. BCF values for organic chemicals are estimated from the following equation (Devillers et al., 1996):

$$\log BCF = 0.910 \log K_{ow} - 1.975 \log(6.8E-7 K_{ow} + 1) - 0.786$$

where:

BCF	=	bioconcentration factor (L/kg, calculated)
K_{ow}	=	octanol/water partition coefficient (unitless).

The Bintein and Devillers model (Devillers et al., 1996) is selected over simpler models adopted by the EPA largely because the Bintein and Devillers approach has undergone scrutiny since first published (Bintein and Devillers, 1993), and considerable effort was expended to validate the model; i.e., to compare modeled and empirical results. The Bintein and Devillers model is probably more realistic than simpler models for chemicals with higher log K_{ow} values. BSAF values are chosen instead of BCFs for those very highly lipophilic chemicals such as the polychlorinated biphenyls (PCB), polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDF) and selected organochlorine pesticides expected to partition almost entirely to benthic sediment.

Soil-to-plant biotransfer factors (Bp) for SVOCs are estimated by a simple model by Travis and Arms (1988), which is based only on log K_{ow}:

$$\log Bp = 1.588 - 0.578 \log K_{ow}$$

where:

Bp	=	soil-to-plant biotransfer factor (unitless, calculated)
K_{ow}	=	octanol/water partition coefficient (unitless).

Separate biotransfer factors are not estimated for the reproductive parts of plants (Bpr) and the vegetative parts of plants (Bpv).

Cattle ingestion-to-beef factors (Bb) for SVOCs are estimated by a simple model by Travis and Arms (1988), which is based only on log K_{ow}:

$$\log Bb = -7.6 + \log K_{ow}$$

where:

Bb	=	cattle ingestion-to-beef biotransfer factor (days/kg, calculated)
K_{ow}	=	octanol/water partition coefficient (unitless).

Cattle ingestion-to-milk factors (Bm) for SVOCs are estimated by a simple model by Travis and Arms (1988), which is based only on log K_{ow}:

$$\log Bb = -8.10 + \log K_{ow}$$

where:

Bm	=	cattle ingestion-to-milk biotransfer factor (days/kg, calculated)
K_{ow}	=	octanol/water partition coefficient (unitless).

The toxicity profiles provide documentation for the gastrointestinal (GI) absorption factor (GAF), which is used to develop the dermal RfD and SF, the dermal absorption factor (ABS), which describes the extent of dermal uptake from soil, and the permeability coefficient (PC) and tau (τ), which are used to estimate the rate of dermal uptake from water. Usually PC and τ are taken from EPA (1992), unless EPA (1992) provides no values, or professional judgement suggests that a log K_{ow} value other than the one provided by EPA (1992) is clearly more appropriate. In these cases, PC is calculated as follows (EPA, 1992):

$$\log(PC) = -2.72 + 0.71(\log K_{ow}) - 0.0061(MW)$$

where:

PC	=	permeability coefficient (centimeters per hour [cm/hour], calculated)
K_{ow}	=	octanol/water partition coefficient (unitless)
MW	=	molecular weight,

and τ is calculated as follows (EPA, 1992):

$$\tau = \frac{L_{sc}}{6 \cdot 10^{(-2.72 - 0.0061 * MW)}}$$

where:

τ	=	time for concentration of contaminant in stratum corneum to reach steady state (hours, calculated)
L_{sc}	=	effective thickness of the stratum corneum (1E-3 cm)
MW	=	molecular weight.

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INORGANIC CHEMICALS

ARSENIC (7440-38-2)

Arsenic is a natural **metalloid** that occurs in both inorganic and organic forms (ATSDR, 1998). Inorganic arsenic is more toxic than organic forms. Major uses in the U.S. include its incorporation into wood preservatives and other agricultural chemicals. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	K_d (L/kg)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
74.92 (element)	NA	NA	2.9E+1[a]	NA	NA	Note 1[b]	Note 2[b]

NA = not applicable
Note 1: Variable: inorganic arsenic compounds are not likely to volatilize; some organic arsenic compounds are low-boiling liquids or gases at normal temperatures.
Note 2: Variable: inorganic arsenic compounds range from practically insoluble to freely miscible in water; most organic arsenic compounds are not readily soluble, most arsenic acid compounds are soluble to freely miscible.
[a]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[b]Agency for Toxic Substances and Disease Registry, (ATSDR), 1998, ***Update Toxicological Profile for Arsenic***, U.S. Public Health Service, Atlanta, Georgia, April.

The major source of arsenic release to the environment is from copper, zinc and lead smelting operations (HSDB, 2001). Releases also occur from several other industries that use arsenic. Most (approximately 80 percent) anthropogenic releases are initially to soil (ATSDR, 1998).

Arsenic occurs in the air as a combination of trivalent and pentavalent forms almost entirely adsorbed to small particles that permit dispersion over long distances (ATSDR, 1998). Residence time in the atmosphere averages approximately nine days. Removal is largely by wet and dry deposition. Arsenic in surface water can undergo a variety of transformations and exist in several soluble forms. Sorption to sediment is often an important removal process, but biotransformation in sediment may return soluble forms to the water. Arsenic in soil generally exists as insoluble forms sorbed to clay or organic matter or complexed with calcium or iron. Mobility is low and leaching is not generally significant, except that increasing soil pH can dramatically increase mobility.

Biotransfer factors for arsenic are compiled below:

BCF (L/kg)	Bpr (unitless)	Bpv (unitless)	Bb (days/kg)	Bm (days/kg)
20[a]	6.0E-3[b]	4.0E-2[b]	2.0E-3[b]	6.0E-5[b]

[a]U.S. Environmental Protection Agency (EPA), 1998, ***Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Volume Two***, Peer Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, EPA530-D-98-001B, July.
[b]Baes, C.F., R.D. Sharp, A.L. Sjoreen, R.W. Shor, 1984, ***A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture***, Health and Safety Division, Oak Ridge National Laboratory, ORNL-5786, September.

Several studies confirm that soluble inorganic arsenic compounds and organic arsenic compounds are nearly completely (>90%) absorbed from the GI tract in both animals and humans (Ishinishi et al., 1986). The absorption efficiency of insoluble inorganic arsenic compounds depends on particle size and stomach pH. The GAF of 0.95 (EPA, 1993) is adopted for this evaluation.

Data regarding the dermal uptake of arsenic were not located. The default ABS of 0.01 for metals (OEPA, 1998) is used herein. The EPA (1992) default PC for metals of 1E-3 cm/hour is selected for arsenic.

Inorganic arsenic may be an essential nutrient, exerting beneficial effects on growth, health and feed conversion efficiency (Underwood, 1977). A lethal dose of arsenic trioxide in humans is 70-180 mg (≈50-140 mg arsenic (Ishinishi et al., 1986). Acute oral exposure of humans to high doses of arsenic produces liver swelling, skin lesions, disturbed heart function and neurological effects. The only noncancer effects in humans clearly attributable to chronic oral exposure to arsenic are dermal hyperpigmentation and keratosis, as revealed by studies of several hundred Chinese exposed to naturally occurring arsenic in well water (EPA, 2001). Similar effects were observed in persons exposed to high levels of arsenic in water in Utah and the northern part of Mexico. EPA (2001) verified an RfD of 3E-4 mg/kg-day for chronic oral exposure, based on a NOAEL of 8E-4 mg/kg-day for hyperpigmentation and kertatosis of the skin from the Chinese data. An uncertainty factor of 3 was applied. An increased incidence of Blackfoot disease was also observed, which may not be related to arsenic alone. Goyer (1991) describes black-foot disease as a peripheral vascular disorder manifested as acrocyanosis and Raynaud's disease, which may progress to gangrene. Confidence in the RfD is medium. EPA (2001) notes that the skin is the more sensitive target organ. Nonetheless, in keeping with EPA (1989) guidance regarding selection of target organ, both the skin and peripheral vascular system are selected as target organs for prolonged oral exposure to arsenic.

Occupational (predominantly inhalation) exposure is also associated with neurological deficits, anemia, and vascular effects (Ishinishi et al., 1986), but concomitant exposure to other chemicals cannot be ruled out. The data are not sufficient for estimation of an inhalation RfC.

Inorganic arsenic is clearly a carcinogen in humans. Inhalation exposure is associated with increased risk of lung cancer in persons employed as smelter workers, in arsenical pesticide applicators, and in a population residing near a pesticide manufacturing plant (EPA, 2001). Oral exposure to high levels in well water is associated with increased risk of skin cancer. Extensive animal testing with various forms of arsenic given by many routes of exposure to several species, however, has not demonstrated the carcinogenicity of arsenic. EPA (2001) classified inorganic arsenic in cancer weight-of-evidence Group A (human carcinogen), and recommended an oral SF of 1.5E+0 per mg/kg-day, based on the incidence of skin cancer in the Chinese study. EPA (2001) noted that the uncertainties associated with the oral unit risk are considerably less than those for most carcinogens, so that the unit risk might be reduced an order of magnitude. An inhalation URF of 4E-3 per $\mu g/m^3$, equivalent to an inhalation SF of 1.5E+1 per mg/kg-day, was derived for inorganic arsenic from the incidence of lung cancer in occupationally exposed men.

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CHROMIUM

Chromium is a naturally occurring **metal** (7440-47-3). It occurs in several valence states; chromium (III) (16065-83-1) and chromium (VI) (18540-29-9) are the forms most commonly encountered in the environment. Chromium is used largely in the metallurgical, refractory and chemical industries (ATSDR, 1998). The largest amount is used in the metallurgical industry in various steels and nonferrous alloys. The second largest use is by the chemical industry in such products as pigments, metal finishing, leather tanning and wood treatment. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	K_d (L/kg)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
52.00 (element)	NA	NA	1.8E+6 (CrIII) 1.9E+1 (CrVI)[a]	NA	NA	ND	Note 1[b]

NA = not applicable, ND = no data.
Note 1: Chromium compounds vary from insoluble to highly soluble.
[a]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[b]Agency for Toxic Substances and Disease Registry, (ATSDR), 1998, ***Toxicological Profile for Chromium***, U.S. Public Health Service, Atlanta, Georgia, July.

Chromium is released into the atmosphere from natural gas, oil and coal combustion, and from use by the industries mentioned above (ATSDR, 1998). Other sources include wind transport from road dust, cement producing plants, the wearing down of asbestos brake linings from automobiles, incineration of municipal refuse and sewage sludge, exhaust emission from automotive catalytic converters, and emissions from cooling towers that use chromium compounds as rust inhibitors. Chromium from these sources exists in a particulate form that may travel great distances from the point of emissions; wet and dry deposition account for the majority of removal from air. Most chromium released to surface water eventually adsorbs to particles and becomes deposited in bottom sediment, but small quantities may remain in the water in both soluble and insoluble forms. Chromium in aquatic media is unlikely to bioaccumulate significantly. Chromium in soil is present mainly as insoluble oxides that are unlikely to be mobile to any significant extent. Soluble forms may also be present, depending on the form of the chemical released, that may be quite mobile in soil.

Biotransfer factors for chromium are compiled below:

BCF (L/kg)	Bpr (unitless)	Bpv (unitless)	Bb (days/kg)	Bm (days/kg)
16[a]	4.5E-3[b]	7.5E-3[b]	5.5E-3[b]	1.5E-3[b]

ND = no data.
[a]U.S. Environmental Protection Agency (EPA), 1986, ***Superfund Public Health Evaluation Manual***, Office of Emergency and Remedial Response, Washington, DC, OSWER Directive 9285-4-1, EPA/540/1-86/060, PB87-183125, October.
[b]Baes, C.F., R.D. Sharp, A.L. Sjoreen, R.W. Shor, 1984, ***A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture***, Health and Safety Division, Oak Ridge National Laboratory, ORNL-5786, September.

A review of several studies suggests that 0.4 to 14.5 percent of orally administered chromium is absorbed by the GI tract of humans, but valence and chemical form and nutritional status (fed vs fasting) appear to influence efficiency of absorption (ATSDR, 1998). The toxicity studies on which the oral RfDs on IRIS for chromium (III) and chromium (VI) are based were performed with rats. The oral RfD for chromium (III) is based on dietary exposure; the oral RfD for chromium (VI) is based on drinking water exposure. Ingestion in both cases is expected to have been gradual throughout the day. Studies reviewed by ATSDR (1998) suggest that GI absorption in rats approximates 1 percent. A GAF of 0.01 is selected for this evaluation.

Quantitative data regarding dermal absorption of chromium were not located; therefore, the default ABS of 0.01 (OEPA, 1998) is adopted. The EPA (1992) empirically determined PC of 1E-3 cm/hour for sodium dichromate is selected for chromium compounds for this evaluation.

Chromium (III) is an essential nutrient involved in maintenance of normal fat, cholesterol and glucose metabolism (ATSDR, 1998). EPA (2001) verified an RfD of 1.5E+0 mg/kg-day for chronic oral exposure to chromium (III) by applying an uncertainty factor of 1000 to a NOEL of 1800 g/kg (1.468 mg/kg body weight/day) as an average total ingested dose in a dietary study in which rats were given 600 feedings of chromic oxide baked into bread. No other dose levels were tested. Confidence in the RfD is low. No target organ was identified for the toxicity of oral exposure to chromium (III).

EPA (2001) verified an RfD for chronic oral exposure to chromium (VI) of 3E-3 mg/kg-day based on a NOAEL of 25 mg/L (2.5 mg/kg body weight/day) in the drinking water of rats exposed for one year. An uncertainty factor of 900 was applied. Confidence in the oral RfD is low.

The data summarized by EPA (2001) are insufficient to identify a mechanism of toxicity or target organ(s) for chronic oral exposure to chromium (VI). Data from other sources, however, are sufficient to identify potential target organs. Goyer (1991) reported that renal tubular necrosis is the major effect in humans from ingestion of chromium compounds. The context, however, suggests that this effect is associated with acute exposure to high doses (e.g., accidental

or attempted suicide ingestion); therefore, the kidney may not be an acceptable candidate as a target organ for chronic oral exposure. Furthermore, a review of human and animal studies by EPA (1998a) did not implicate the kidney as a target organ for chronic oral exposure. EPA (1998a), however, reported GI effects in a cohort of 155 Chinese villagers who consumed water from a well located adjacent to a chromium alloy plant. Symptoms included oral ulcers, diarrhea, abdominal pain, indigestion and leukocytosis with a left shift. The dose rate of chromium (VI) was estimated at 0.57 mg/kg-day, nearly 200 times the oral RfD. It is likely that the GI symptoms reflect the irritant nature of chromium (VI).

EPA (1998a) also reviewed several reproductive studies. An early and inadequately conducted study reported no effects in rats fed a diet containing 0.125 percent K_2CrO_4. A diet containing 0.25 percent resulted in "subnormal condition" (including rough coat) and "subnormal" offspring; a diet containing 0.5 percent resulted in diarrhea and sterility. Assuming rats consume food equivalent to 5 percent of their body weight each day (EPA, 1980), dietary levels of 0.125, 0.25 and 0.5 percent correspond to chromium (VI) dose rates of 17, 33, and 67 mg/kg/day, respectively. A well controlled study reported slightly decreased erythrocyte size and hemoglobin content in rats and mice of either sex fed diets containing 400 ppm K_2CrO_4. The effects were interpreted as "suggestive of a potential bone marrow/erythroid response." The 400 ppm diet is equivalent to a chromium (VI) dose rates of 6.4 mg/kg-day in rats (EPA, 1998a) and approximately 11 mg/kg-day in mice, assuming that mice consume food equivalent to 10 percent of their body weight/day (EPA, 1980). In addition, cytoplasmic vacuolization of hepatocytes was observed in mice fed diets containing 50, 100 or 400 ppm K_2CrO_4, but it is not clear if either the incidence or intensity occurred in a dose-related manner. The 50 ppm diet, the lowest associated with hepatocellular vacuolization, is equivalent to a chromium (VI) intake rate of approximately 1.3 mg/kg-day. A subsequent study reported decreased erythrocyte hemoglobin content in female mice fed a diet containing 100 ppm K_2CrO_4, equivalent to a chromium (VI) dose rate of 6.0 mg/kg-day.

The GI signs reported in humans are clearly an indication of adverse effects; therefore, the GI tract is selected as a target organ. The mechanism of toxicity is assumed to be the irritation induced by tissue contact with chromium (VI). The slight hematologic changes observed in rats and mice and the hepatocellular vacuolization observed in mice do not appear to be sufficiently threatening to be considered adverse. They do, however, suggest that the bone marrow and the liver may be target organs as dose increases. Therefore, target organs selected for chronic oral exposure to chromium (VI) include the GI tract, bone marrow and liver.

The oral RfD for chromium (VI) is 500-fold lower than the oral RfD for chromium (III). No adverse effects, however, were observed for ingestion exposure to either chromium (VI) or chromium (III). The difference in the oral RfDs, therefore, arises solely from the available data, and does not reflect differences in the chronic toxicity of ingestion exposure to low levels of chromium (VI) and chromium (III). Furthermore, recent investigations reveal that ingested chromium (VI) is rapidly and virtually completely reduced to chromium (III), at least at concentrations less than or equal to 10 mg/L, in the acid milieu of the stomach before reaching the blood stream (Kerger et al., 1997; Finley et al., 1997). Given these considerations, the oral

RfD for chromium (III) of 1.5E+0 mg/kg-day will be used instead of the oral RfD for chromium (VI) of 3E-3 mg/kg-day, unless the analytical data identify the form(s) of chromium present.

Inhalation (occupational) exposure to chromium may induce respiratory symptoms, changes in lung function and irritation, erosion or perforation of the nasal septum, depending in part on the exposure level (EPA, 1993). No adverse effects were observed in workers exposed to 1E-3 mg/m^3 for 0.2 to 23.6 years (average 2.5 years). EPA (1998b, 2001) reviewed several human and animal studies, and determined that effects observed from inhalation exposure to chromium (VI) are not relevant to exposure to chromium (III). EPA (1998c) concluded that chromium (VI) is the only form of chromium of concern for inhalation exposure.

EPA (2001) developed separate chronic inhalation RfC values for human exposure to chromic acid mists and dissolved chromium (VI) aerosols, and for exposure to chromium (VI) particulates. A verified inhalation RfC of 8E-6 mg/m^3 for chromic acid mists and dissolved chromium (VI) aerosols is based on an adjusted LOAEL of 7.14E-4 mg/m^3 associated with atrophy of the nasal septum in occupationally exposed humans. An uncertainty factor of 90 was used. Confidence in the inhalation RfC is low. The upper respiratory tract is considered the target organ for inhalation exposure to chromic acid mists and dissolved chromium (VI) aerosols. The RfC is equivalent to an inhalation RfD of 2.3E-6 mg/kg-day.

Inhalation exposure to chromium (VI) particulates is associated with pneumocyte toxicity; i.e., with effects on the lungs themselves. EPA (2001) derived an RfC of 1E-4 mg/m^3 for chronic inhalation exposure to chromium (VI) particulates from an adjusted benchmark concentration of 3.4E-2 mg/m^3 associated with altered enzyme activity in bronchioalveolar lavage fluid from rats exposed to sodium dichromate dust intermittently for up to 90 days. An uncertainty factor of 300 was used. Confidence in the RfC is medium. The RfC is equivalent to a chronic inhalation RfD of 2.9E-5 mg/kg-day. The lung is considered to be the target organ for chronic inhalation exposure to chromium (VI) particulates.

EPA (1998c) notes that exposure to chromic acid mists and dissolved chromium (VI) aerosols is likely to be restricted to occupational settings and that most environmental exposures would involve exposure to chromium (VI) particulates. The inhalation RfC for chromium particulates of 1E-4 mg/m^3 equivalent to an inhalation RfD of 2.9E-5 mg/kg-day will be used in this evaluation.

Chromium (VI) is classified in cancer weight-of-evidence group A based on the consistent finding of lung cancer in epidemiologic studies of occupationally exposed workers in chromate production and the chrome pigment industry (EPA, 2001). There is no evidence that oral exposure to chromium (VI) induces cancer. An inhalation URF of 1.2E-2 per ug/m^3 equivalent to an inhalation SF of 4.2E+1 per mg/kg-day was based on increased risk of lung cancer deaths in chromate production workers.

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U.S. Environmental Protection Agency (EPA), 1998a, ***Toxicological Review of Hexavalent Chromium (CAS No. 18540-29-9) In Support of Summary Information on the Integrated Risk Information System (IRIS)***, August, on line.

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LEAD (7439-92-1)

Lead is a naturally occurring **metal** used in the manufacture of batteries, ammunition, and other metal products (ATSDR, 1997). Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	K_d (L/kg)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
207.2 (element)	NA	NA	ND	NA	NA	ND	9.9E+3[a]

NA = not applicable, ND = no data.
[a] Value for lead chloride as a typical lead salt (Agency for Toxic Substances and Disease Registry, [ATSDR], 1997, ***Update Toxicological Profile for Lead***, Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia, August.)

Lead may enter the environment during mining, ore processing, smelting, refining, use, recycling or disposal (ATSDR, 1997; HSDB, 2001). Emission from automobile exhaust was at one time the largest source of atmospheric lead. Natural sources are minor compared with anthropogenic sources. Generally the form of lead that enters the atmosphere is not known. However, metallic lead may be released from smelting and refining plants. Lead in air exists attached to small particles that may travel great distances before removal by wet or dry deposition. Lead deposited on or released to soil generally remains in the top 2 to 5 cm where it remains relatively immobile, although a small percentage may be present in soluble forms that are subject to leaching. Acid conditions increase the potential for leaching. Lead released to surface water tends to form salts that are only sparingly soluble. Deposition in bed sediment is the primary removal mechanism, although biomethylation may mobilize lead and return it to the water column. Soil and sediment act as sinks for anthropogenic releases of lead.

Lead in fish is localized in the mucus on the epidermis, the dermis, and scales so that the edible portions generally do not pose a hazard to human health (HSDB, 2001). Therefore, the BCF listed below probably overstates the danger to humans. Lead does not biomagnify through the aquatic or terrestrial food chains (ATSDR, 1997). Biotransfer factors for lead are compiled below:

BCF (L/kg)	Bpr (unitless)	Bpv (unitless)	Bb (days/kg)	Bm (days/kg)
49[a]	9.0E-3[b]	4.5E-2[b]	3.0E-4[b]	2.5E-4[b]

ND = no data.
[a]U.S. Environmental Protection Agency (EPA), 1986, ***Superfund Public Health Evaluation Manual***, Office of Emergency and Remedial Response, Washington, DC, OSWER Directive 9285-4-1, EPA/540/1-86/060, PB87-183125, October.
[b]Baes, C.F., R.D. Sharp, A.L. Sjoreen, R.W. Shor, 1984, ***A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture***, Health and Safety Division, Oak Ridge National Laboratory, ORNL-5786, September.

Studies in humans indicate that an average of 10 percent of ingested lead is absorbed, but estimates as high as 40 percent were obtained in some individuals (Tsuchiya, 1986). Nutritional factors have a marked effect on GI absorption efficiency. Children absorb ingested lead more efficiently than adults; absorption efficiencies up to 53 percent were recorded for children three months to eight years of age. Similar results were obtained for laboratory animals; absorption efficiencies of 5-10 percent were obtained for adults and greater than or equal to 50 percent were obtained for young animals. Data were not located regarding dermal uptake of lead from soil. For purposes of this evaluation, the GAF of 0.1 (EPA, 1993) and the default ABS of 0.01 (OEPA, 1998) were chosen. The EPA (1992) recommended PC for lead compounds of 4E-6 cm/hour based on empirical data with lead acetate is used in this evaluation.

The noncancer toxicity of lead to humans has been well characterized through decades of medical observation and scientific research (EPA, 2001). The principal effects of acute oral exposure are gastrointestinal colic with diffuse paroxysmal abdominal pain (probably due to vagal irritation), anemia, and, in severe cases, acute encephalopathy, particularly in children (Tsuchiya, 1986). The primary effects of long-term exposure are neurological and hematological. Limited occupational data indicate that long-term exposure to lead may induce kidney damage. The principal target organs of lead toxicity are the nervous system and the erythrocyte. Some of the effects on the blood, particularly changes in levels of certain blood enzymes, and subtle neurobehavioral changes in children, appear to occur at levels so low as to be considered non-threshold effects. In part for this reason the EPA (1990, 2001) considered inappropriate the derivation of an RfD for chronic oral exposure.

The Integrated Exposure, Uptake Biokinetic Model (IEUBK) Version 0.99D (EPA, 1994a) is generally used to evaluate lead in children, the most sensitive receptor under a residential exposure scenario. The IEUBK model integrates lead uptake from inhalation, drinking water, diet, soil and dust ingestion, and ingestion of incidental sources such as chips of lead-based paint, and estimates blood lead concentrations over the first seven years of a child's life. Generally, it is considered that childhood blood lead levels below 10 μg/dL reflect minimal likelihood of adverse effects from exposure to lead. Since it is plausible that children could be present under most residential site-use scenarios, it is appropriate to use the IEUBK to establish target levels for lead in soil for residential use. EPA (1994b) used the IEUBK to estimate a lead concentration of 400 mg/kg in bare soil to which children might be regularly exposed as the level below which further evaluation and exposure-reduction action is not necessary.

The IEUBK, however, does not address lead concentrations in media to which adults may be exposed in a non-residential site-use scenario. EPA (1996) adopted a model similar to the IEUBK to estimate blood lead concentrations in adult women in an occupational exposure scenario. The pregnant woman is assumed to be the member of the adult population most sensitive to exposure to lead because of the potential for developmental effects on the fetus. The EPA (1996) adult blood lead model estimates a lead concentration in soil of approximately 750 mg/kg (EPA, 2001) as the level below which the 95th percentile fetal blood lead concentration would not exceed 10 μg/dL.

EPA (2001) classified lead in cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate evidence in humans and sufficient animal evidence. The human data consist of several epidemiologic occupational studies that yield confusing results. All the studies lacked quantitative exposure date and failed to control for smoking and concomitant exposure to other possibly carcinogenic metals. Rat and mouse bioassays showed statistically significant increases in renal tumors following dietary and subcutaneous exposure to several soluble lead salts. Various lead compounds were observed to induce chromosomal alterations in vivo and in vitro, sister chromatid exchange in exposed workers and cell transformation in Syrian hamster embryo cells, to enhance simian adenovirus induction, and to alter molecular processes that regulate gene expression. EPA (2001) declined to estimate risk for oral exposure to lead because many factors (e.g., age, general health, nutritional status, existing body burden and duration of exposure) influence the bioavailability of ingested lead, introducing a great deal of uncertainty into any estimate of risk.

References for Lead

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U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

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MANGANESE (7439-96-5)

Manganese is a naturally occurring **metal** used in the manufacture of steel, and in other metallurgical processes, batteries, and various manganese-containing chemicals including matches, glass and porcelain, fireworks, varnishes, ceramics and fungicides (ATSDR, 1997; Keen and Leach, 1988). Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	K_d (L/kg)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
54.94 (element)	NA	NA	ND	NA	NA	ND	Note1[a]

NA = not applicable, ND = no data.
Note 1: Metallic manganese decomposes in the presence of water. Manganous chloride as a typical manganese salt: 7.23E+5.
[a]Agency for Toxic Substances and Disease Registry, (ATSDR), 1997, ***Update Toxicological Profile for Manganese***, Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia, September.

Anthropogenic sources of atmospheric manganese include metal processing, disposal of manganese-containing materials, resuspension of manganese-containing soil dust, fly ash emissions from incinerators, and the combustion of gasoline containing manganese anti-knock

ingredients (ATSDR, 1997; HSDB, 2001). Manganese may be released to water by discharge from industrial facilities or in leachate from landfills and soil. Landfill disposal of manganese-containing wastes is the predominant source of manganese release to soil.

Manganese exists in the air bound to particles; dry deposition is the primary removal mechanism, although wet deposition may also be significant (ATSDR, 1997). Manganese in fly ash exists as chlorides and oxides that are relatively soluble and mobile in the environment.

Manganese in water exists as any number of sparingly soluble salts that attach to suspended sediment (ATSDR, 1977). Sedimentation is the primary removal process. Soluble forms also exist, depending on pH of the water, and may be released from sediment. The extent of absorption to constituents of soil is highly variable. Low concentrations may occur in an irreversibly "fixed" form to clay, but higher concentrations often manifest considerable mobility.

Biotransfer factors for manganese are compiled below:

BCF (L/kg)	Bpr (unitless)	Bpv (unitless)	Bb (unitless)	Bm (unitless)
See below	5.0E-2[a]	2.5E-1[a]	4.0E-4[a]	3.5E-4[a]

[a]Baes, C.F., R.D. Sharp, A.L. Sjoreen, R.W. Shor, 1984, ***A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture***, Health and Safety Division, Oak Ridge National Laboratory, ORNL-5786, September.

Manganese in aquatic systems tends to bioaccumulate more strongly in plants and lower trophic levels, and less strongly in edible fish. ATSDR (1997) reports BCFs of 10,000 to 20, 000 L/kg for marine and freshwater plants, 2500 to 6300 L/kg for phytoplankton, 300 to 5500 L/kg for marine algae, 800 to 830 L/kg for intertidal mussels, and 100 to 600 L/kg reported for fin fish. The midpoint of the BCF range for intertidal mussels of 815 L/kg is used herein for shellfish. The midpoint of the BCF range for fin fish of 350 L/kg is used herein for fin fish.

Keen and Leach (1988) and ATSDR (1997) reviewed the empirical data and reported that approximately three to five percent of dietary manganese is absorbed, regardless of the amount present in the diet. EPA (2001) selected five percent as a rough approximation of the extent of GI absorption. This value (0.05) is selected as the GAF for manganese.

The ABS of 0.01 is an OEPA (1998) default for metals for which empirical data are lacking. The EPA (1992) default PC of 1E-3 cm/hour for metals is used in this evaluation.

Manganese is nutritionally required in humans for normal growth and health (EPA, 2001). Humans exposed to approximately 0.8 mg manganese/kg-day in drinking water (28 mg/L) exhibited lethargy, increased muscle tonus, tremor and mental disturbances. The elderly

appeared to be more sensitive than children. Oral treatment of laboratory rodents induces biochemical changes in the brain, but rodents do not exhibit the neurological signs exhibited by humans. Occupational exposure to high concentrations in air induce a generally typical spectrum of neurological effects, and increased incidence of pneumonia (ACGIH, 1991).

EPA (2001) derived an oral RfD for manganese of 1.4E-1 mg/kg-day from a NOAEL of 1.4E-1 mg/kg-day for neurologic effects from human dietary studies and an uncertainty factor of 1. Confidence in the RfD is medium. The oral RfD of 1.4E-1 mg/kg-day will be used for dietary items other than drinking water. EPA (2001) recommends that a modifying factor of 3 should be used to adjust the RfD for use when oral exposure involves drinking water and non-dietary ingestion. The oral RfD resulting from application of the modifying factor, 4.7E-2 mg/kg-day, will be used for drinking water and incidental ingestion of non-dietary items, and will serve as the basis for developing the dermal RfD. The CNS is the target organ for chronic oral exposure to manganese.

EPA (2001) presents a verified chronic inhalation RfC of 5E-5 mg/m^3 (equivalent to an inhalation RfD of 1.4E-5 mg/kg-day) based on a LOAEL for neurological effects in occupationally exposed humans and an uncertainty factor of 1000. Confidence in the RfC is medium. The CNS is the target organ for inhalation exposure to manganese.

EPA (2001) classified manganese in cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans). Quantitative cancer risk estimates are not derived for Group D chemicals.

References for Manganese

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U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

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ORGANIC CHEMICALS

ACETONE (67-64-1)

Acetone is a **VOC** used principally as an intermediate in chemical synthesis and as a solvent in a wide variety of applications (ATSDR, 1992; HSDB, 2001). Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
58.08	-0.22[a]	3.88E-5[b]	-0.24[b]	1.24E-1[b]	1.14E-5[b]	2.99E-1[a]	Miscible[b]

[a]U.S. Environmental Protection Agency (EPA), 1994, ***Technical Background Document for Soil Screening Guidance***, Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, Publication No. 9355.4-17, EPA540/R-94/106, PB95-963532, November.
[b]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.

Acetone's production and use as a solvent or extracting agent in many applications may result in its release to the environment through various waste streams (HSDB, 2001). Its use as a starting material or intermediate in the manufacture of chemical products may also lead to its release to the environment. Other important sources include vehicular exhaust, tobacco smoke, wood burning and pulping, refuse and polyethylene combustion, off-gassing from petroleum storage, and landfills (ATSDR, 1992). Acetone occurs naturally as a metabolic byproduct of plants and animals and is released into the atmosphere by animals, plants, and in volcanoes and forest fires. Municipal and industrial discharge to landfills may lead to soil contamination and, by leaching, groundwater contamination.

Acetone is expected to exist in the ambient atmosphere solely as a vapor, based on its high vapor pressure (ATSDR, 1992; HSDB, 2001). Vapor-phase acetone is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals and by photodecomposition by sunlight. Half-life estimates range from 22 to 80 days, suggesting the potential for long distance transport in the atmosphere. Acetone is expected to have very high mobility in soils based upon its low K_{oc}, indicating that the compound will leach readily to groundwater. Volatilization from moist or dry soil surfaces is expected to be a major removal process for acetone. Acetone is expected to biodegrade under aerobic and anaerobic conditions. Acetone in water is not expected to adsorb to suspended solids or sediment. Volatilization from water surfaces is expected to be

an important removal process. Acetone is not expected to participate significantly in food-chain pathways; therefore, biotransfer factors are not provided.

Acetone is "rapidly and almost completely absorbed" following oral administration to laboratory animals (ATSDR, 1992). Inhalation and urinary excretion studies with radiolabeled acetone orally administered to rats indicate GI absorption of at least 74 to 83 percent of the dose. This estimate does not account for C14 retained in the body. The upper end of the empirical range, 0.83, is selected as the GAF for this evaluation.

Application of neat compound to the skin of humans results in fairly rapid absorption, as reflected in increased blood concentrations of acetone. Data regarding dermal uptake from soil, however, were not located. The OEPA (1998) default ABS of 0.1 for organic chemicals is adopted for this evaluation. From the molecular weight and log K_{ow} provided above, a PC of 5.88E-4 cm/hour and a τ of 1.98E-1 hours are estimated by the method of EPA (1992).

Oral LD_{50} values for adult rats range from 5.8 to 10.7 g/kg, indicating that the acute toxicity of acetone is low (ATSDR, 1992). Prolonged oral exposure toxicity data are limited to a comprehensive 90-day gavage study in rats, in which 100 mg/kg-day was a NOEL and 500 mg/kg-day was a LOAEL associated with increased liver and kidney weight and tubular nephropathy (EPA, 2001). A verified RfD for chronic oral exposure of 1E-1 mg/kg-day was derived by applying an uncertainty factor of 1000 to the NOEL of 100 mg/kg-day. Confidence in the RfD is low. The liver and kidney are both considered to be target organs for prolonged oral exposure to acetone.

Studies of workers exposed to acetone reveal irritation of the ocular and respiratory tract mucosa, and, at high concentrations, central nervous system (CNS) effects (ACGIH, 1991). Rats exposed by inhalation to high concentrations exhibit narcosis and slight decreases in organ and body weight, compared with controls, but no clinicopathological or histopathological evidence of organ damage. The data, however, are insufficient for derivation of an inhalation RfC for acetone.

Acetone is classified as a cancer weight-of-evidence Group D compound (not classifiable as to carcinogenicity to humans), based on a lack of human or animal carcinogenicity data (EPA, 2001). Quantitative cancer potency estimates are not available for Group D chemicals.

References for Acetone

Agency for Toxic Substances and Disease Registry, (ATSDR), 1992, ***Toxicological Profile for Acetone***, Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia.

American Conference of Governmental Industrial Hygienists (ACGIH), 1991, ***Documentation of the Threshold Limit Values and Biological Exposure Indices***, Sixth Edition, ACGIH, Cincinnati, OH, pp. 10-11.

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U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

AMINODINITROTOLUENES (ADNT)

The ADNTs, 2-amino-4,6-dinitrotoluene (35572-78-2) and 4-amino-2,6-dinitrotoluene (1946-51-0) are **SVOCs** that are present in environmental media presumably as microbial reduction products of 2,4,6-trinitrotoluene (TNT) (ATSDR, 1993; HSDB, 2001). Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
Note[a]							
197.17	1.60[b]	4.57E-7[b]	3.20[b]	5.61E-2[c]	6.8E-6[d]	2.62E-7[b]	1.30E+2[b]

[a]The values provided herein (except for molecular weight and diffusivity in air) are for 2,4,6-trinitrotoluene, which is adopted as a surrogate based on structural similarity because data are not available for the ADNTs.
[b]Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[c]Calculated as described in Introduction to the Toxicity Profiles.
[d]Montgomery, J.H., 1996, ***Groundwater Chemicals Desk Reference, Second Edition***, Lewis Publishers, New York, pp. 1043-1044.

The ADNTs may be released to the environment as degradation products of TNT or similar compounds (HSDB, 2001).

Data regarding the environmental fate of the ADNTs were not located in the available literature. It is assumed, however, that the ADNTs may behave similarly to TNT because of the structural similarity of these compounds. Under this assumption, the ADNTs are likely to persist in soil; hydrolysis and volatilization are unlikely to be significant (HSDB, 2001). They are likely to occur almost entirely in the vapor phase in the atmosphere, and may be subject to direct photolysis and photochemical degradation.

The capability of microorganisms to biotransform TNT under aerobic conditions in water is well established; however, reduction rates under aerobic conditions are very slow (HSDB, 2001). It is

unclear the extent to which the ADNTs may be subject to further microbial reduction. Photolysis, which is the most important removal process for TNT in surface water, may also be significant for the ADNTs. Hydrolysis and volatilization are not significant for TNT and also are not expected to be significant for the ADNTs. The extent of adsorption to suspended or benthic sediment is expected to be moderate.

Generally TNT is not expected to bioconcentrate in aquatic systems or participate significantly in food chain pathways under normal environmental conditions (HSDB, 2001). It is assumed that the ADNTs will not bioconcentrate significantly and biotransfer factors are not estimated.

Data regarding the extent of GI absorption of the ADNTs were not located in the available literature. ATSDR (1993) summarized the results of toxicokinetic studies in which a single oral dose of radiolabeled TNT was given to rats, mice, dogs and rabbits, and radiolabel was quantified in various body compartments 24 hours after dosing. The appearance of red pigment in the urine of the rats and mice indicated that absorption is rapid. Urinary recovery accounted for approximately 60 percent of the dose in rats, mice and dogs, and 74 percent of the dose in rabbits. The extent of urinary recovery may serve as a conservative estimate of the extent of GI absorption. Assuming that the ADNTs may be absorbed to the same extent as TNT, the GAF for TNT of 0.6 is also adopted for the ADNTs.

Data regarding the extent of dermal uptake of the ADNTs from soil were not located. The OEPA (1998) default ABS of 0.1 for organic compounds is adopted for this evaluation. A PC of 1.07E-3 cm/hour and a τ of 2.12E+0 hours are estimated from the data provided above by the method of EPA (1992).

Data regarding the acute toxicity of oral exposure to the ADNTs are limited to LD_{50} values. Oral LD_{50} values in rats and mice are summarized below (EPA, 1993a):

Oral LD_{50} Values in Rats (mg/kg)		
Chemical	Males	Females
TNT	1010	820
2-Amino-4,6-dinitrotoluene	2240	1394
4-Amino-2,6-dinitrotoluene	1360	959
Oral LD_{50} Values in Mice (mg/kg)		
TNT	1009	1014
2-Amino-4,6-dinitrotoluene	1522	1722
4-Amino-2,6-dinitrotoluene	1342	1495

The data suggest that the acute toxicity of the ADNTs is not greater than TNT.

Data were not located regarding the chronic oral toxicity of the ADNTs. EPA (1993a) evaluated the toxicity of TNT and 2,4-dinitrotoluene, and concluded that TNT is the more appropriate surrogate for the ADNTs. A verified oral RfD for TNT of 5E-4 mg/kg-day is based on a LOAEL for liver effects of 0.5 mg/kg-day in a 26-week feeding study in dogs (EPA, 2001). An uncertainty factor of 1000 was applied to the LOAEL to derive the oral RfD. Data reviewed by ATSDR (1993) clearly identifies the erythrocyte (methemoglobinemia and hemolytic anemia) as another target for low-level exposure of mice, rats and dogs to TNT. Target organs for TNT; therefore, include the liver and erythrocyte. EPA (1993a) estimated a LOAEL for the ADNTs of 0.58 mg/kg-day by adjusting the TNT LOAEL of 0.5 mg/kg-day by the difference in molecular weight (MW) (i.e., MW of TNT divided by MW of ADNT). Application of an uncertainty factor of 10,000 yields a provisional RfD for chronic oral exposure of the ADNTs of 5.8E-5 mg/kg-day, which is rounded to 6E-5 mg/kg-day. The liver and erythrocyte are assumed to be the target organs for prolonged oral exposure to the ADNTs. Confidence in the provisional oral RfD is low.

Data are not available regarding the toxicity of inhalation exposure to the ADNTs; therefore, an inhalation RfC cannot be estimated.

EPA (1993b) classified the ADNTs in EPA cancer weight-of-evidence Group D, not classifiable as to carcinogenicity in humans, to reflect a total lack of human or animal data. Potency factors are unavailable.

EPA Region IX has developed preliminary remediation goals (PRG) that are useful for screening chemical concentrations in environmental media (EPA, 2000). The Region IX PRGs are based on standard default exposure assumptions, and are often adapted for the risk-based screening step for selecting chemicals of potential concern for human health risk assessments.

PRGs are available for nearly 600 chemicals for soil for residential use, for soil for industrial use, for ambient air, and for tap water (EPA, 2000). Exposure routes addressed by PRGs for soil include incidental ingestion, dermal contact, and inhalation of volatiles or dust; exposure routes addressed by PRGs for tap water include drinking water ingestion and inhalation of volatiles. EPA (2000) provides the methodology and standard exposure default assumptions with which to estimate PRGs for chemicals not included in the tables. Generally, PRGs are developed for both cancer risk and noncancer hazard, and the smaller of the two estimates is chosen. Data regarding the carcinogenicity of the ADNTs are not available; therefore, only PRGs based on noncancer effects are developed for these compounds

PRGs are not available for the ADNTs presumably because EPA-verified toxicity values are not available. The provisional oral RfD values described above, however, are applied to the equations developed by EPA (2000) to estimate PRGs for the ADNTs as follows:

Chemical	Provisional Oral RfD (mg/kg-day)	Inhalation RfD (mg/kg-day)[b]	Particle Emission Factor (m^3/kg)	PRG[a]		
				Residential Soil (mg/kg)	Industrial Soil (mg/kg)	Tap Water (µg/L)
2-Amino-4,6-dinitrotoluene or 4-Amino-2,6-dinitrotoluene	6E-5	6E-5	1.316E+9	3.666 (3.7E+0)	52.855 (5.3E+1)	2.190 (2.2E+0)

[a]Values in parentheses are rounded to two significant figures.
[b]EPA (2000) methodology adopts the oral RfD for inhalation exposure when an inhalation RfC is not available.

The PRGs are based on a target hazard index of 1.

References for Aminodinitrotoluenes

Agency for Toxic Substances and Disease Registry (ATSDR), 1993, ***Toxicological Profile for 2,4,6-Trinitrotoluene***, Draft for Public Comment, U.S. Department of Health and Human Services, May.

Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.

Ohio Environmental Protection Agency (OEPA), 1998, ***U.S. NASA Plum Brook, Erie County, Ohio LD#: 322-0552, Risk Assessment Work Plans***, letter from R.E. Nabors, Site Coordinator, to L.S. Ingram, Department of the Army, June 22.

U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 1993a, ***Risk Assessment Issue Paper for: Derivation of Oral RfD for 2-Amino-4,6-Dinitrotoluene (CASRN 35572-78-2) and 4-Amino-2,6-Dinitrotoluene (CASRN 19406-51-0) By Analogy to 2,4,6-Trinitrotoluene Systemic Toxicity Assessment***, National Center for Environmental Assessment, Cincinnati, OH, 23 February.

U.S. Environmental Protection Agency (EPA), 1993b, ***Risk Assessment Issue Paper for: Carcinogenicity of 2-Amino-4,6-Dinitrotoluene (CASRN 35572-78-2) and 4-Amino-2,6-Dinitrotoluene (CASRN 19406-51-0)*** , National Center for Environmental Assessment, Cincinnati, OH, 23 February.

U.S. Environmental Protection Agency (EPA), 2000, ***Region 9 Preliminary Remediation Goals (PRGs) 2000 Update***, online, 1 November.

U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

BENZENE (71-43-2)

Benzene is a naturally occurring **VOC**, present in low levels in many plants and animals, as well as a synthetic compound derived from petroleum (ATSDR, 1995). Benzene is widely used as a solvent and in the manufacturing of other organic compounds such as styrene, phenol, detergents, pesticides, explosives, polychlorinated biphenyls, flavors, perfumes, paints and coatings, nylon intermediates and photographic chemicals, among others. It is also used in food processing and leather tanning and occurs a component of gasoline. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
78.1	2.13[a]	5.56E-3[b]	1.77[b]	8.80E-2[b]	9.80E-6[b]	1.25E-1[c]	1.75E+3[b]

[a]U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[b]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[c]U.S. Environmental Protection Agency (EPA), 1994, ***Technical Background Document for Soil Screening Guidance***, Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, Publication No. 9355.4-17, EPA540/R-94/106, PB95-963532, November.

Benzene will enter the atmosphere primarily from fugitive emissions and exhaust connected with its use in gasoline (ATSDR, 1995; HSDB, 2001). Other important sources are emissions associated with its production and use as a solvent, as an industrial intermediate in the production of materials mentioned above, and coke oven blast furnaces and coke by-product recovery plants. In addition, there are discharges into water from industrial effluents and losses during spills. Sources of release to soil include land disposal of benzene-containing wastes, industrial discharge and leaks from underground storage tanks.

Benzene released to the atmosphere will exist almost exclusively in the vapor phase (ATSDR, 1995; HSDB, 2001). It is not subject to direct photolysis but it will react with photochemically produced hydroxyl radicals with a half-life of approximately 13 days. The reaction time in polluted atmospheres which contain nitrogen oxides or sulfur dioxide is accelerated with the half-life being reported as 4-6 hours. Products of photooxidation include phenol, nitrophenols, nitrobenzene, formic acid, and peroxyacetyl nitrate. Benzene is fairly soluble in water and is removed from the atmosphere in rain.

Benzene released to soil will be subject to rapid volatilization near the surface; that which does not evaporate will be highly to very highly mobile in the soil and may leach to groundwater (ATSDR, 1995; HSDB, 2001). Benzene may be subject to biodegradation under aerobic conditions. Microbial transformation proceeds through formation of cis-dihydrodiols to catechols, which lead to fission of the aromatic ring.

Benzene may be subject to photooxidation and biodegradation in shallow, aerobic groundwaters, but probably not significantly under deeper or anaerobic conditions (ATSDR, 1995; HSDB, 2001). Benzene released to surface water will be subject to rapid volatilization. It is not expected to sorb to sediment or to hydrolyze significantly. It may be subject to biodegradation, but this is unlikely to be a significant fate process in sediment.

Benzene is not expected to participate significantly in food-chain pathways (HSDB, 2001); therefore, biotransfer factors are not provided.

Benzene is efficiently absorbed from the GI tracts of laboratory animals (ATSDR, 1995). Absorption efficiency in the rat was estimated as at least 90 percent, based on urinary and pulmonary excretion of radioactivity following treatment with C14-labeled compound. An estimate of 97 percent absorption was reported for mice. The absorption efficiency of 1.0 reported by Jones and Owen (1989) and adopted by EPA (2001) is chosen as the GAF for this evaluation. Data were not located for dermal uptake of benzene from soil. The OEPA (1998) default ABS of 0.1 for organic chemicals is adopted for this evaluation. EPA (1992) provides a PC for benzene of 2.1E-2 cm/hour and a τ of 2.6E-1 hours.

Short-term exposure to benzene induces central nervous system (CNS) effects such as drowsiness, dizziness and headaches; long-term exposure may induce anemia (ATSDR, 1995). Oral dosing in animals induces hematopoietic and immune effects. EPA (1996) derived a provisional RfD for chronic oral exposure of 3E-3 mg/kg-day, based on a LOAEL of 8 mg/kg-day in a 28-day drinking water study in mice. The LOAEL was associated with minor hematologic effects (erythrocytopenia, leucopenia, lymphocytopenia), all associated with decreased cell counts, and increased response in several tests of immunologic activity. Depressed immunologic activity was observed at higher dose levels. An uncertainty factor of 3000 was applied to derive the provisional RfD from the LOAEL. Confidence in the RfD is medium. The hematopoietic mechanism and the immune system are the target organs for chronic oral exposure to benzene.

A provisional chronic inhalation RfC of 6E-3 mg/m^3 for benzene was based on a LOAEL of 32 mg/m^3 for depressed hematopoiesis in a study in which mice were exposed intermittently for up to 178 days (EPA, 1994). The exposure concentration was adjusted to an equivalent human continuous exposure concentration of 5.7 mg/m^3. Application of an uncertainty factor of 1000 to the LOAEL of 5.7 mg/m^3 yields the RfC of 6E-3. The RfC is equivalent to an RfD of 1.7E-3 mg/kg-day. Confidence in the inhalation RfC is low. The hematopoietic mechanism and the immune system are the target organs for chronic inhalation exposure to benzene.

Benzene is classified as an EPA cancer weight-of-evidence Group A chemical (known human carcinogen) based on epidemiologic studies and case studies that provide clear evidence of a causal association between exposure to benzene and acute nonlymphocytic leukemia, and that also provide supportive evidence for chronic nonlymphocytic leukemia and chronic lymphocytic leukemia (EPA, 2001). Other neoplastic conditions that are associated with an increased risk in humans are hematologic neoplasms, blood disorders such as preleukemia and aplastic anemia, Hodgkin's lymphoma, and myelodysplastic syndrome. Experimental animal data add to the weight of evidence that exposure to benzene increases the risk of cancer in multiple species at multiple organ sites (hematopoietic, oral and nasal, liver, forestomach, preputial gland, lung, ovary, and mammary gland).

A verified URF for inhalation exposure of 2.2E-6 to 7.8E-6 per $\mu g/m^3$ was based on the incidence of leukemia in humans exposed to benzene while employed in the Pliofilm industry (EPA, 2001). A low-dose linearity model utilizing maximum likelihood estimates was used to estimate the URF. The range reflects differences in the exposure assumptions estimated from the study. EPA (2001) concluded that neither any specific URF value nor either end of the range is more defensible than the other. Therefore, the upper end of the range, 7.8E-6 per $\mu g/m^3$, is conservatively selected for this evaluation. The URF of 7.8E-6 per $\mu g/m^3$ is equivalent to an inhalation SF of 2.7E-2 per mg/kg/day.

The occupational data that serve as the basis for the inhalation URF also serve as the basis for a verified oral SF for benzene (EPA, 2001). The inhalation URF range was mathematically converted to an equivalent oral SF range by applying standard inhalation rate and body weight assumptions, and by adjusting for route-specific differences in absorption. EPA (2001) assumed that GI absorption is 100 percent and that respiratory tract uptake is 50 percent. The oral SF range so derived is 1.5E-2 to 5.5E-2 per mg/kg-day. The upper end of the range, 5.5E-2 per mg/kg-day, is selected as the oral SF for this evaluation.

References for Benzene

Agency for Toxic Substances and Disease Registry, (ATSDR), 1995, ***Update Toxicological Profile for Benzene***, Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia, August.

Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.

Jones, TD. and BA Owen, 1989, ***Health Risks from Mixtures of Radionuclides and Chemicals in Drinking Water***, Oak Ridge National Laboratory, Oak Ridge, TN, ORNL-6533.

Ohio Environmental Protection Agency (OEPA), 1998, ***U.S. NASA Plum Brook, Erie County, Ohio LD#: 322-0552, Risk Assessment Work Plans***, letter from R.E. Nabors, Site Coordinator, to L.S. Ingram, Department of the Army, June 22.

U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 1994, ***Risk Assessment Issue Paper for: Derivation of a Provisional Chronic Inhalation RfC for Benzene (CASRN 71-43-2)***, National Center for Environmental Assessment, Cincinnati, OH, March 23.

U.S. Environmental Protection Agency (EPA), 1996, ***Risk Assessment Issue Paper for: Derivation of a Provisional Oral RfD for Benzene (CASRN 71-43-2)***, National Center for Environmental Assessment, Cincinnati, OH, July 2.

U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

2-BUTANONE (METHYL ETHYL KETONE, MEK) (78-93-3)

2-Butanone is a **VOC** used as the solvent of choice in a wide range of applications because of its low cost and excellent solvent properties (ATSDR, 1992; HSDB, 2001). It is used as a sterilizer of instruments and equipment in dental and medical applications. 2-Butanone is important in the polymerization of polystyrene, acrylonitrile-butadiene-styrene, and styrene-butadiene-rubber. An important application is its use in coatings where its volatilization to the atmosphere is intentional. 2-Butanone occurs naturally as a metabolic byproduct of plants and animals and is released into the atmosphere by volcanoes and forest fires (HSDB, 2001). Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
72.0	0.29[a]	4.7E-5[b]	1.50[b]	8.09E-2[c]	9.4E-6[d]	1.20E-1[b]	3.53E+5[d]

[a]U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[b]Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[c]U.S. Environmental Protection Agency (EPA), 1987, ***Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF) – Air Emission Models***, Office of Air Quality Planning and Standards, Research Triangle Park, EPA-450/3-87-06, December.
[d]Montgomery, J.H., 1996, ***Groundwater Chemicals Desk Reference, Second Edition***, Lewis Publishers, New York, pp. 147-149.

The production and use of 2-butanone as a chemical intermediate for organic synthesis, and as a solvent for coatings, resins, rubbers, plastics, pharmaceuticals, adhesives and rubber cements will result in its release to the environment via intentional volatilization and through various waste streams (ATSDR, 1992; HSDB, 2001). Automobile exhaust is another source. By far, the

greatest release is to the atmosphere. 2-Butanone occurs naturally as a metabolic byproduct of plants and animals and is released into the atmosphere by volcanoes and forest fires.

2-Butanone is expected to exist solely as a vapor in the ambient atmosphere because of its high vapor pressure (ATSDR, 1992; HSDB, 2001). It is subject to degradation in the atmosphere by reaction with photochemically-produced hydroxyl radicals and by photolysis by natural sunlight. It may also be subject to wet deposition. Long distance transport in the air is not expected. 2-Butanone is expected to have very high mobility in soils based upon relatively low K_{oc} values, indicating that the compound will readily leach to groundwater. Volatilization from moist and dry soil surfaces is expected to be a significant transport process. 2-Butanone is expected to biodegrade under aerobic and anaerobic conditions in soil. 2-Butanone in water is not expected to sorb to sediment or suspended organic matter. Volatilization from the surface is expected to be a significant removal process. 2-Butanone is not expected to participate significantly in food-chain pathways; therefore, biotransfer factors are not provided.

Quantitative data regarding the GI absorption of 2-butanone were not located in the available literature. ATSDR (1992) reviewed the available data and concluded that 2-butanone was "rapidly absorbed and eliminated." This conclusion is consistent with a GAF of 0.9, which is adopted for use in this evaluation. Data were not located regarding dermal uptake of 2-butanone from soil. The OEPA (1998) default ABS of 0.1 for organic chemicals is chosen for this evaluation. EPA (1992) provides a PC of 1.1E-3 cm/hour and a τ of 2.4E-1 hours.

The acute toxicity of oral exposure to 2-butanone is relatively low; LD_{50} values in rats and mice range from 2.7 to 5.5 g/kg (ATSDR, 1992, EPA, 2001). Acute toxicity is associated with tubular necrosis in the kidneys. Data were not located regarding chronic oral exposure to 2-butanone. However, evidence was located that about 96 percent of an administered dose of 2-butanol is metabolized to 2-butanone (EPA, 2001). Therefore, the results of a multigeneration study with 2-butanol is selected as the basis for a verified oral RfD. In this study, decreased fetal birth weight was observed in rats provided with drinking water containing 2-butanol. The NOAEL was 1771 mg/kg-day; the LOAEL was 3122 mg/kg-day. Application of an uncertainty factor of 3000 to the NOAEL yields the RfD of 6E-1 mg/kg-day. Confidence in the RfD is low. The fetus is the target organ for oral exposure to 2-butanone.

Acute inhalation exposure of humans to 2-butanone results in irritation of the exposed mucosal membranes and the respiratory tract (ATSDR, 1992). Prolonged inhalation exposure of humans to low levels is not associated with effects on any organ system. A verified RfC of 1E+0 mg/m^3 for 2-butanone is derived from a human equivalent concentration NOAEL of 2978 mg/m^3 in a developmental toxicity study in mice (EPA, 2001). An uncertainty factor of 3000 was applied. Confidence in the RfC is low. The human equivalent concentration LOAEL, 8906 mg/m^3, was associated with decreased fetal birth weight. The fetus is the target organ for inhalation exposure to 2-butanone. The RfC is equivalent to an inhalation RfD of 2.9E-1 mg/kg-day.

2-Butanone is classified as a cancer weight-of-evidence Group D chemical (not classifiable as to carcinogenicity to humans) because of a lack of human data and inadequate animal data (EPA, 2001). Potency factors are not developed for Group D chemicals.

References for 2-Butanone

Agency for Toxic Substances and Disease Registry, (ATSDR), 1992, ***Toxicological Profile for 2-Butanone***, U.S. Public Health Service, Atlanta, Georgia.

Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.

Ohio Environmental Protection Agency (OEPA), 1998, ***U.S. NASA Plum Brook, Erie County, Ohio LD#: 322-0552, Risk Assessment Work Plans***, letter from R.E. Nabors, Site Coordinator, to L.S. Ingram, Department of the Army, June 22.

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U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

CARBON DISULFIDE

Carbon disulfide is a **VOC** widely used as a solvent in the manufacture of rayon, rubber and rubber products, resins, coatings and adhesives, soil disinfectants, electronic vacuum tubes, and in the metal industry (ATSDR, 1994; HSDB, 2001). It is used as a solvent for phosphorus, sulfur, selenium, bromine, iodine, fats and resins. Food-related uses include preservation of fresh fruit, in adhesive compositions for food packaging, and as a solvent in the extraction of growth inhibitors. It is also used in optical glass, paints, enamels, varnishes, paint removers, tallow, explosives, rocket fuel, putty preservatives and rubber cement. It has been used formerly as an insecticide for fumigation of nursery stock and for soil treatment against insects and nematodes, and as a fumigant in airtight storage warehouses, airtight flat storages, bins, grain elevators, railroad boxcars, shipholds, barges and cereal mills. It is used as in intermediate in the manufacture of an extremely wide range of organic chemicals, particularly those containing nitrogen or sulfur. Carbon disulfide also occurs as a natural organic compound. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
80.0	2.24[a]	3.02E-2[b]	1.66[b]	1.04E-1[b]	1.00E-5[b]	4.47E-1[c]	Miscible[b]

[a]U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[b]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[c]U.S. Environmental Protection Agency (EPA), 1994, ***Technical Background Document for Soil Screening Guidance***, Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, Publication No. 9355.4-17, EPA540/R-94/106, PB95-963532, November.

Carbon disulfide is a naturally occurring organic chemical (ATSDR, 1994; HSDB, 2001). The ocean appears to be a major global source of atmospheric carbon disulfide. Current data suggest that coastal areas and other areas of high biological productivity emit more carbon disulfide than the open ocean. The microbial reduction of sulfates in soil produces carbon disulfide. Other natural sources include volcanic emissions and marshlands. Some higher plants are known to emit carbon disulfide; the principle source is tree roots.

Carbon disulfide's production and use as a solvent and a chemical intermediate may result in its release to the environment through various waste streams, or during transportation and use (ATSDR, 1994; HSDB, 2001). Anthropogenic releases are primarily and predominantly to the atmosphere. Carbon disulfide will exist solely as a vapor in the ambient atmosphere because of its high vapor pressure. Vapor-phase carbon disulfide will degrade in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 5.5 days. Carbon disulfide has a weak UV adsorption band, suggesting the potential for direct photolysis.

Carbon disulfide released to soil is expected to exhibit moderate to high mobility based upon its estimated K_{oc} (ATSDR, 1994; HSDB, 2001). Volatilization from moist or dry soil surfaces is expected to occur. Hydrolysis and biodegradation may occur, but empirical data regarding the significance of these phenomena are not available. Some adsorption to suspended solids and sediment in the water column is expected based upon the estimated K_{oc}. Volatilization from water surfaces is expected to be a rapid and very significant removal process based upon the Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 2.6 hours and 3.5 days, respectively. Hydrolysis and biodegradation in water are not expected to be significant because of the rapidity of volatilization.

Carbon disulfide is not expected to bioconcentrate or accumulate in aquatic organisms (ATSDR, 1994) or, presumably, in terrestrial organisms. Therefore, biotransfer factors are not estimated for the compound.

Carbon disulfide is readily absorbed by the respiratory tract, from the GI tract and through the skin (HSDB, 2001). Administration of a single gavage dose of radiolabeled carbon disulfide to rats was followed by recovery of 63 percent of radioactivity in exhaled air within 4 hours (ATSDR, 1994). ATSDR (1994) concluded that "a large fraction of orally administered carbon disulfide is absorbed by rats." Lacking other quantitative GI absorption data, the GAF of 0.9 is judged to be consistent with the qualitative description and is adopted for this evaluation as appropriately reflecting the empirical data.

Experimental data suggests that dermal uptake of aqueous solutions of carbon disulfide by humans is substantial (ATSDR, 1994), but data regarding dermal uptake from soil were not located. Lacking empirical data, the OEPA (1998) default ABS of 0.1 for organic chemicals is adopted for this evaluation. EPA (1992) provides a PC of 2.4E-2 cm/hour and a τ of 2.7E-1 hours, which are used in this evaluation.

The acute oral toxicity of carbon disulfide is low; an LD_{50} of 3 g/kg is reported for mice (ATSDR, 1994). Acute oral treatment with high doses leads to hind leg paralysis in laboratory animals. A verified RfD of 1E-1 mg/kg-day for chronic oral exposure is based on a NOEL of 11 mg/kg-day for developmental effects in rabbit fetuses (EPA, 2001). The rabbit dams were exposed by inhalation for 34 weeks before mating and through the gestation period. The NOEL was estimated from the experimental concentration (62.3 mg/m^3) expanded to continuous exposure, and adjusted to account for inhalation-to-oral extrapolation. An uncertainty factor of 100 was applied. Confidence in the RfD is medium. The fetus is the target for the toxicity of prolonged oral exposure to carbon disulfide.

Occupational exposure to carbon disulfide has been linked to increased mortality, but concurrent exposure to other chemicals cannot be ruled out (ATSDR, 1994). Nonetheless, vascular atherosclerotic changes, possibly related to increased serum cholesterol levels, are known to be a primary effect of long-term exposure of humans. The nervous system is also a primary target in humans, which experience a wide range of central and peripheral nerve effects, as well as behavioral effects. A verified inhalation RfC of 7E-1 mg/m^3 is derived from a benchmark concentration of 55.1 mg/m^3 for peripheral nervous system dysfunction in an occupational study (EPA, 2000). An uncertainty factor of 30 was applied. The RfC is equivalent to an inhalation RfD of 2.0E-1. Confidence in the RfC is medium. The nervous system is the target organ for inhalation exposure in humans.

Data regarding the potential carcinogenicity of carbon disulfide were not located.

<u>References for Carbon Disulfide</u>

Agency for Toxic Substances and Disease Registry, (ATSDR), 1994, ***Update Toxicological Profile for Carbon Disulfide*** , Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia.

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U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

DINITROBENZENES

The dinitrobenzenes are **SVOCs** that exist in three isomeric forms: 1,2-dinitrobenzene (ortho- or o- dinitrobenzene), 1,3-dinitrobenzene (meta- or m-dinitrobenzene), and 1,4-dinitrobenzene (para- or p-dinitrobenzene). The dinitrobenzenes are used in organic synthesis, particularly in the manufacture of dyes, in explosives, and as a camphor substitute in the production of celluloids (ACGIH, 1991; Lewis, 1997; HSDB, 2001). 1,3-Dinitrobenzene, the isomer most frequently encountered in the environment, is also used in the preparation of m-phenylenediamine, in the detection of 17-ketosteroids, in the production of aminocresols and other aromatic amines (HSDB, 2001). Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
1,2-Dinitrobenzene (528-29-0)							
168.11	1.58[a]	2.33E-6[b,c]	1.47[b]	6.24E-2[d]	7.9E-6[a]	5.13E-6[b,c]	1.32E+2[a]
1,3-Dinitrobenzene (99-65-0)							
168.11	1.49[a]	2.33E-6[b]	1.39[b]	6.24E-2[d]	7.9E-6[a]	5.13E-6[b]	5.0E+2[a]
1,-4-Dinitrobenzene (100-25-4)							
168.11	1.48[a]	4.79E-7[a]	1.36[b]	6.24E-2[d]	7.9E-6[a]	2.96E-7[a]	8.0E+1[a]

ND = no data.
[a]Montgomery, J.H., 1996, ***Groundwater Chemicals Desk Reference, Second Edition***, Lewis Publishers, New York, pp. 421-426.
[b]Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[c]Value for 1,3-dinitrobenzene used as a surrogate (HSDB, 2001).
[d]Calculated as described in Introduction to Toxicity Profiles.

Environmental release of the dinitrobenzenes may result from their use as intermediates in organic syntheses, during the production of 2,4,6-trinitrotoluene (TNT) and in the production of dyes (ATSDR, 1993; HSDB, 2001). Its presence in environmental media at former ordnance works may reflect its formation as a degradation product of TNT. Dinitrobenzene released to

soil may adsorb to clay but adsorption to soils that are not predominantly clay is expected to be weak. Therefore, the dinitrobenzenes are expected to be mobile or highly mobile in soil and may readily leach to groundwater. Volatilization from soil surfaces may occur but this expected to be slow. Reduction to aromatic amines may occur under anaerobic conditions.

The dinitrobenzenes are expected to exist largely in the vapor phase in air (ATSDR, 1993). These chemicals are expected to react with photochemically generated hydroxyl radicals with an estimated half-life of 14.15 hours (HSDB, 2001). Direct photolysis in the atmosphere may also occur, but a rate cannot be estimated.

The dinitrobenzenes may biodegrade in water and volatilization may occur, but these removal processes are expected to be slow (HSDB, 2001). Direct photolysis may also occur, but rate data are not available. Information was not located regarding partitioning to sediment.

The low log K_{ow} values for these compounds suggest that bioconcentration or bioaccumulation are unlikely to be important (HSDB, 2001). Empirical data for 1,4-dinitrobenzene supports this assumption; therefore, biotransfer factors are not estimated for the dinitrobenzenes.

Of the three dinitrobenzenes, toxicokinetic data are available only for the 1,3-isomer. Rabbits and rats treated with a single oral dose of radiolabeled 1,3-dinitrobenzene excreted 63 to 80 percent of the radioactivity in the urine within 48 hours (ATSDR, 1993). This observation suggests that absorption from the GI tract is rapid; the 63 to 80 percent urinary excretion can be adopted as a minimal estimate of the extent of absorption. A GAF of 0.8 is adopted for all the dinitrobenzenes for the purposes of this evaluation.

The dinitrobenzenes are readily absorbed through the skin, either as solid, liquid, or vapor. However, data regarding the extent of dermal uptake from soil were not located. In the absence of empirical data, the OEPA (1998) default ABS of 0.1 for organic chemicals is selected for this evaluation. From the MW and log K_{ow} values given above and the EPA (1992) method, PC and τ values are estimated as follows:

Chemical	PC (cm/hour)	τ (hours)
1,2-Dinitrobenzene	2.38E-3	9.28E-1
1,3-Dinitrobenzene	2.05E-3	9.28E-1
1,4-Dinitrobenzene	2.02E-3	9.28E-1

Acute oral LD_{50} values are limited to an LD_{50} of 83 mg/kg for 1,3-dinitrobenzene in rats (ATSDR, 1993; Montgomery, 1997; HSDB, 2001). Acute exposure is associated with cyanosis resulting from the oxidation of hemoglobin to methemoglobin in the erythrocytes. Methemoglobin is unable to release oxygen to the tissues resulting in tissue anoxia. Doses approximately one-half the oral LD_{50} are also associated with testicular degeneration and impaired fertility.

Prolonged oral exposure of laboratory animals to 1,3-dinitrobenzene is associated with reduced blood hemoglobin concentrations,equivocal evidence of neurotoxicity and testicular degeneration (ATSDR, 1993; EPA, 2001). EPA (2001) verified an RfD for chronic oral exposure of 1E-4 mg/kg-day based on a NOAEL of 3 ppm (0.4 mg/kg-day) in a 16-week drinking water study in male and female rats. An uncertainty factor of 3000 was applied to the NOAEL to derive the RfD. The LOAEL, 8 ppm, was associated with increased spleen weights, an indication of accelerated erythrocyte turnover. The concentration of 20 ppm was associated with decreased body weight gain in females, decreased hemoglobin concentrations and testicular atrophy in males, and splenic enlargement and hemosiderin deposits in both rats of either sex. The erythrocyte and testis are considered the target organs for prolonged oral exposure to 1,3-dinitrobenzene. Effects on the spleen are judged to be secondary to erythrocyte destruction. Confidence in the verified oral RfD is low.

Data regarding the toxicity of prolonged oral exposure to the other dinitrobenzene isomers was not located in the available literature. EPA (1997) derived a provisional oral RfD of 4E-4 mg/kg-day for 1,2-dinitrobenzene and 1,4-dinitrobenzene by analogy to 1,3-dinitrobenzene. Although it is not entirely clear, it appears that EPA (1997) applied an uncertainty factor of 1000 to the NOAEL of 0.4 mg/kg-day for 1,3-dinitrobenzene described above. Justification for using an uncertainty factor of 1000, rather than 3000, was not presented; however, HSDB (2001) notes that the meta isomer is the most important toxicologically, especially as a methemoglobin former.

Human (occupational) exposure to the dinitrobenzenes is associated with effects on the liver, aplastic anemia, yellowing of the skin, cornea and conjunctiva, and several overt symptoms including headache, burning pain and paresthesias in the feet, ankles, hands, and forearms, cyanosis, visual disturbance, central scotomas, bad taste, burning mouth, and dry throat (ACGIH, 1991; HSDB, 2001). The skin, conjunctiva, and ocular fundus may show bluish discoloration from formation of methemoglobin. Vision has been affected in numerous cases of occupational exposure. The vision fields have been slightly contracted, and visual acuity has been much reduced, with central scotomas, particularly for red and green. Partial optic atrophy has been observed in some cases. Dermal exposure is thought to play a major role in the effects associated with occupational exposure (ACGIH, 1991). The data are insufficient for development of an inhalation RfC for any of the dinitrobenzenes.

EPA (2001) classifies 1,3-dinitrobenzene in weight-of-evidence cancer Group D – not classifiable as to human carcinogenicity because of a lack of relevant human or animal data. Data regarding the carcinogenicity of 1,2- or 1,4-dinitrobenzene were not located, and these isomers were not assigned to a cancer weight-of-evidence group. URFs and SFs are not available for any of the dinitrobenzenes.

<u>References for Dinitrobenzene</u>

Agency for Toxic Substances and Disease Registry (ATSDR), 1993, ***Toxicological Profile for 1,3-Dinitrobenzene and 1,3,5-Trinitrobenzene***, Draft for Public Comment, U.S. Department of Health and Human Services, May.

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U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, Washington, DC, 9200.6-303(97-1), EPA 540/R-97-036, PB97-921199.

U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

DINITROTOLUENE (DNT)

The dinitrotoluenes are **SVOCs** that are used predominantly as intermediates in the production of polyurethanes, dyes, rubber, plastics, toluidines, toluenediisocyanates, flexible and rigid foams, surface coatings, and other organic chemicals (ATSDR, 1997; HSDB, 2001). Another use is as a gelatinizing and waterproofing agent in the production of explosives. The dinitrotoluenes may appear in environmental media as break down products of 2,4,6-trinitrotoluene. Isomers include 2,3-, 2,4-, 2,5-, 2,6-, 3,4- and 3,5-dinitrotoluene. The compounds of most interest in environmental exposure include 2,4- and 2,6-dinitrotoluene. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
2,3-Dinitrotoluene (602-01-7)							
182.1	2.0[a]	ND	2.46[a]	5.91E-2[b]	6.85E-6[b]	ND	ND
2,4-Dinitrotoluene (121-14-2)							
182.1	1.98[c]	9.27E-8[d]	1.98[d]	2.03E-1[d]	7.06E-6[d]	2.29E-7[e]	2.70E+2[d]
2,5-Dinitrotoluene (619-15-8)							
182.1	2.0[a]	ND	2.46[a]	5.91E-2[b]	6.85E-6[b]	ND	ND
2,6-Dinitrotoluene (606-20-2)							
182.1	1.72[c]	7.46E-7[d]	1.84[d]	3.27E-2[d]	7.26E-6[d]	7.47E-7[e]	1.82E+2[d]

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
3,4-Dinitrotoluene (610-39-9)							
182.1	2.0[a]	ND	2.46[a]	5.91E-2[b]	6.85E-6[b]	ND	ND
3,5-Dinitrotoluene (618-85-9)							
182.1	2.28[a]	3.97E-7[a]	2.62[a]	5.91E-2[b]	6.85E-6[b]	ND	ND

ND = no data.
[a]Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[b]Calculated as described in Introduction to the Toxicity Profiles.
[c]U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[d]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[e]U.S. Environmental Protection Agency (EPA), 1994, ***Technical Background Document for Soil Screening Guidance***, Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, Publication No. 9355.4-17, EPA540/R-94/106, PB95-963532, November.

The physical properties of 2,4-dinitrotoluene can be used for the dinitrotoluene mixture (25321-14-6) and for isomers where chemical-specific data are not available.

The dinitrotoluenes are released into the environment in waste streams from processes in which they are manufactured or used (ATSDR, 1997; HSDB, 2001). Dinitrotoluenes released to soil are expected to have moderate mobility and may leach to groundwater. No information on biodegradation in soil was found; however, biodegradation may be an important fate process in soil based on the observation that all dinitrotoluene isomers are metabolized in surface water to which yeast extract was added. Dinitrotoluenes are not expected to hydrolyze in soils.

Dinitrotoluenes released to water, may sorb weakly to moderately to sediment (ATSDR, 1997; HSDB, 2001). Evaporation from water is not expected to be an important transport process. Biodegradation may be an important fate process in water, as indicated above. Dinitrotoluenes in water may be susceptible to photolysis, based on the behavior of 2,4- and 2-6-dinitrotoluene, which had photolytic half-lives ranging from 2.7 to 43 hours (2,4-dinitrotoluene) or 0.2 hours (2,6-dinitrotoluene) in various water environments.

Dinitrotoluenes released to the atmosphere may be susceptible to direct and indirect photolysis (ATSDR, 1997; HSDB, 2001). The estimated vapor phase half-life in the atmosphere is 8 hours. Data regarding the partitioning of the dinitrotoluenes between particulate and vapor phase were not located.

Bioconcentration of the dinitrotoluenes is expected to be negligible (ATSDR, 1997); therefore, biotransfer factors are not estimated.

The rapid disappearance of radioactivity from the small intestine of rats following oral administration of radiolabeled 2,4- or 2,6-dinitrotoluene suggests that absorption from the GI tract is rapid and essentially complete (ATSDR, 1997; EPA, 1992a). Species differences in the excretion of dinitrotoluene, however, confound quantification of the extent of GI absorption. Fecal excretion and the GI tract (tissue + contents) accounted for 9.2 to 17.3 percent of the dose of radioactivity 24 hours after administration of radiolabeled 2,4-dinitrotoluene to rats, rabbits, dogs and monkeys, and 83.1 to 85 percent in mice in the same study (EPA, 1992a). Biliary excretion appears to have been more important in mice than in the other species tested. Somewhat different results were obtained in another study. The elimination and metabolism of a single oral 100 mg/kg dose of 2,4-dinitrotoluene (2,4-dinitrotoluene) in A/J mice was examined (HSDB, 2001). Four hours after oral administration, only 28.5% of the dose was excreted in the urine, which increased to 66% after 8 hours. Elimination via the feces was minimal (< 2.1% of the dose), suggesting that GI absorption is virtually complete. Together, the data for the 2,4-isomer suggest that the GI absorption of the dinitrotoluenes is virtually complete; the GAF of 1 is adopted for the dinitrotoluenes for this evaluation.

Data regarding dermal uptake from soil were not located; therefore, the OEPA (1998) default ABS of 0.1 for organic chemicals is chosen. PC and τ values are estimated as follows:

Chemical	PC (cm/hour)	τ (hours)
2,3-Dinitrotoluene	3.88E-3[a]	1.13E+0[a]
2,4-Dinitrotoluene	3.8E-3[b]	1.1E+0[b]
2,5-Dinitrotoluene	3.88E-3[a]	1.13E+0[a]
2,6-Dinitrotoluene	2.5E-3[b]	1.1E+0[b]
3,4-Dinitrotoluene	3.88E-3[a]	1.13E+0[a]
3,5-Dinitrotoluene	6.14E-3[a]	1.13E+0[a]

[a]Estimated from the data compiled above by the method of EPA (1992b).
[b]Taken from EPA (1992b).

Data regarding the toxicity of oral exposure to 2,3-dinitrotoluene is limited to the statement that the 2,4-, 2,6- and 3,4-isomers are more toxic to rats than the 2,3- or 2,5-isomers.

Acute oral exposure to 2,4-dinitrotoluene induces methemoglobinemia; dogs appear to be more sensitive than rats, which are more sensitive than mice (ATSDR, 1997). Oral LD_{50} values include 270 mg/kg for rats and 1630 mg/kg for mice. Subchronic or chronic oral exposure to 2,4-dinitrotoluene in rats is associated with depressed weight gain, reticulocytosis and splenic

hemosiderosis, and decreased spermatogenesis (HSDB, 2001). Some rats had widespread and stiff-legged gaits and demyelination in the cerebellum and brain stem. A verified chronic oral RfD of 2E-3 mg/kg-day for 2,4-dinitrotoluene is based on neurotoxicity, hematologic effects and biliary tract hyperplasia in dogs given capsules containing the test substance for 2 years (EPA, 2001). Progressive paralysis, accompanied by degenerative lesions in the central nervous system, were observed in dogs treated with 10 mg/kg-day. Hematologic effects, including methemoglobinemia and its sequelae, were observed in dogs treated with 1.5 mg/kg-day, which is the LOAEL for this study. No adverse effects were observed in dogs treated with 0.2 mg/kg-day. Application of an uncertainty factor of 100 to the NOAEL of 0.2 mg/kg-day yields an RfD of 2E-3 mg/kg-day. Confidence in the RfD is high. The CNS, erythrocyte and liver appear to be the target organs for prolonged oral exposure, at least in dogs.

HSDB (2001) reports oral LD_{50} values for 2,5-dinitrotoluene of 707 mg/kg for rats and 1231 mg/kg for mice. Data regarding the effects of prolonged oral exposure were not reported.

Oral LD_{50} values for 2,6-dinitrotoluene for rats (665 mg/kg) and mice (714 mg/kg) are similar (ATSDR, 1997; HSDB, 2001). Dogs, however, appear to be more sensitive than rodents in subchronic studies. A provisional oral RfD of 1E-3 mg/kg-day for 2,6-dinitrotoluene is based on a 13-week dietary study with 2,6-dinitrotoluene in dogs (EPA, 1997). The NOAEL in this study was 4 mg/kg-day, somewhat higher than the LOAEL for 2,4-dinitrotoluene. An uncertainty factor of 3000 was applied. The CNS, erythrocyte, liver and kidney appear to be the target organs for prolonged oral exposure to 2,6-dinitrotoluene. The oral data in dogs suggest that the 2,6-isomer is somewhat less toxic than the 2,4-isomer for prolonged oral exposure. The oral RfD for the 2,6-isomer, however, is less than the oral RfD for the 2,4-isomer. This apparent contradiction is an artifact of the lesser quality data base for 2,6-dinitrotoluene and, consequently, the higher uncertainty factor used to derive the RfD for the 2,6-isomer.

The verified oral RfD of 2E-3 mg/kg-day for 2,4-dinitrotoluene can be used for the other dinitrotoluene isomers for which data are not available.

Occupational studies indicate that acute exposure to dinitrotoluene causes methemoglobinemia, which produces headache, irritability, dizziness, weakness, nausea, vomiting, dyspnea, drowsiness, unconsciousness and, in extreme cases, death (ACGIH, 1991). Occupational exposure may lead to increased risk of ischemic heart disease, possibly arising from decreased oxygen-carrying capacity of the blood. The data are insufficient to develop inhalation RfCs for the dinitrotoluene isomers.

EPA (2001) classified the 2,4-/2,6-dinitrotoluene mixture in EPA cancer weight-of-evidence Group B2 (probably human carcinogen) on the basis of multiple tumor types in male and female rats and renal tumors in male mice in several dietary studies. Occupational data provide no evidence of carcinogenicity, but the studies reviewed lack the power to reveal small differences in cancer risk (ACGIH, 1991). EPA (2001) verified an oral SF of 6.8E-1 per mg/kg-day for exposure to the 2,4-/2,6-dinitrotoluene mixture based on an increased incidence of a variety of tumors in female rats. The test material contained about 98 percent 2,4-dinitrotoluene and 2 percent 2,6-dinitrotoluene. Other studies suggest that much of the carcinogenicity of the mixture

is the result of the 2,6-isomer. The B2 classification and the oral SF of 6.8E-1 per mg/kg-day are used in this evaluation for both 2,4- and 2,6-dinitrotoluene and the 2,4-/2,6-dinitrotoluene mixture. The data are insufficient for development of potency factors for inhalation exposure.

References for Dinitrotoluenes

Agency for Toxic Substances and Disease Registry, (ATSDR), 1997, ***Update Toxicological Profile for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene***, Draft for Public Comment, U.S. Department of Health and Human Services, Atlanta, GA, September.

American Conference of Governmental Industrial Hygienists (ACGIH), 1991, ***Documentation of the Threshold Limit Values and Biological Exposure Indices***, Sixth Edition, ACGIH, Cincinnati, OH, pp. 506-511.

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U.S. Environmental Protection Agency (EPA), 1992a, ***Health Advisory for 2,4- and 2,6-Dinitrotoluene (DNT)***, Health and Ecological Criteria Division, Office of Water, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1992b, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, 9200.6-303 (97-1), EPA-540-R-97-036, NTIS No. PB97-921199.

U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

ETHYLBENZENE (100-41-4)

Ethylbenzene, also known as phenylethane, is a **VOC** used primarily as a precursor in the manufacture of styrene (ATSDR, 1997). It is also used as a solvent and diluent, and as an intermediate in the manufacturing of cellulose acetate, rubber and other organic compounds (ATSDR, 1997; HSDB, 2001). It is also a constituent of asphalt, naphtha, and automotive and aviation fuels. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
106.2	3.15[a]	7.88E-3[b]	2.56[b]	7.50E-2[b]	7.80E-6[b]	1.26E-2[c]	1.69E+2[b]

[a]U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[b]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[c]U.S. Environmental Protection Agency (EPA), 1994, ***Technical Background Document for Soil Screening Guidance***, Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, Publication No. 9355.4-17, EPA540/R-94/106, PB95-963532, November.

Ethylbenzene enters the atmosphere primarily from fugitive emissions and exhaust connected with its use in gasoline (ATSDR, 1997; HSDB, 2001). More localized sources to the air and other environmental media include emissions, waste water and spills from its production and industrial use, leaking underground storage tanks, land disposal of ethylbenzene-containing waste, and municipal and hazardous waste combustion.

Ethylbenzene exists in the air in the vapor phase (ATSDR, 1997; HSDB, 2001). It is somewhat water soluble and may be removed by precipitation; however, it is likely to reenter the air by volatilization. Ethylbenzene is transformed in air by various oxidative processes to yield ethylphenols, benzaldehyde, acetophenone, and m- and p-nitroethylbenzene. Reaction with photolytically generated hydroxyl radicals is probably the most significant reaction, with half-lives estimated to range from 0.5 to 2 days, suggesting that ethylbenzene will not persist in the air.

Ethylbenzene released to soil will volatilize rapidly (ATSDR, 1997; HSDB, 2001). That which infiltrates is expected to be quite mobile in soil and may leach to groundwater, because sorption to soil particles is not sufficiently strong to retard movement. Biodegradation in soil in aerobic conditions involves oxidation of the ethyl side chain, ring hydroxylation and ring cleavage and may be a significant source of removal. Anaerobic degradation is expected to be insignificant.

Ethylbenzene released to surface water will volatilize rapidly to air (ATSDR, 1997; HSDB, 2001). Biodegradation in aerobic conditions will significantly reducing water-borne concentrations. Photolysis and hydrolysis are unlikely to be significant. Ethylbenzene partitions weakly to sediment.

Ethylbenzene is not expected to participate significantly in food-chain pathways (ATSDR, 1997; HSDB, 2001); therefore, biotransfer factors are not provided.

Recovery of ethylbenzene metabolites in the urine of rabbits ranged from 72 to 92 percent of a single oral dose (ATSDR, 1997). Recovery was 84 percent in a similar study in rats. ATSDR (1997) concluded that ethylbenzene is quickly and effectively absorbed from the GI tract. The

EPA (no date) recommended GAF of 0.92 is adopted for this evaluation. Data were not located for dermal uptake of ethylbenzene from soil. The OEPA (1998) default ABS of 0.1 for organic chemicals is used in this assessment. EPA (1992) provides a PC for ethylbenzene of 7.4E-2 cm/hour and a τ of 3.9E-1 hour.

An oral LD_{50} in rats of 5.46 g/kg (HSDB, 2001) suggests that the acute toxicity of ingested ethylbenzene is low. Subchronic to chronic oral exposure of laboratory animals to ethylbenzene induces mild liver and kidney lesions (EPA, 2001). EPA (2001) presents a verified chronic oral RfD for ethylbenzene of 1E-1 mg/kg-day based on a NOEL for liver and kidney lesions in female rats of 136 mg/kg-day in a subchronic gavage study. The LOAEL in this study was 408 mg/kg-day. An uncertainty factor of 1000 was applied to the NOEL to derive the RfD. Confidence in the oral RfD is low. The liver and kidney are the target organs for prolonged oral exposure to ethylbenzene.

Acute inhalation exposure induces irritation of the mucous membranes in animals and humans (ACGIH, 1991). Prolonged inhalation exposure induces liver enzymes and elevated liver and kidney weights; prolonged exposure to relatively high levels is associated with mild histopathological lesions of the liver, kidney and testes (ACGIH, 1991; EPA, 2001). EPA (2001) considers that the effects on the liver at the lower exposure concentrations are adaptative rather than adverse. EPA (2001) presents a verified chronic inhalation RfC of 1 mg/m^3 derived from a human equivalent adjusted NOAEL of 434 mg/m^3 in studies on developmental effects in rats and rabbits. An uncertainty factor of 300 was used. The human equivalent adjusted LOAEL of 4340 mg/m^3 was associated with equivocal evidence of reduced fetal size in rabbits, an increased incidence of extra ribs in rats fetuses, and increased liver, kidney and spleen weights in the rats. The inhalation RfC is equivalent to 2.9E-1 mg/kg-day. Confidence in the RfC is low.

The key study from which the inhalation RfC is derived does not clearly identify target organ(s) for inhalation exposure to ethylbenzene. The entire inhalation exposure data base, however, suggests that the liver, kidneys and fetus may be the most significant target organs for prolonged inhalation exposure.

Ethylbenzene is classified as a cancer weight-of-evidence Group D compound (not classifiable as carcinogenicity to humans) (EPA, 2001) based on an absence of human or animal cancer studies. Cancer potency factors are not estimated for Group D compounds.

References for Ethylbenzene

Agency for Toxic Substances and Disease Registry, (ATSDR), 1997, ***Update Toxicological Profile for Ethylbenzene***, Draft for Public Comment, U.S. Department of Health and Human Services, Atlanta, GA, September.

American Conference of Governmental Industrial Hygienists (ACGIH), 1991, ***Documentation of the Threshold Limit Values and Biological Exposure Indices***, Sixth Edition, Cincinnati, OH, p. 581-584.

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METHYLENE CHLORIDE (DICHLOROMETHANE) (75-09-2)

Methylene chloride is a **VOC** used predominantly as a paint remover and as a solvent and flammability depressant in aerosol products such as coatings, paint removers, hair sprays, room deodorants, herbicides and insecticides (ATSDR, 1998; HSDB, 2001). Methylene chloride is also used in the foam blowing of polyurethanes, in metal degreasing, stripping and degreasing of electronic components, in resin production, photographic film splicing, adhesive production, and other solvent, cleaning and thinning applications. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
84.9	1.25[a]	2.19E-3[b]	1.07[b]	1.01E-1[b]	1.17E-5[b]	4.87E-1[c]	1.30E+4[b]

[a]U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[b]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[c]U.S. Environmental Protection Agency (EPA), 1994, ***Technical Background Document for Soil Screening Guidance***, Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, Publication No. 9355.4-17, EPA540/R-94/106, PB95-963532, November.

Methylene chloride is highly volatile; therefore, most environmental releases are to the atmosphere (ATSDR, 1998; HSDB, 2001). Large amounts (greater than a hundred million pounds) are released each year during its industrial and consumer use. Methylene chloride exists solely as a vapor in air and may travel long distances before removal. It is subject to reaction

with photochemically generated hydroxyl radicals with a half-life of a few months. It is also subject to direct photolysis.

Methylene chloride released to soil will be highly mobile and will infiltrate or leach to greater depths or to groundwater (ATSDR, 1998; HSDB, 2001). Some will also volatilize. Methylene chloride released to water will be rapidly lost primarily by volatilization. It is not expected to partition to sediment. It is subject to hydrolysis and biodegradation, but these processes are less significant than volatilization. Methylene chloride is not expected to participate significantly in food-chain pathways; therefore, biotransfer factors are not provided.

Animal studies indicate that methylene chloride is readily absorbed from the GI tract (ATSDR, 1998). The GAF of 1.0 suggested by Jones and Owen (1989) is consistent with the ATSDR (1998) summary and is used in this evaluation. Data were not located for dermal uptake of methylene chloride from soil. The OEPA (1998) default ABS of 0.1 for organic chemicals is used in this assessment. EPA (1992) provides a PC of 4.5E-3 cm/hour and a τ of 2.9E-1 hours for methylene chloride.

Oral LD_{50} values in rats and mice approximate 2 g/kg, suggesting that the acute toxicity of methylene chloride is moderate (ATSDR, 1998). Prolonged oral exposure induces liver lesions in laboratory animals. EPA (2001) verified an RfD for chronic oral exposure of 6E-2 mg/kg-day by applying an uncertainty factor of 100 to a NOAEL of about 6 mg/kg-day in a two-year drinking water study in rats. The LOAEL, about 55 mg/kg-day, was associated with histopathologic lesions in the liver. Confidence in the RfD is medium. In addition, metabolism of the dihalogenated methanes is known to yield carbon monoxide, which combines with hemoglobin to form carboxyhemoglobin in the erythrocytes. Carboxyhemoglobin is incapable of transporting oxygen to the tissues. This mechanism of toxicity should also be considered when combining hazard indices for simultaneous exposure to multiple chemicals. Therefore, the liver and erythrocyte are the target organs for prolonged oral exposure to methylene chloride.

Occupational exposure to high concentrations of methylene chloride is associated with a wide variety of neurological dysfunctions and elevated blood levels of carbon monoxide (a metabolite of methylene chloride) and carboxyhemoglobin (ACGIH, 1991). Chronic inhalation exposure of laboratory animals induces liver effects. EPA (1997) derived a provisional inhalation RfC of 3E+0 mg/m^3 based on a NOAEL of 695 mg/m^3 in a two-year intermittent exposure study in rats. An uncertainty factor of 100 was used. Higher levels were associated with unspecified effects on the liver. The RfC is equivalent to an inhalation RfD of 8.6E-1 mg/kg-day. In addition, metabolism of the dihalogenated methanes is known to yield carbon monoxide, which combines with hemoglobin to form carboxyhemoglobin in the erythrocytes. Carboxyhemoglobin is incapable of transporting oxygen to the tissues. This mechanism of toxicity should also be considered when combining hazard indices for simultaneous exposure to multiple chemicals. Therefore, the liver and erythrocyte are considered the target organs for prolonged inhalation exposure to methylene chloride.

Methylene chloride is classified in EPA cancer weight-of-evidence Group B2 (probable human carcinogen), based on inadequate human data and sufficient evidence of carcinogenicity in

animals (EPA, 2001). Animal inhalation studies showed increased incidence of hepatocellular neoplasms and alveolar/bronchiolar neoplasms in male and female mice, mammary tumors in rats of either sex, salivary gland sarcomas in male rats and leukemia in female rats. Oral studies were inconclusive. An oral SF of 7.5E-3 per mg/kg-day was based on the incidence of liver tumors in two inhalation studies in mice. An inhalation URF of 4.7E-7 per ug/m^3 was based on the incidence of liver and lung tumors in one inhalation study. The inhalation URF is equivalent to 1.6E-3 per mg/kg-day.

References for Methylene Chloride

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Ohio Environmental Protection Agency (OEPA), 1998, ***U.S. NASA Plum Brook, Erie County, Ohio LD#: 322-0552, Risk Assessment Work Plans***, letter from R.E. Nabors, Site Coordinator, to L.S. Ingram, Department of the Army, June 22.

U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, 9200.6-303 (97-1), EPA-540-R-97-036, NTIS No. PB97-921199.

U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

NITROTOLUENES

The nitrotoluenes consist of three isomers: o-nitrotoluene (1-methyl-2-nitrobenzene), m-nitrotoluene (1-methyl-3-nitrobenzene) and p-nitrotoluene (1-methyl-4-nitrobenzene) (Lewis, 1997). All behave in the environment as **VOCs**. The nitrotoluenes, especially the o- and p-isomers, are used as intermediates in the synthesis of other organic chemicals, particularly toluidine, tolidine, fuchsine and other synthetic dyes, explosives, petrochemicals, pesticides,

pharmaceuticals, rubber and agricultural chemicals, dyes and pigments (HSDB, 2001). Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
o-Nitrotoluene (88-72-2)							
137.13	2.30[a]	5.65E-5[a]	2.44[a]	7.14E-2[b]	8.0E-6[c]	1.32E-4[a]	6.52E+2[a]
m-Nitrotoluene (99-08-1)							
137.13	2.45[a]	7.5E-5[a]	2.16[a]	7.14E-2[b]	8.0E-6[c]	2.72E-4[a]	4.98E+2[c]
p-Nitrotoluene (99-99-0)							
137.13	2.37[a]	5.0E-5[a]	2.49[a]	7.14E-2[b]	8.1E-6[c]	1.32E-4[a]	4.42E+2[c]

ND = no data.
[a]Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[b]Calculated as described in Introduction to the Toxicity Profiles.
[c]Montgomery, J.H., 1996, ***Groundwater Chemicals Desk Reference, Second Edition***, Lewis Publishers, New York, pp. 790-795.

The major sources of release of nitrotoluenes to the environment appear to be production and use facilities and plants which produce these compounds as by-products (HSDB, 2001). These include manufacturers of dinitrotoluene, trinitrotoluene, intermediates for rubber and agricultural chemicals, and various azo and sulfur dye intermediates. Nitrotoluenes may also enter the environment from the disposal of waste products which contain these compounds.

Nitrotoluenes released to soil are expected to be resistant to oxidation and chemical hydrolysis (HSDB, 2001). The nitrotoluenes are reported to biodegrade under anaerobic conditions to form toluidine; one study under aerobic conditions in a mixed culture of soil microorganisms resulted in persistence exceeding 64 days. The nitrotoluenes are expected to be moderately to highly mobile in soil and volatilize slowly from dry soil surfaces.

Nitrotoluenes released to water are expected to be susceptible to photolysis, volatilization and aerobic biodegradation, provided suitable acclimation has been achieved (HSDB, 2001). Oxidation, chemical hydrolysis, adsorption to suspended solids and sediments and bioaccumulation in aquatic organisms are not expected to be significant fate processes. Insufficient data were available to indicate the significance of anaerobic biodegradation as a possible removal mechanism.

Nitrotoluenes released to the atmosphere are expected to exist entirely in the vapor phase (HSDB, 2001). The dominant removal mechanism is expected to be reaction with photochemically generated hydroxyl radicals (estimated half-life 8 hours) and direct photolysis. Photoproducts include 2-methyl-6-nitrophenol and 2-methyl-4-nitrophenol (o-isomer), 3-methyl-

4-nitrophenol, 3-methyl-2-nitrophenol and 3-methyl-6-nitrophenol (m-isomer) and 2-methyl-6-nitrophenol (p-isomer).

The nitrotoluenes are not expected to bioconcentrate or bioaccumulate significantly (HSDB, 2001); therefore, biotransfer factors are not estimated.

Data regarding the extent of GI absorption of the nitrotoluenes were not located in the available literature. Toxicokinetic studies suggest that the dinitrotoluenes are nearly completely absorbed (ATSDR, 1997; EPA, 1992a), and that nitrobenzene is at least 84 percent absorbed from the GI tract (ATSDR, 1990; HSDB, 2001). Lacking empirical data, an estimated GAF of 0.9 is selected for these chemicals. Data regarding the dermal uptake of the nitrotoluenes from soil were not located in the available literature; the OEPA (1998) default ABS of 0.1 for organic chemicals is selected for this evaluation. PC and τ values for the nitrotoluenes are estimated by the EPA (1992b) method as follows:

Chemical	PC (cm/hour)	τ (hours)
o-Nitrotoluene	1.19E-2	6.0E-1
m-Nitrotoluene	1.52E-2	6.0E-1

Chemical	PC (cm/hour)	τ (hours)
p-Nitrotoluene	1.34E-2	6.0E-1

Data regarding the acute toxicity of oral exposure to the nitrotoluenes were not located. A 13-week dietary study with the three nitrotoluene isomers in rats and mice indicated that effects were most notable with o-nitrotoluene (ACGIH, 1991). Effects included biochemical evidence of altered liver function, and splenic and renal lesions. EPA (1997) derived a provisional RfD of 1E-2 mg/kg-day for chronic oral exposure to all three nitrotoluene isomers from data for o-nitrotoluene. In the key study, rats were treated by gavage for 6 months. The LOAEL was 200 mg/kg-day associated with lesions in the spleen. An uncertainty factor of 10,000 was applied to the LOAEL. The derivation of the provisional RfD is unclear, because dividing the LOAEL of 200 mg/kg-day by an uncertainty factor of 10,000 would be expected to yield an RfD of 2E-2 mg/kg-day, not 1E-2 mg/kg-day as reported by EPA (1997). The liver, spleen and kidney are considered to be the target organs for chronic oral exposure to the nitrotoluenes.

Data regarding the toxicity of inhalation exposure to the nitrotoluenes were not located in the available literature. The data are inadequate for developing an inhalation RfC.

Data regarding the potential carcinogenicity of the nitrotoluenes were not located in the available literature. The nitrotoluenes are not assigned to a cancer weight-of-evidence group and URFs and SFs are not available.

References for Nitrotoluenes

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U.S. Environmental Protection Agency (EPA), 1992a, ***Health Advisory for 2,4- and 2,6-Dinitrotoluene (DNT)***, Health and Ecological Criteria Division, Office of Water, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1992b, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 1997, ***Health Effects Assessment Summary Tables, FY 1997 Update***, Office of Solid Waste and Emergency Response, Washington, DC, 9200.6-303(97-1), EPA 540/R-97-036, PB97-921199.

POLYAROMATIC HYDROCARBONS (PAHs)

The PAHs regularly observed in environmental media include acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, carbazole, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene and pyrene. All are **SVOCs** except acenaphthene, acenaphthylene and naphthalene, which are **VOCs**. PAHs are the products of incomplete combustion of fossil fuels or other organic matter, hence include both natural and anthropogenic sources (ATSDR, 1993a). Naphthalene is used in the synthesis of phthalic anhydride, the insecticide carbaryl, leather tanning agents and surface active agents, and is a component of diesel and other fuel oils (ATSDR, 1993b). Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
Acenaphthene (83-32-9)							
154.21	3.98[a]	1.46E-4[b]	3.66[a]	6.61E-2[c]	6.4E-6[b]	2.9E-11[a]	I[a]
Acenaphthylene (208-96-8)							
154.2	4.07[a]	1.45E-3[a]	1.40[a]	6.61E-2[c]	6.6E-6[b]	3.82E-5[a]	3.93+0[a]
Anthracene (120-12-7)							
178.2	4.45[a]	8.6E-5[a]	4.15[a]	3.24E-2[d]	7.74E-6[d]	2.2E-8[a]	I[a]
Benzo(a)anthracene (56-55-3)							
228.29	5.66[e]	1E-6[a]	5.30[a]	5.10E-2[d]	9.00E-6[d]	2.9E-11[a]	I[a]
Benzo(a)pyrene (50-32-8)							
252.3	6.16[e]	4.9E-7[a]	6.74[a]	4.30E-2[d]	9.00E-6[d]	7.4E-12[a]	3.8E-3[a]
Benzo(b)fluoranthene (205-99-2)							
252.3	6.12[e]	1.22E-5[a]	5.74[a]	2.26E-2[d]	5.56E-6[d]	1.3E-9[a]	I[a]

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
Benzo(k)fluoranthene. (207-08-9)							
252.3	6.06[a]	3.87E-5[a]	5.74[a]	2.26E-2[d]	5.56E-6[d]	6.6E-10[a]	I[a]
Benzo(g,h,i)perylene (191-24-2)							
276.34	6.50[a]	1.44E-7[a]	6.20[a]	4.48E-2[c]	4.9E-6[b]	1.4E-13[a]	2.6E-3[a]
Carbazole (86-74-8)							
167.20	3.57[f]	1.53E-8[d]	3.53[d]	3.90E-2[d]	7.03E-6[d]	3.50E-7[f]	7.48E+0[d]
Chrysene (218-01-9)							
228.3	5.66[e]	1.05E-6[a]	5.30[a]	2.48E-2[d]	6.21E-6[d]	8.3E-12[a]	I[a]
Dibenzo(a,h)anthracene (53-70-3)							
278.35	6.84[e]	7.3E-8[a]	6.52[a]	2.02E-2[d]	5.18E-6[d]	8.2E-12[a]	5E-7[a]
Fluoranthene (206-44-0)							
202.26	4.95[e]	6.5E-6[a]	4.58[a]	3.02E-2[d]	6.35E-6[d]	6.6E-9[a]	2.06E-1[d]
Fluorene (86-73-7)							
166.2	4.18[a]	6.4E-5[a]	3.86[a]	3.63E-2[d]	7.88E-6[d]	9.3E-7[a]	1.83E+0[a]
Indeno(1,2,3-cd)pyrene (193-39-5)							
276.3	6.58[e]	6.95E-8[a]	6.20[a]	1.90E-2[d]	5.66E-6[d]	1.3E-12[a]	6.23E-2[a]
Naphthalene (91-20-3)							
128.19	3.30[e]	4.6E-4[f]	2.97[g]	5.90E-2[d]	7.50E-6[d]	1.14E-4[g]	3.17E+1[g]
Phenanthrene (85-01-8)							
178.2	4.57[e]	2.26E-4[a]	4.15[a]	6.00E-2[c]	5.9E-6[b]	1.3E-6[a]	I[a]
Pyrene (129-00-0)							
202.3	4.88[a]	5.1E-6[a]	4.58[a]	2.72E-2[d]	7.24E-6[d]	3.3E-9[a]	I[a]

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)

I = virtually insoluble in water.
[a]Agency for Toxic Substances and Disease Registry (ATSDR), 1993a, ***Update Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs)***, Draft for Public Comment, U.S. Department of Health and Human Services, Atlanta, Georgia, October.
[b]Montgomery, J.H., 1996, ***Groundwater Chemicals Desk Reference, Second Edition***, Lewis Publishers, New York.
[c]Calculated as described in Introduction to the Toxicity Profiles.
[d]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[e]U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[f]U.S. Environmental Protection Agency (EPA), 1994, ***Technical Background Document for Soil Screening Guidance***, Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, Publication No. 9355.4-17, EPA540/R-94/106, PB95-963532, November.
[g] Agency for Toxic Substances and Disease Registry, (ATSDR), 1993b, ***Update Toxicological Profile for Naphthalene***, Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia, October.

The PAHs are ubiquitous products of incomplete combustion; natural sources include volcanoes and forest fires (ATSDR, 1993a, b; HSDB, 2001). There is some evidence for biosynthesis by plants, bacteria and algae. Some of the PAHs occur naturally in fossil fuels. Anthropogenic releases to the environment, primarily to the atmosphere, greatly outweigh the natural sources and include any processes that involve incomplete combustion of fossil fuels and organic matter, including wood-burning for home heat (the predominant source), cigarette smoke, internal combustion engine exhaust, and fuel oil emissions. Other sources include various crude oils, fresh and used motor oils, gasolines, charcoal-broiled foods, processed foods, various oils, margarine, butter and fats, fruits, vegetables, and cereals, roasted coffee and tea. Naphthalene is released during its manufacture and processes that involve its use (e.g., vaporization from moth balls).

PAHs exist in the atmosphere as both gases and particulates, the proportion depending on the vapor pressure of the individual chemical (ATSDR, 1993a, b; HSDB, 2001). They may travel short or long distances before removal from the air. Wet and dry deposition accounts for removal of the particulates. Vapor forms are subject to chemical oxidation processes in the air.

The predominant sources of PAHs in surface water are deposition from the atmosphere, industrial and sewage effluent and oil spills (ATSDR, 1993a, b). Runoff and erosion can also contribute PAHs to surface water bodies. Depending on solubility and vapor pressure, volatilization is a significant fate process for some of the PAHs in surface water. Adsorption to sediment is another significant removal process. Low molecular weight PAHs (acenaphthene,

acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene) are subject to chemical degradation and biodegradation. Naphthalene is relatively water soluble and may remain largely in solution. PAHs in sediment may biodegrade or accumulate in living organisms.

Deposition from the atmosphere is the principal source of PAHs in soil (ATSDR, 1993a, b). Other sources include industrial activities, disposal of sewage sludge, and leaching from coal storage sites. Most PAHs sorb to soil constituents because of their low solubility and high affinity for organic matter. Volatilization is an important removal process for the low molecular weight compounds. Some of the low molecular weight compounds, particularly naphthalene, may leach fairly rapidly to groundwater.

The propensity for the PAHs to participate in food-chain pathways is chemical specific, depending largely on the tendency for biodegradation or biotransformation (ATSDR, 1993a, b; HSDB, 2001). Biotransfer factors for the PAHs are compiled below:

BCF (L/kg)	Bpr[a,b] (unitless)	Bpv[a,b] (unitless)	Bb[a] (days/kg)	Bm[a] (days/kg)
Acenaphthene				
400[c]	1.94E-1	1.94E-1	2.40E-4	7.59E-5
Acenaphthylene				
272[d]	1.72E-1	1.72E-1	2.95E-4	9.33E-5
Anthracene				
675[c]	1.04E-1	1.04E-1	7.08E-4	2.24E-4
Benzo(a)anthracene				
350[e]	2.07E-2	2.07E-2	1.15E-2	3.63E-3
Benzo(a)pyrene				
480[e]	1.07E-2	1.07E-2	3.63E-2	1.15E-2
Benzo(b)fluoranthene				
2800[f]	1.12E-2	1.12E-2	3.31E-2	1.05E-2
Benzo(k)fluoranthene				
17,100[a]	1.22E-2	1.22E-2	2.88E-2	9.12E-3
Benzo(g,h,i)perylene				
14,000[a]	6.78E-3	6.78E-3	7.94E-2	2.51E-2
Carbazole				

BCF (L/kg)	Bpr[a,b] (unitless)	Bpv[a,b] (unitless)	Bb[a] (days/kg)	Bm[a] (days/kg)
500[g]	3.35E-1	3.35E-1	9.33E-5	2.95E-5
Chrysene				
700[f]	2.07E-2	2.07E-2	1.15E-2	3.63E-3
Dibenzo(a,h)anthracene				
10[e]	4.31E-3	4.31E-3	1.74E-1	5.50E-2
Fluoranthene				
4000[h]	5.33E-2	5.33E-2	2.24E-3	7.08E-4
Fluorene				
1500[h]	1.49E-1	1.49E-1	3.80E-4	1.20E-4
Indeno(1,2,3-cd)pyrene				
12,800[a]	6.09E-3	6.09E-3	9.55E-2	3.02E-2
Naphthalene				
ND[i]	4.79E-1	4.79E-1	5.01E-5	1.58E-5
Phenanthrene				
2250[a]	8.84E-2	8.84E-2	9.33E-4	2.95E-4
Pyrene				
785[h]	5.85E-2	5.85E-2	1.91E-3	6.03E-4

BCF (L/kg)	Bpr[a,b] (unitless)	Bpv[a,b] (unitless)	Bb[a] (days/kg)	Bm[a] (days/kg)

ND = no data.
[a]Calculated as described in Introduction to the Toxicity Profiles.
[b]The methodology for estimating biotransfer of organic chemicals to plants does not differentiate vegetative and reproductive portions.
[c]Empirical data in Bluegill Sunfish (Lepomis macrochirus) from Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[d]Estimated value from Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[e]Empirical data in golden ide fish (Leuciscus idus melanotus) from Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[f]Empirical data in clams from Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[g]Empirical data in guppies (Poecilia reticulata), from Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[h]Empirical data in fathead minnows, from Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[i]It is assumed that VOCs are labile and do not bioconcentrate significantly.

The BCFs for acenaphthylene, indeno(1,2,3-cd)pyrene, naphthalene and phenanthrene may be overestimated because the PAHs are generally readily metabolized by vertebrates, reducing the potential for bioconcentration (ATSDR, 1993a; HSDB, 2001). The BCF for benzo(b)fluoranthene is probably overestimated for fin fish because fin fish biotransform and eliminate PAHs much more readily than invertebrates.

Jones and Owen (1989) report that the GI absorption of naphthalene is 100 percent. The GAF of 1.0 from the Jones and Owen (1989) compilation is adopted for naphthalene. Toxicokinetic studies of several PAHs summarized by ATSDR (1993a) provide limited quantitative information regarding the extent of GI absorption. Qualitatively, these studies indicate that absorption is incomplete. A study of benzo(a)pyrene in rats suggested that GI absorption ranges from 38 to 58 percent. The GAF of 0.5 (Jones and Owen, 1989), near the midpoint of the range from the rat study, is selected for benzo(a)pyrene and the other PAHs for which quantitative data are not available. A study in rats reported absorption efficiency for anthracene ranging from 53 to 74 percent; 0.7 is selected as the GAF for this evaluation. GI absorption of pyrene, chrysene and dibenzo(a,h)anthracene is described as high; a GAF of 0.8 is assumed for these compounds.

Anecdotal evidence from using cloth diapers stored in contact with naphthalene indicates that naphthalene is absorbed by the skin, but quantitative data are not available (ATSDR, 1993b). Empirical data with pure compound dissolved or suspended in vehicles suggest that dermal uptake of benzo(a)pyrene is extensive (ATSDR, 1993a), but data regarding absorption from soil were not located. Lacking suitable empirical data for dermal uptake from soil, the OEPA (1998) Region IV default ABS of 0.1 for organic chemicals is chosen for the PAHs. PC and τ values are estimated as follows:

Chemical	PC (cm/hour)	τ (hours)
Acenaphthene	1.46E-1[a]	7.63E-1[a]
Acenaphthylene	1.69E-1[a]	7.63E-1[a]
Anthracene	2.25E-1[a]	1.07E+0[a]
Benzo(a)anthracene	8.1E-1[b]	2.23E+0[b]
Benzo(a)pyrene	1.2E+0[b]	2.9E+0[b]
Benzo(b)fluoranthene	1.2E+0[b]	3.03E+0[b]
Benzo(k)fluoranthene	1.11E+0[a]	3.03E+0[a]
Benzo(g,h,i)perylene	1.62E+0[a]	4.24E+0[a]
Carbazole	6.23E-2[a]	9.16E-1[a]
Chrysene	8.1E-1[b]	2.2E+0[b]
Dibenzo(a,h)anthracene	2.7E+0[b]	4.4E+0[b]
Fluoranthene	3.6E-1[b]	1.5E+0[b]
Fluorene	1.71E-1[a]	9.03E-1[a]
Indeno(1,2,3-cd)pyrene	1.9E+0[b]	4.2E+0[b]
Naphthalene	6.9E-2[b]	5.3E-1[b]
Phenanthrene	2.3E-1[b]	1.1E+0[b]
Pyrene	3.24E-1[a]	1.50E+0[a]

[a]Estimated by the method of U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[b]Taken from U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

The PAHs are generally divided into two EPA cancer weight-of-evidence groups: Group D – not classifiable as to carcinogenicity to humans, and Group B2 – probable human carcinogens.

The Group D PAHs have not been evaluated for carcinogenicity by toxicity testing; therefore, cancer SFs or URFs cannot be estimated for these compounds (EPA, 1986, 2001). Risk evaluation and development of remedial goal options (RGO) for these compounds are limited to noncancer effects. It is theoretically possible that cancer risk could be the "driver" for some of

these compounds. However, the mechanism of carcinogenicity of the PAHs is fairly well understood to be correlated with molecular morphology and the propensity to form certain active metabolites (ATSDR, 1993a). The Group D PAHs either do not fit the morphologic mold or have been shown empirically to be unlikely to cause cancer, reducing greatly the uncertainty that significant cancer risk is being overlooked.

Cancer SFs and URFs are available for the Group B2 compounds but noncancer RfDs or RfCs are not. Therefore, evaluation and RGO development for these compounds are limited to cancer risk. These compounds have the morphologic requirements for carcinogenicity; therefore, it has been thought that cancer risk is the driver, and that noncancer effects are relatively insignificant, although empirical data were lacking.

Recent data, however, support this assumption. De Jong et al. (1999) reported a study in which male rats were treated by gavage with benzo(a)pyrene 5 days per week for 35 days at dose rates of 0 (control), 3, 10, 30 or 90 mg/kg. Significantly reduced rate of body weight gain and altered organ weights were observed in the 90 mg/kg group. Forestomach lesions were found in the 30 and 90 mg/kg group. Decreased thymus weights and hematological evidence of erythrocyte toxicity were observed in a dose-related manner in rats treated with 10 mg/kg and above. Subtle alterations in measures of immune function were also observed in these groups, establishing 10 mg/kg as the LOAEL and 3 mg/kg as the NOAEL for this study. The 3 mg/kg dose is equivalent to an adjusted NOAEL of 2.1 mg/kg-day. Application of an uncertainty factor of 1000 (factor of 10 to expand from subchronic to chronic exposure, and factors of 10 each to provide additional protection for intra- and interspecies variation) allows development of a preliminary oral RfD of 2E-3 mg/kg-day. Uncertainty surrounding the preliminary oral RfD is very high because the data base for benzo(a)pyrene is essentially limited to one study and several toxicological endpoints (e.g., developmental, reproductive, neurological) were not investigated.

The sole purpose for developing the oral RfD is to evaluate the potential for noncancer effects to be the driver for the Group B2 PAHs. The oral SF for benzo(a)pyrene is 7.3 per mg/kg-day (please see below), from which it is estimated that the oral RfD is equivalent to a cancer risk of 1.5E-2. This cancer risk is orders of magnitude above the EPA (1990) risk management range of 1E-6 to 1E-4, strengthening the position that noncancer effects are unlikely to be the driver for the Group B2 PAHs.

Data regarding the toxicity of acute oral exposure to the PAHs are generally scarce.

Prolonged oral exposure to the Group D PAHs is associated with a number of renal, hematologic and other effects, depending on the compound. Subchronic (90 day) gavage treatment of mice with acenaphthene is associated with histopathologic evidence of liver hypertrophy. A verified RfD of 6E-2 mg/kg-day for chronic oral exposure was derived from the NOAEL of 175 mg/kg-day and an uncertainty factor of 3000 (EPA, 2001). The LOAEL in this study was 350 mg/kg-day. Confidence in the RfD is low. The liver is considered the target organ for prolonged oral exposure to acenaphthene.

A verified RfD of 3E-1 mg/kg-day for chronic oral exposure to anthracene was derived from a NOEL of 1000 mg/kg-day, the highest dose tested, in a 90-day gavage study in mice (EPA, 2001). An uncertainty factor of 3000 was applied. Confidence in the RfD is low. The data are inadequate to identify a target organ for prolonged oral exposure to anthracene.

Subchronic exposure to fluoranthene induces liver and kidney effects and hematologic alterations in orally treated mice (EPA, 2001). A verified RfD of 4E-2 mg/kg-day for chronic oral exposure was derived from a NOAEL of 125 mg/kg-day in a 13-week gavage study. The LOAEL was 250 mg/kg-day in this study. An uncertainty factor of 3000 was applied. Confidence in the oral RfD is low. The kidney, liver and blood cells are chosen as the target organs for prolonged oral exposure to fluoranthene.

Subchronic exposure to fluorene induces hemolytic anemia in orally treated mice (EPA, 2001). A verified RfD of 4E-2 mg/kg-day for chronic oral exposure was derived from a NOAEL of 125 mg/kg-day in a 13-week gavage study. The LOAEL was 250 mg/kg-day in this study. An uncertainty factor of 3000 was applied. Confidence in the oral RfD is low. The erythrocyte is the target organ for prolonged oral exposure to fluorene.

Single-dose LD_{50} values for naphthalene include 533 to 710 mg/kg for mice and 2200 to 2400 mg/kg for rats, establishing the mouse as more sensitive to the lethal effects of acute oral exposure (ATSDR, 1993b). Decreased terminal body weights, accompanied by a remarkable absence of hematological and histopathological effects, were observed in rats treated by gavage for 13 weeks (EPA, 2001). The LOAEL in this study was 142 mg/kg-day associated with greater than 10 percent reduction in terminal body weights. The NOAEL was 71 mg/kg-day. The high dose rate, 286 mg/kg-day was a FEL associated with increased mortality. Application of an uncertainty factor of 3000 to the NOAEL of 71 mg/kg-day yields the verified oral RfD of 2E-2 mg/kg-day. Confidence in the RfD is low.

Adults, children and neonates exposed to moth balls have exhibited hemolytic anemia, evidence of liver disease and neurological deficits (EPA, 1993a, 1998). The liver effects and neurological deficits may be secondary to hemolytic anemia and reduced oxygen-carrying capacity of the blood. Hemolytic anemia and cataract formation have been seen also in orally exposed humans (EPA, 1998). The data suggest that the erythrocyte may be the most sensitive tissue in humans. Among commonly used species of laboratory mammals, hemolytic anemia is seen only in dogs (EPA, 1998). Cataracts are seen in several laboratory mammals, but only at relatively high doses. The key study identifies reduced body weight as the critical effect in rats. Rats, however, do not exhibit hemolytic anemia, and exhibit cataracts only at very high doses, suggesting that rats may not be a totally acceptable model for the toxicity of naphthalene to humans. Therefore, based on the effects observed in humans, the erythrocyte is selected as the target organ for prolonged oral exposure to naphthalene. Reduced body weight is also included as a "target organ" because this was the only endpoint observed in rats in the critical study with naphthalene.

EPA (1993a, 2001) reported a 2-year study in which mice were exposed to naphthalene vapors for 6 hours/day on 5 days/week. Inflammation of the nasal and olfactory epithelium was the most consistently observed sign; granulomatous lesions were also observed in the lungs. There

was equivocal evidence of hematologic involvement. The lowest exposure concentration, 10 ppm, was a LOAEL for the nasal effects, which are considered the critical effects of inhalation exposure. The LOAEL is equivalent to a human equivalent concentration of 9.3 mg/m^3 (EPA, 2001). Application of an uncertainty factor of 3000 yields a verified RfC of 3E-3 mg/m^3, which is equivalent to an inhalation RfD of 8.6E-4 mg/kg-day. The nasal and olfactory epithelia are the target organ for inhalation exposure to naphthalene. Confidence in the RfC is medium.

Subchronic exposure to pyrene induces mild renal tubular degeneration and reduced kidney weight in orally treated mice (EPA, 2001). A verified RfD of 3E-2 mg/kg-day for chronic oral exposure was derived from a NOAEL of 75 mg/kg-day in a 13-week gavage study. The LOAEL was 125 mg/kg-day in this study. An uncertainty factor of 3000 was applied. Confidence in the oral RfD is low. The kidney tubule is chosen as the target organ for chronic oral exposure to pyrene.

Data regarding prolonged oral exposure are not available for several of the Group D PAHs, which hinders estimation of an RfD or RfC and compromises evaluation of the potential for noncancer effects. Therefore, surrogates are used to develop toxicity values for the noncancer effects.

Generally surrogates are chosen on the basis of the following hierarchy:

- Toxicological similarity (effects and dose-response relationship).
- Toxicokinetic similarity, assuming that likeness in absorption, distribution and especially products of biotransformation suggests toxicological similarity.
- Structural similarity, assuming that likeness in structure suggests similarity in toxicokinetics.

Selection of defensible surrogates for the PAHs is compromised because toxicological and toxicokinetic data are virtually non-existent, and the structural similarities are not very convincing, which imparts a great deal of uncertainty to the effort. Therefore, the most defensible approach for some of the PAHs is to select the most conservative surrogate; i.e., the PAH with the smallest verified oral RfD, which happens to be pyrene.

Data regarding the effects of chronic or subchronic exposure to acenaphthylene were not located in the available literature. Acenaphthene is adopted as a reasonable surrogate for acenaphthylene based on structural similarity, since the surrogate differs from the principal chemical only in the presence of two hydrogen atoms and the absence of a double bond. Therefore, the verified oral RfD of 6E-2 mg/kg-day for acenaphthene is adopted as the oral RfD for chronic exposure to acenaphthylene. The liver, which is the target organ for acenaphthene, is adopted for oral exposure to acenaphthylene.

Data regarding the effects of chronic or subchronic exposure to benzo(g,h,i)perylene were not located in the available literature. Pyrene is adopted as a reasonable surrogate for

benzo(g,h,i)perylene based somewhat on structural similarity, but more on the selection of a conservative approach as justified above. Therefore, the verified oral RfD of 3E-2 mg/kg-day for pyrene is adopted as the oral RfD for chronic exposure to benzo(g,h,i)perylene. The kidney tubule, which is the target organ for pyrene, is adopted for oral exposure to benzo(g,h,i)perylene.

Relevant data regarding chronic or subchronic exposure to phenanthrene were not located. Potential surrogates based on similarity in chemical structure include anthracene and pyrene. Pyrene is selected as the surrogate only because it is the more conservative choice. Therefore, the verified oral RfD of 3E-2 mg/kg-day for pyrene is adopted as the oral RfD for chronic exposure to phenanthrene. The kidney tubule, which is the target organ for pyrene, is adopted for oral exposure to phenanthrene.

Acenaphthylene, anthracene, benzo(g,h,i)perylene, fluoranthene, fluorene, phenanthrene and pyrene are classified in EPA cancer weight-of-evidence Group D (not classifiable as to carcinogenicity to humans) because of a lack of human data and inadequate animal data (EPA, 2001). Data regarding the carcinogenicity of acenaphthene were not located. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, carbazole, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene are classified in EPA weight-of-evidence Group B2 (probable human carcinogens) (EPA, 1997, 2001). Benzo(a)pyrene is the most extensively studied member of the class, inducing tumors in tissues at the point of contact of virtually all laboratory species tested by all routes of exposure. Although epidemiology studies suggested that complex mixtures that contain PAHs (coal tar, soots, coke oven emissions, cigarette smoke) are carcinogenic to humans, the carcinogenicity cannot be attributed to PAHs alone because of the presence of other potentially carcinogenic substances in these mixtures (ATSDR, 1993a). In addition, recent investigations showed that the PAH fraction of roofing tar, cigarette smoke and coke oven emissions accounted for only 0.1-8% of the total mutagenic activity in *Salmonella* of the unfractionated complex mixture (Lewtas, 1988). Aromatic amines, nitrogen heterocyclic compounds, highly oxygenated quinones, diones, and nitrooxygenated compounds, none of which would be expected to arise from in vivo metabolism of PAHs, probably accounts for the majority of the mutagenicity of coke oven emissions and cigarette smoke. Furthermore, coal tar, which contains a mixture of many PAHs, has a long history of use in the clinical treatment of a variety of skin disorders in humans (ATSDR, 1993a).

Because of the lack of human cancer data, assignment of individual PAHs to EPA cancer weight-of-evidence groups is based largely on the results of animal studies with large doses of purified compound (EPA, 2001). Frequently, unnatural routes of exposure, including implants of the test chemical in beeswax and trioctanoin in the lungs of female rats, intratracheal instillation, and subcutaneous or intraperitoneal injection, were used.

EPA (2001) verified a SF for oral exposure to benzo(a)pyrene of 7.3E+0 per mg/kg-day, based on several dietary studies in mice and rats. Recent reevaluations of the carcinogenicity and mutagenicity of the Group B2 PAHs suggest that there are large differences between individual PAHs in cancer potency (Krewski et al., 1989). Based on the available cancer and mutagenicity data, and assuming that there is a constant relative potency between different carcinogens across different bioassay systems and that the PAHs under consideration have similar dose-response

curves, EPA (1993b) adopted relative potency values for several PAHs. These values and the corresponding oral SFs, based on a relative potency for benzo(a)pyrene of 1.0, are presented below.

Relative Potencies and Slope Factors for PAHs				
PAH	Relative Potency	Oral Slope Factor (/mg/kg-day)	Inhalation	
			Unit Risk (/μg/m^3)	Slope Factor (/mg/kg-day)
Benzo[a]pyrene	1.0	7.3E+0	8.8E-4	3.1E+0
Benzo[a]anthracene	0.1	7.3E-1	8.8E-5	3.1E-1
Benzo[b]fluoranthene	0.1	7.3E-1	8.8E-5	3.1E-1
Benzo[k]fluoranthene	0.01	7.3E-2	8.8E-6	3.1E-2
Chrysene	0.001	7.3E-3	8.8E-7	3.1E-3
Dibenzo[a,h]anthracene	1.0	7.3E+0	8.8E-4	3.1E+0
Indeno[1,2,3-cd]pyrene	0.1	7.3E-1	8.8E-5	3.1E-1

Although the EPA has not verified SFs for Group B2 PAHs other than benzo(a)pyrene, the SFs above represent reasonable estimates based on the data available. The relative potency approach employed here meets criteria considered to be desirable for this type of analysis (Lewtas, 1988). For example, the chemicals compared have similar chemical structures and would be expected to have similar toxicokinetic fate in mammalian systems. In addition, the available data suggest that the Group B2 PAHs have a similar mechanism of action, inducing frameshift mutations in *Salmonella* and tumor initiation in the mouse skin painting assay. Similar noncancer effects (minor changes in the blood, liver, kidneys) of the Group D PAHs support the hypothesis of a common mechanism of toxicity. Finally, the same endpoints of toxicity, i.e., potency in various cancer assays, and related data, were used to derive the relative potency values (Krewski et al., 1989). The oral SF for benzo(a)pyrene of 7.3E+0 per mg/kg-day, and the SFs presented above for the other Group B2 PAHs are adopted for the purposes of this evaluation.

An EPA (1994) evaluation of the inhalation cancer data suggests adoption of an inhalation SF for benzo(a)pyrene of 3.1E+0 per mg/kg-day, based on the incidence of upper respiratory and digestive tract tumors in hamsters. Applying the relative potency estimates presented above yield the inhalation SFs for the other Group B2 PAHs presented above.

Carbazole was not investigated in the relative potency investigations described above. EPA (1997) presents a provisional oral SF of 2E-2 per mg/kg-day based on the incidence of liver tumors in a 96-week dietary study in mice. The location of primary tumors distal to the point of contact (the GI tract) suggests a mechanism of toxicity different from benzo(a)pyrene and the other Group B2 PAHs discussed above. The data are inadequate for estimation of an inhalation URF or SF for carbazole.

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POLYCHLORINATED BIPHENYLS (PCBs)

The PCBs are a class of **SVOC**s including 209 possible individual congeners, each consisting of a biphenyl structure and 1 to 10 chlorine atoms (ATSDR, 1995). The PCBs manufactured and used in the U.S. are called Aroclors. The Aroclors are mixtures of several PCB congeners and related compounds. Aroclors were used as dielectric and heat exchange agents in several open and closed systems, but since the middle 1970s, use has been restricted largely to electrical transformers and capacitors.

Analysis of PCBs in environmental media frequently involves "fingerprinting" the mixture, and reporting the result as the Aroclor(s) that most closely reflect the fingerprint(s) (ATSDR, 1995). Recently, however, more attention has been paid to analyzing and reporting individual congeners, because of the possibility that certain congeners may be dioxin-like in their mechanism of toxicity. The Aroclors most commonly identified in environmental media include Aroclor-1016, -1221, -1232, -1242, -1248, -1254, -1260, -1262, and -1268. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
Aroclor-1016 (12674-11-2)							
257.9[a,b]	5.6[b]	2.9E-4[b]	4.96[c]	4.69E-2[d]	6.8E-6[c]	5.3E-7[b]	4.2E-1[b]

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
Aroclor-1221 (11104-28-2)							
200.7[a,b]	4.7[b]	3.5E-3[b]	2.44[c]	5.54E-2[d]	7.5E-6[c]	8.8E-6[b]	5.9E-1[b]
Aroclor-1232 (11141-16-5)							
232.2[a,b]	5.1[b]	8.64E-4[c]	2.83[c]	5.03E-2[d]	7.2E-6[c]	5.34E-6[b]	4.5E-1[b]
Aroclor-1242 (53469-21-9)							
266.5[a,b]	5.6[b]	5.2E-4[b]	4.59[c]	4.59E-2[d]	6.1E-6[c]	5.34-7[b]	2.2E-1[b]
Aroclor-1248 (12672-29-6)							
299.5[a,b]	6.2[b]	2.8E-3[b]	5.64[c]	4.24E-2[d]	6.6E-6[c]	6.5E-7[b]	5.7E-2[b]
Aroclor-1254 (11097-69-1)							
328[a,b]	6.5[b]	2.0E-3[b]	5.00[c]	3.99E-2[d]	5.6E-6[c]	1.01E-7[b]	3.5E-2[b]
Aroclor-1260 (11096-82-5)							
375.7[a,b]	6.8[b]	4.6E-3[b]	6.42[c]	3.65E-2[d]	5.3E-6[c]	5.33E-8[b]	4.1E-2[b]
Aroclor-1262 (1336-36-3)							
389[a,b]	ND	ND	ND	3.57E-2[d]	4.13E-6[d]	ND	5.2E-2[b]
Aroclor-1268 (11100-14-4)							
453[a,b]	ND	ND	ND	3.22E-2[d]	3.73E-6[d]	ND	3.0E-1[b]

ND = no data.
[a]Average molecular mass for the proportions of individual congeners in the commercial product.
[b]Agency for Toxic Substances and Disease Registry (ATSDR), 1995, ***Update Toxicological Profile for Polychorinted Biphenyls***, Draft for Public Comment, U.S. Department of Health and Human Services, Atlanta, Georgia, August.
[c]Montgomery, J.H., 1996, ***Groundwater Chemicals Desk Reference, Second Edition***, Lewis Publishers, New York.
[d]Calculated as described in Introduction to the Toxicity Profiles.

Former PCB releases occurred as a result of their manufacture, use, disposal, and leakage from damaged PCB-containing equipment (ATSDR, 1995) . Currently the major source of PCB release to the environment is recycling of PCBs previously introduced into the environment, which involves volatilization from ground surfaces (water, soil) into the atmosphere with subsequent removal from the atmosphere via wet/dry deposition, followed by volatilization (HSDB, 2001). PCBs are also currently released to the environment from landfills containing PCB waste materials and products, incineration of municipal refuse and sewage sludge, and improper (or illegal) disposal of PCB materials, such as waste transformer fluid, to open areas.

Major sources to air include emissions from the overhaul, repair or reuse of PCB-containing items, and the recycling of previously released PCBs described above (ATSDR, 1995; HSDB, 2001). The vapor pressures of the PCBs indicate that they would exist primarily in the vapor-phase in the atmosphere; monitoring data have shown that between 87 and 100% of the PCBs in air are in the vapor-phase. Vapor pressure of the PCBs generally decreases with an increase in the extent of chlorination; therefore, the more highly chlorinated PCBs are more likely to be associated with the particulate-adsorption-phase in air than are the lesser chlorinated PCBs. Physical removal of PCBs in the atmosphere is accomplished by wet and dry deposition; dry deposition occurs only for PCBs in the particulate phase.

Major sources to soil include leaks or discharges from PCB-containing items and deposition from the atmosphere (ATSDR, 1995). PCBs sorb tightly to constituents of soil with adsorption generally increasing with the degree of chlorination. Although the lesser chlorinated biphenyls may exhibit low mobility in soil, PCBs will generally not leach significantly in most aqueous soil systems. In the presence of organic solvents, PCBs may leach quite rapidly through soil. Vapor loss of PCBs from soil surfaces appears to be an important loss mechanism with the rate of volatilization decreasing with increasing chlorination. Although the volatilization rate may be low, the total loss by volatilization over time may be significant because of the persistence and stability of PCBs. In general, the persistence of PCBs increases with an increase in the degree of chlorination (HSDB, 2001). Mono-, di- and trichlorinated biphenyls (Aroclors-1221 and -1232) biodegrade relatively rapidly, tetrachlorinated biphenyls (Aroclors-1016 and -1242) biodegrade slowly, and higher chlorinated biphenyls (Aroclors-1248, 1-254 and -1260) are resistant to biodegradation. The position of chlorination in the isomeric classes also determines the extent of biodegradation. Although biodegradation of higher chlorinated congeners may occur very slowly on an environmental basis, no other degradation mechanisms have been shown to be important in soil systems; therefore, biodegradation may be the ultimate degradation process in soil.

Former sources of PCBs to surface water include waste streams and discharges from waste water treatment plants (ATSDR, 1995). Currently, direct deposition, runoff and erosion probably predominate. Removal from water involves sorption to particles and sedimentation, as well as volatilization.

The PCBs are among the compounds that bioaccumulate in food chain pathways and are of special concern for biomagnification from sediment in benthic fish. Biotransfer factors for the PCBs are compiled below:

BSAF (unitless)	Bpr[a,b] (unitless)	Bpv[a,b] (unitless)	Bb[a] (days/kg)	Bm[a] (days/kg)
Aroclor-1016				
See below	2.24E-2	2.24E-2	1.00E-2	3.16E-3
Aroclor-1221				

BSAF (unitless)	Bpr[a,b] (unitless)	Bpv[a,b] (unitless)	Bb[a] (days/kg)	Bm[a] (days/kg)
See below	7.44E-2	7.44E-2	1.26E-3	3.98E-4
Aroclor-1232				
See below	4.37E-2	4.37E-2	3.16E-3	1.00E-3
Aroclor-1242				
See below	2.24E-2	2.24E-2	1.00E-2	3.16E-3
Aroclor-1248				
See below	1.01E-2	1.01E-2	3.98E-2	1.26E-2
Aroclor-1254				
See below	6.78E-3	6.78E-3	7.94E-2	2.51E-2
Aroclor-1260				
See below	4.55E-3	4.55E-3	1.58E-1	5.01E-2
Aroclor-1262				
See below	ND	ND	ND	ND
Aroclor-1268				
See below	ND	ND	ND	ND

ND = no data.
[a]Calculated as described in Introduction to the Toxicity Profiles.
[b]The methodology for estimating biotransfer of organic chemicals to plants does not differentiate vegetative and reproductive portions.

EPA (1995) reported a biota/sediment absorption factor (BSAF) for total PCBs of 1.85 for trout in the Great Lakes ecosystem. The BSAF of 1.85 is applied to all PCBs in this evaluation.

Toxicokinetic data from laboratory animals suggest that the efficiency of GI absorption is roughly inversely related to the degree of chlorination (ATSDR, 1995). The GI absorption of mono- to hexachlorinated biphenyls exceeds 90 percent. Dichlorobiphenyl GI absorption efficiency is approximately 95 percent, but the absorption efficiency of octachlorobiphenyl approximates only 75 percent. GI absorption efficiency of Aroclor-1254 approximates 85.4 percent in ferrets and greater than 90 percent in monkeys. These data generally support the GAF of 0.9, which is adopted for all PCBs for the noncancer evaluation. However, an oral-to-dermal adjustment factor of 1 is used for the cancer evaluation to be consistent with the application of the cancer SF recommended by EPA (2001).

The PCBs appear to be readily absorbed by the skin when applied as neat compound or mixed with a suitable vehicle (ATSDR, 1995), but efficiency falls when soil is the medium of exchange. The EPA (1992) recommended ABS of 0.06 for PCBs is used in this evaluation. EPA (1992) provides PC and τ values for 4-chlorobiphenyl and hexachlorobiphenyl. Generally, the more highly chlorinated PCB congeners are the more persistent in the environment; therefore, the PC of 7.1E-1 cm/hour and the τ of 1.4E+1 hours for hexachlorobiphenyl are applied to all PCBs in this evaluation.

The acute oral toxicity of the PCBs is low to moderate, as indicated by LD_{50} values in laboratory animals ranging from 750 mg/kg (mink) to 4250 mg/kg (rats) (ATSDR, 1995). Mink appear to be unusually sensitive. Death appears to be due to respiratory depression and dehydration from diarrhea.

The best known incident involving oral exposure by humans is the "Yusho" incident in Japan, in which persistent chloracne, gastrointestinal irritation and central nervous symptoms followed ingestion of cooking oil contaminated with PCBs (Gaffey, 1983). Further investigation, however, revealed that concentrations of polychlorinated dibenzofurans (PCDF) and polychlorinated quaterphenyls in the cooking oil were similar to those of PCBs, which confounds interpretation of the reported observations and symptoms.

Prolonged oral exposure of laboratory animals leads to liver damage, signs of chloracne, immunological effects, and neurological impairment, particularly of the young. A verified oral RfD for Aroclor-1254 of 2E-5 mg/kg-day for chronic oral exposure is based on a LOAEL of 5E-3 mg/kg-day associated with chloracne and related signs and immunological effects in monkeys treated with the test material in gelatin capsules for over five years (EPA, 2001). An uncertainty factor of 300 was applied. Confidence in the RfD is medium. The immune system and skin are considered the target organs for prolonged oral exposure to Aroclor-1254. A verified oral RfD of 7E-5 mg/kg-day for Aroclor-1016 is based on a NOAEL of 7E-3 mg/kg-day in a long-term perinatal and neurobehavioral toxicity study in monkeys. An uncertainty factor of 100 was applied to the NOAEL. The LOAEL (2.8E-2 mg/kg-day) was associated with low birth weights. The fetus is considered the sensitive target tissue for prolonged oral exposure to Aroclor-1016. Confidence in the oral RfD is medium.

Occupational exposure to PCBs, which involved both inhalation and dermal exposure, was associated with upper respiratory tract and ocular irritation, loss of appetite, liver enlargement and increased serum concentrations of liver enzymes, skin irritation, rashes and chloracne, and, in heavily exposed female workers, decreased birth weight of their infants (ATSDR, 1995). Concurrent exposure to PCB contaminants, such as PCDFs, confounds the interpretation of the occupational exposure studies. Rats, mice, rabbits and guinea pigs intermittently exposed to Aroclor-1254 vapors exhibit moderate liver degeneration, decreased body weight gain and slight renal tubular degeneration; however, the accuracy of the reported exposure concentration is in doubt. Neither verified nor provisional chronic inhalation RfC values are available.

EPA (2001) classified PCBs in cancer weight-of-evidence Group B2 (probable human carcinogen) based on adequate evidence for liver tumors in laboratory animals and inadequate

data in humans. EPA (2001) established a tiered approach for estimating the cancer potency of exposure to the PCBs. For the high risk tier, A SF of 2.0E+0 per mg/kg-day is verified as an upper-bound for exposure to PCBs via ingestion in the food chain, ingestion of soil or sediment, inhalation of dust or aerosol, or dermal contact with soil or sediment if an absorption factor is applied. In addition, the SF of 2.0E+0 per mg/kg-day is used for any congeners considered to be persistent or acting in a dioxin-like manner, and for any early life exposures. The high risk tier SF for central tendency (CT) analyses is 1.0E+0 per mg/kg-day. EPA (2001) verified an upper-bound SF of 4.0E-1 per mg/kg-day for the low risk tier, which includes ingestion of water-soluble congeners, inhalation of evaporated congeners, and dermal exposure if no absorption factor is applied. A SF of 3E-1 per mg/kg-day is recommended for the low risk CT evaluation. The SF of 2.0E+0 per mg/kg-day is used for all exposure scenarios and exposure routes in this evaluation because analytical data that demonstrate the absence of dioxin-like or persistent congeners are not available, and the exposure of children or youths is plausible.

References for PCBs

Agency for Toxic Substances and Disease Registry, (ATSDR), 1995, ***Update Toxicological Profile for Polychlorinated Biphenyls***, Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia, August.

Gaffey, W.R., 1983, "The epidemiology of PCBs," In: ***PCBs: Human and Environmental Hazards***, F.M. D'itri and M.A. Kamrin, Eds., Boston: Butterworth Publishers.

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U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 1995, ***Great Lakes Water Quality Initiative, Technical Support Document for the Procedure to Determine Bioaccumulation Factors***, EPA.820.8.95.CC5, PB95-187290.

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TOLUENE

Toluene is a **VOC** that is back-blended into gasoline to improve octane rating, used to produce benzene, used as a solvent in paints, coatings, adhesives, inks and cleaning agents, and used in the synthesis of a wide range of organic chemicals, particularly benzene and its derivatives (ATSDR, 1998; HSDB, 2001). Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
92.1	2.73[a]	6.63E-3[b]	2.26[b]	8.70E-2[b]	8.60E-6[b]	3.71E-2[c]	3.10E+2[b]

[a]U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[b]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[c]U.S. Environmental Protection Agency (EPA), 1994, ***Technical Background Document for Soil Screening Guidance***, Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, Publication No. 9355.4-17, EPA540/R-94/106, PB95-963532, November.

Large amounts of toluene are released into the atmosphere each year, principally from the production, transport and use of gasoline (ATSDR, 1998; HSDB, 2001). Other major sources include volatilization of toluene-based solvents and thinners, and motor vehicle exhaust. Considerable amounts are discharged into waterways or spilled on land during the storage, transport and disposal of fuels and oils.

Toluene in the atmosphere will exist predominantly in the vapor phase , where it is subject to reaction with photochemically produced hydroxyl radicals (ATSDR, 1998; ATSDR, 2001). It is also subject to reaction with various oxidizing agents in the atmosphere, but these reactions are far less significant. Wet deposition is another important process for removal of toluene from the atmosphere.

Toluene is expected to be moderately to highly mobile in soil and may leach to groundwater (ATSDR, 1998; HSDB, 2001). Volatilization is another important removal process for toluene near the surface of the soil. Biodegradation may also be significant in soil. Toluene in water will be lost by both volatilization to the atmosphere and biodegradation. Which process predominates will depend on water temperature, mixing conditions and the existence of acclimated microorganisms at the site. The compound is not expected to sorb significantly to sediment or suspended organic matter in water.

Toluene theoretically may be expected to bioconcentrate because of its lipophilicity (ATSDR, 1998), but empirical data show that it is subject to rapid biotransformation, which greatly reduces this tendency. Overall, biotransfer is not expected to be significant and biotransfer factors are not provided.

ATSDR (1998) reviewed data regarding the mechanism of absorption and concluded that toluene was readily absorbed from the GI tract, but provided no quantitative estimates. Jones and Owen (1989), however, reported an absorption efficiency of 1.0. This value is consistent with rapid absorption of lipophilic solvents and is adopted as the GAF for this evaluation. ATSDR (1998) noted that binding to soil slowed GI absorption but did not decrease the overall extent of GI absorption.

Data were not located for dermal uptake from soil; therefore, the OEPA (1998) Region IV default ABS of 0.1 for organic chemicals is used for this evaluation. EPA (1992) provides a PC of 4.5E-2 cm/hour and a τ of 3.2E-1 hours, which are used herein.

Acute inhalation (glue sniffing, solvent abuse, industrial accidents) or ingestion exposure to high levels of toluene induces CNS dysfunction and narcosis (ATSDR, 1994). Acute oral LD_{50} values include 2.6 to 7.5 g/kg in rats (HSDB, 2001). Acute ingestion is associated with lesions in the heart, liver, lungs and kidneys (ATSDR, 1998). Prolonged oral exposure to lower levels is associated with pathological changes in the liver, kidney and brain. Changes in liver and kidney weights were observed in rats treated by gavage for 13 weeks at a dose rate of 446 mg/kg-day (EPA, 2001). The NOAEL in this study was 223 mg/kg-day. Application of an uncertainty factor of 1000 yields a verified RfD of 2E-1 mg/kg-day for oral exposure. Confidence in the RfD is medium. The liver and kidney and brain are considered the target organs for oral exposure to toluene.

Prolonged (occupational) inhalation exposure to toluene at concentrations near 100 ppm induces upper respiratory tract irritation and CNS dysfunction (EPA, 2001). The CNS effects appear to be the more sensitive endpoint, and serve as the basis for a verified inhalation RfC of 4E-1 mg/m^3. The RfC is based on an exposure-adjusted LOAEL of 119 mg/m^3 and an uncertainty factor of 300. The RfC is equivalent to an inhalation RfD of 1.1E-1 mg/kg-day. Confidence in the RfC is medium. The CNS and upper respiratory tract are the target organs for inhalation exposure to toluene.

EPA (2001) verified toluene as a cancer weight-of-evidence Group D compound (not classifiable as to carcinogenicity to humans) based on a lack of human data and inadequate animal testing data.

References for Toluene

Agency for Toxic Substances and Disease Registry, (ATSDR), 1998, ***Update Toxicological Profile for Toluene***, Draft for Public Comment, U.S. Public Health Service, Atlanta, Georgia, August.

Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.

Jones, TD. and BA Owen, 1989, ***Health Risks from Mixtures of Radionuclides and Chemicals in Drinking Water***, Oak Ridge National Laboratory, Oak Ridge, TN, ORNL-6533.

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U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

2,4,6-TRINITROTOLUENE (TNT) (118-96-7)

TNT is an **SVOC** classified as a high explosive and is used as a military explosive in bombs and grenades (ATSDR, 1993). It has found wide use in filling shells and airborne detonation bombs because it can withstand the shock of ejection from a gun barrel but can be exploded on impact with a detonator mechanism. It is used as a pure compound or combined with other explosive chemicals for military application. Small amounts are used in industrial explosives. Minor applications include use as a chemical intermediate in the manufacture of dyestuffs and photographic chemicals. Relevant physical properties are compiled below:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
227.13	1.60[a]	4.57E-7[a]	3.20[a]	ND	6.8E-6[b]	2.62E-7[a]	1.30E+2[b]

ND = no data.
[a]Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.
[b]Montgomery, J.H., 1996, ***Groundwater Chemicals Desk Reference, Second Edition***, Lewis Publishers, New York, pp. 1043-1044.

TNT may be released to the environment in wastewater and air effluents from its production and use as a military explosive and propellant, and during the disposal or open detonation of outdated or unwanted munitions (ATSDR, 1993; HSDB, 2001). The behavior of TNT in the environment is expected to be controlled largely by its relatively high water solubility and relatively low vapor pressure. In addition, photolysis yields a large number of degradation products, many of which are persistent in environmental media.

Although low, the vapor pressure of TNT is sufficient to suggest that the compound will exist largely in the vapor phase in the atmosphere, where it is expected to be subject to photolysis (HSDB, 2001). Its solubility in water suggests that wet deposition may be a significant removal process.

TNT on the surface of soil is subject to photolysis (ATSDR, 1993; HSDB, 2001). Mobility in soil is expected to be low to moderate. Large quantities released to soil (e.g., from former munitions production works) may result in substantial concentrations in groundwater. TNT in soil is subject to degradation to a number of nitro reduction products (amino compounds, mono- and dinitro compounds).

TNT in surface water is subject to photolysis; volatilization and hydrolysis are not expected to be significant (ATSDR, 1993; HSDB, 2001). Photolysis gives rise to the persistent red or pink water condition frequently observed with TNT contamination. Biodegradation occurs too slowly to be an important removal process. TNT and some of its degradation products will partition moderately to sediment or suspended particles in water.

Bioconcentration or bioaccumulation are not expected to be significant for TNT (ATSDR, 1993; HSDB, 2001); therefore, biotransfer factors are not developed.

Pharmacokinetic data are limited to studies of oral administration of radiolabeled compound to several species followed by collection and measurement of radioactivity in urine, gastrointestinal tract (including contents) and feces (ATSDR, 1993). Total recovery from these compartments ranged from 92 to 104 percent, suggesting little metabolism to radioactive metabolites that were exhaled. The percent of the dose recovered in the urine is adopted as a minimal estimate of GI absorption, because the extent of biliary excretion and enterohepatic recirculation has not been investigated. Urinary recovery averaged 60 percent in rats, mice and dogs, and approximately 74 percent in rabbits. The 60 percent recovery in the urine of dogs is selected as the GAF for this evaluation.

Studies indicate that TNT is rapidly absorbed through the skin of occupationally exposed humans, but quantitative data were not located (ATSDR, 1993). Dermal absorption ranged from 17 to 68 percent of a single dose of radioactivity in studies using laboratory animals exposed for 24 hours to radiolabeled compound. Absorption appeared to be more complete in rabbits and mice than in rats and dogs, suggesting that species differences are significant. Data were not located regarding the dermal uptake of TNT from soil, which would account for the matrix effect, or the ability of soil to bind the chemical and retard its dermal uptake. In the absence of quantitative data, the default ABS of 0.1 for organic chemicals recommended by OEPA (1998) is adopted for this evaluation. A PC of 1.07E-3 cm/hour and a τ of 2.12E+0 hours are estimated from the data provided above by the method of EPA (1992).

Information regarding the inhalation toxicity of TNT are limited to occupational studies, which probably also include dermal exposure, generally associated with the manufacture of explosives for World War I and World War II (ATSDR, 1993). Effects attributed to occupational exposure include deaths from liver disease and aplastic anemia, anemia, dermatitis and cataracts. The data are insufficient to derive an RfC for inhalation exposure to TNT.

The critical effect of prolonged oral exposure of animals to TNT is liver damage (EPA, 2001). Dogs appear to be more sensitive than rats or mice. A verified RfD for chronic oral exposure of 5E-4 mg/kg-day was derived from a LOAEL of 0.5 mg/kg-day associated with hepatic swelling and hepatocytomegaly in a 26-week feeding study in dogs. An uncertainty factor of 1000 was applied. Hemosiderosis, evidence of erythrocyte destruction, was observed in dogs treated at a dose rate as low as 2 mg/kg-day (ATSDR, 1993). Confidence in the oral RfD is medium.

Although the key study is described as a comprehensive and well designed subchronic study, only effects on the liver were reported by EPA (2001), presumably because the liver effects were the critical effects upon which the oral RfD is based. Specifically, observations regarding clinical chemistry, hematology, urinalyses, periodic electrocardiography and ophthalmic examinations were not reported. Additional information, however, indicates that anemia is one of the major signs of TNT toxicity consistently observed in rats, mice and dogs (ATSDR, 1993). TNT and/or its metabolites induce the oxidation of intracellular hemoglobin to methemoglobin, which results in erythrocytic hemolysis. Hemolytic anemia is followed by a compensatory

response manifested primarily as reticulocytosis. Effects on the testes, including irreversible atrophy and decreased reproductive performance, apparently secondary to altered zinc and copper nutrition, are observed in rats treated with much higher dose rates (e.g., 125 mg/kg-day).

Target organs at or near the threshold for toxicity include the erythrocyte and liver. Effects on the erythrocyte arise from the oxidation of hemoglobin to methemoglobin, which is consistently observed with exposure to inorganic nitrates and nitrites, as well as with many other nitroaromatic compounds (HSDB, 2001). Mild effects on the liver occur at slightly lower doses; the mechanism of hepatotoxicity has not been elucidated. Effects on the testes at higher levels probably arise from reduced levels of circulating ceruloplasmin, which is necessary for proper zinc nutrition at the cellular level.

TNT is classified in EPA weight-of-evidence Group C (possible human carcinogen) on the basis of positive mutagenicity studies and dietary studies that showed an increased incidence of urinary bladder tumors in rats (EPA, 2001). Human data are inadequate. An oral SF of 3E-2 per mg/kg-day is based on the incidence of bladder tumors in female rats in a 24-month dietary study. The data are inadequate for potency estimation for inhalation exposure.

References for 2,4,6-Trinitrotoluene

Agency for Toxic Substances and Disease Registry, (ATSDR), 1993, ***Toxicological Profile for 2,4,6-Trinitrotoluene***, Draft for Public Comment, U.S. Public Health Service, Atlanta, GA, May.

Hazardous Substance Data Bank (HSDB), 2001, National Library of Medicine, on line.

Ohio Environmental Protection Agency (OEPA), 1998, ***U.S. NASA Plum Brook, Erie County, Ohio LD#: 322-0552, Risk Assessment Work Plans***, letter from R.E. Nabors, Site Coordinator, to L.S. Ingram, Department of the Army, June 22.

U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.

U.S. Environmental Protection Agency (EPA), 2001, ***Integrated Risk Information System (IRIS)***, National Center for Environmental Assessment, Cincinnati, OH, on line.

XYLENES, TOTAL

The xylenes (1330-20-7), also known as dimethylbenzenes, are synthetic **VOCs** derived from coal tar, coal gas, and petroleum distillation (ATSDR, 1993; HSDB, 2001). Natural sources include petroleum, forest fires and volatiles from plants.

Xylenes are used in the manufacture of other organic compounds, dyes, insecticides and pharmaceuticals, and as solvents (ATSDR, 1993; HSDB, 2001). They are components of aviation gasoline, asphalt and naphtha, and automobile exhaust. Technical xylene consists of

approximately 44 percent m-xylene (1,3-dimethylbenzene [108-38-3]), 20 percent o-xylene (1,2-dimethylbenzene [95-47-6]), 20 percent p-xylene (1,4-dimethylbenzene [106-42-3]), and 15 percent ethylbenzene. Laboratory analyses of environmental media often report values for total xylenes (1330-20-7), mixed xylenes or m- and p- xylene. The xylene isomers have similar physical property values and are toxicologically similar; therefore, the relevant physical properties for m-xylene, presented below, may be applied to the mixed xylenes, total xylene or any of the three isomers:

MW (g/mole)	log K_{ow} (unitless)	H (atm-m^3/mole)	log K_{oc} (unitless)	D_a (cm^2/s)	D_w (cm^2/s)	VP (atm)	S (mg/L)
106.2	3.20[a]	7.34E-3[b]	2.61[b]	7.00E-2[b]	7.8E-6[b]	1.06E-2[c]	1.61E+2[b]

[a]U.S. Environmental Protection Agency (EPA), 1992, ***Dermal Exposure Assessment: Principles and Applications***, Interim Report, Office of Research and Development, Washington, DC, EPA/600/8-91/011B, January.
[b]U.S. Environmental Protection Agency (EPA), 1996, ***Soil Screening Guidance: Users Guide***, Office of Solid Waste and Emergency Response, Washington, DC, Publication 9355.4-23, April.
[c]U.S. Environmental Protection Agency (EPA), 1994, ***Technical Background Document for Soil Screening Guidance***, Review Draft, Office of Solid Waste and Emergency Response, Washington, DC, Publication No. 9355.4-17, EPA540/R-94/106, PB95-963532, November.

Naturally occurring sources of xylenes are petroleum, forest fires and volatiles from plants (ATSDR, 1993; HSDB, 2001). The production and use of xylenes in petroleum products and as chemical solvents and intermediates may result in their release to the environment through various waste streams. Outgassing from landfills and automobile exhaust are other significant sources. Spills, leaking underground storage tanks, and leaching from landfills may release xylenes to soil and groundwater.

Xylenes will exist solely in the vapor phase in the ambient atmosphere, where they are subject to degradation by reaction with photochemically-produced hydroxyl radicals as the only significant removal process (ATSDR, 1993; HSDB, 2001). The atmospheric lifetime of xylenes is about 1 to 2 days. Products of photooxidation include a wide variety of ring hydroxylation and ring cleavage products.

Volatilization is expected to be the major removal mechanism for xylenes released to surface soil, but, depending on the size and rate of release, the majority of the release may infiltrate to subsurface soil (ATSDR, 1993). Photooxidation may degrade a significant part of the small amount that remains at the surface. Biodegradation is probably the only significant subsurface removal mechanism, but it is expected to be slow. A wide range of experimental K_{oc} values have been reported in soil samples with differing pH and organic carbon content (HSDB, 2001), suggesting a wide range in the extent to which the xylenes adsorb to soil particles. Generally, however, xylene is fairly mobile and may readily leach to groundwater.

Volatilization is probably the most significant removal mechanism for xylenes in surface water (ATSDR, 1993). Biodegradation may occur in surface water, groundwater and landfill leachate, although quite slowly. Oxidative reactions are expected to be insignificant. Xylenes are expected to adsorb somewhat to suspended solids and sediment in water (HSDB, 2001).

Xylenes are not expected to participate significantly in food-chain pathways (ATSDR, 1993; HSDB, 2001); therefore, biotransfer factors are not provided.

Based on the recovery of urinary metabolites in orally-treated animals, ATSDR (1993) concluded that xylenes are well absorbed. Jones and Owen (1989) report that xylene is completely absorbed from the GI tract. The GAF of 1.0 is adopted for the purposes of this evaluation. Neat xylene is readily absorbed by the skin. Data regarding the dermal uptake of xylene from soil, however, were not located; the OEPA (1998) default ABS of 0.1 for organic chemicals is used in this evaluation. EPA (1992) reported a PC of 8.0E-2 cm/hour and a τ of 3.9E-1 hours for m-xylene. The GAF, ABS, PC and τ values described above are applied to all xylenes.

Oral LD_{50} values for xylenes include 3.5 to 8.6 g/kg in rats and 1.6 to 5.6 g/kg in mice (HSDB, 2001), suggesting that the acute toxicity is low, but that mice may be slightly more sensitive than rats to the acute effects of ingested xylenes. Prolonged oral exposure of animals to xylenes is associated with CNS signs and increased mortality without histopathological alterations in the internal organs (EPA, 2001). EPA (2001) presents a verified chronic oral RfD for total xylenes of 2E+0 mg/kg-day based on a NOAEL for hyperactivity and decreased body weight and increased mortality in male rats in chronic gavage studies with mixed xylenes. An uncertainty factor of 100 was used. Confidence in the chronic oral RfD is medium. EPA (1997) presents provisional RfDs for o-xylene and m-xylene of 2E+0 mg/kg-day based on the same study. The CNS is considered the target organ for prolonged oral exposure to the xylenes. The oral RfD of 2E+0 mg/kg-day is applied to total or mixed xylenes, and to each of the xylene isomers.

Occupational exposure to xylenes induces CNS effects and GI disturbances (ACGIH, 1991). Other effects attributed to occupational exposure to xylene (blood dyscrasias, and heart, liver and kidney damage) may arise from concurrent exposure to other chemicals. The data are not sufficient for derivation of an inhalation RfC. The CNS is the principal target organ for inhalation exposure to the xylenes.

Xylene is classified as a cancer weight-of-evidence Group D compound (not classifiable as to carcinogenicity to humans) (EPA, 2001). There are no reported human cancer data, and gavage studies in rat and mice of both sexes did not result in significant increases in tumor incidence.

References for Xylenes, Total

American Conference of Governmental Industrial Hygienists (ACGIH), 1991, ***Documentation of the Threshold Limit Values and Biological Exposure Indices***, Sixth Edition, Cincinnati, OH, pp. 1732-1740.

Agency for Toxic Substances and Disease Registry, (ATSDR), 1993, ***Toxicological Profile for Xylenes***, Draft for Public Comment, U.S. Department of Health and Human Services, Atlanta, GA.

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November 2, 2001

U.S. Army Engineer District, Nashville
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Nashville, Tennessee 37203

Submittal of the Final Report of Findings (Volume I). Baseline Human Health Risk Assessment (Volume II), and the Ecological Risk Assessment (Volume III) for TNT Areas A and C, Plum Brook Ordnance Works, Sandusky, Ohio; Contract No. DACA62-00-D-0002; IT P/N 807112 and 807111

Dear Mrs. Ingram:

In accordance with the requirements of Delivery Orders 0004 and 0003 of Contract Number DACA62-00-D-0002, IT Corporation is pleased to submit the final Report of Findings (Volume I), Baseline Human Health Risk Assessment (Volume II), and the Ecological Risk Assessment (Volume III) for the Remedial Investigations and Feasibility Studies – TNT Area A and TNT Area C at the former Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio. These report volumes have been revised in response to technical review comments on the draft documents previously submitted.

Enclosed are six (6) copies of the Volumes I, II, and III. In accordance with your previous direction, copies of these documents have also been forwarded to the recipients shown on the distribution list, quantities as indicated. Should you have any questions or require additional information regarding this submittal, please do not hesitate to call the undersigned at (860) 688-1151, extension 229.

Sincerely,

Mikael L. Spangberg
Project Manager

Enclosure

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Client Name: U.S. Army Engineer District, Nashville; CELRN-EC-R-M

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☐ SHP or SSHP		**Document Status**
☐ _____ Report		☐ Preliminary
☒ Risk Assessment / Evaluation	Volume III, Ecological Risk Assesmnt, TNT Areas A and C, Rev. 1, October 2001	☐ Internal Draft
☐ Specifications & Plans		☐ Draft
☐ Design Calculations		☐ Draft Final
☐ Tables		☒ Final
☐ Drawings / Figures		☐ Other: _____
☐ Other: _____		

	Name, Grade	Discipline	Signature	Date
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NOTICE: By signature above, parties certify that the subject document has been prepared by and/or reviewed by them (as appropriate), that all review comments have been resolved, and that the document is ready for submittal.

Response to U. S Army Corps of Engineers Review Comments
Draft Baseline Human Health Risk Assessment Work Plan
TNT Areas A and TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio
October 2000

Comments from Cheryl Groenjes, Chemist, dated August 7, 2001.

Comment 1: **p.2-6, 2.1.2. The magnitude of discrepancy between the results for dinitrotoluenes by GC/MS (2,4-DNT and 2,6- DNT isomers) and HPLC (total DNT) is not identified. Within a factor of two is typical. Above that, further information should be obtained to try and identify the source, and impact from that bias. Accepting the conservative value may be appropriate for use within the Risk Assessment, but working to identify and overcome these problems is more beneficial. The magnitude of discrepancy and the various methods? results are important in trying to understand the potential source of error and uncertainty in the results. Suggest a table be incorporated for any discrepancies greater than 2 times to relay this information, if desired. For instance, the response factors (for HPLC) are much more sensitive for 2,4-DNT than 2,6-DNT. So depending on the calibration procedures employed and used to quantitate the `total DNT? (i.e., assume 50/50 composition of 2,4 and 2.6-DNT) versus which isomers are actually present, a positive or negative bias in the HPLC data can result. Another possibility is that other compounds may also be coeluting with the DNT pairs. However, the lab should have identified this potential within the data package. Finally, one should note that HPLC columns are currently available that do separate these DNT isomers, and any future analyses conducted should attempt to optimize the method separation (i.e., use phenomenox column, vary eluant composition). Upon further clarification, these data discrepancies can be addressed within the uncertainty analysis.**

Response: The Nashville District of the Army Corps (USACE) and the IT Team appreciate being alerted to check the magnitude of the discrepancy between total DNT and the 2,4- and 2,6- isomer totals. As stated by the reviewer, Method 8330 gives the option of reporting 2,4-DNT and 2,6-DNT as total DNT instead of individual isomers. The laboratory that initially performed the explosive analysis chose the latter option. The laboratory that will be performing this method for all future PBOW work will, at the request of the IT Project Chemist, report individual isomers.

Thank you also for the guideline that discrepancies within a factor of two are reasonable. Applying this guideline reveals that there are no unreasonable discrepancies with any of the media evaluated except for subsurface soil at TNT Area A. The sum of the 2,4- and 2,6-DNT analyses exceeds the total DNT analysis by approximately 7-fold. Examination of the raw data reveals that the discrepancy arises from a single sample, AA0426. The data package for AA0426 was retrieved and examined by IT's Senior Chemist. The discrepancy appears to

arise from the following:

- Sample heterogeneity: The lab received two separate containers for this sample, one for Method 8330 and one for Method 8270C. Subsampling from the two separate containers may exacerbate the heterogeneity problem.
- Dilution factors: The aliquot for Method 8270C was diluted 4000-fold; the aliquot for Method 8300 was diluted 200-fold. Dilution will multiply discrepancies arising from the heterogeneity described above.
- Matrix effects: Matrix spike recovery data suggest the presence of matrix effects that can cause considerable variation in results.

The Senior Chemist concluded that the results from Method 8270C (individual isomers) are preferred to those from Method 8330, but notes that the results should be considered "estimated." The Senior Chemist's review of the data package is attached.

We appreciate the suggestion to tabulate the discrepancies, but feel that the effort is not justified since most discrepancies are small. We strongly agree, however, with the suggestion to address the matter in the uncertainty section. Therefore, the following will be inserted between the first and second paragraphs under ***Sampling and Analytical Limitations*** in Section 6.0: "Two different methods were used to analyze DNTs in soil. Method 8330 returned results for total DNTs. Method 8270C returned results for the 2,4- and 2,6-DNT isomers separately. Neither method appeared to consistently give the "best" results; therefore, results from the method returning the more conservative (larger) concentrations were used. Generally, the difference between the methods was less than a factor of 2, which is within the range of normal laboratory variation. One subsurface soil sample at TNT Area A, however, yielded a 7-fold difference in results. The uncertainty about this sample could be significant because the results from this sample determined the STCs of the DNTs, which were risk drivers in total soil. Evaluation of the data package showed that the discrepancy was probably due to sample heterogeneity, exacerbated by matrix effects and the requirement for sample dilution, and that the results should be considered as estimated, reflecting greater uncertainty in their accuracy. The uncertainty about this sample would not significantly alter the conclusions of the RA."

Comment 2: p.4-8, 4.6. Because the SVOC data allows an evaluation of isomeric-specific data for each of the sample locations, unclear why the conservative assumption (i.e., use of 2,6-DNT RfD value) is the procedure followed. Suggest that if both isomers are present, agree the more conservative value should be used. But to apply the more conservative value inappropriately when only one isomer is present should be avoided.

Response: Please see response to Comment #11 below.

Comments from Anita Meyer, Risk Assessor, dated August 7, 2001.

Comment 1: General. Very well written risk assessment. Kudos to the Nashville District and IT team on a job well done.

Response: USACE and the IT Team are grateful for the kind words. We also appreciate the level of review given the document; particularly the reviewers' sensitivity to the need to articulate thoroughly all sources of uncertainty and their impact on the results and interpretation of the final product.

Comment 2: General. Reference is made several times to "USACE 2000a, b" when discussing land use, these are the Scopes of Work for Areas A and C. It is not appropriate to give reference the scope in the work product, especially since it would not be part of the administrative record, nor be readily available to the public. Recommend deleting these references and providing other reference sources as necessary, preferably to any management plans that NASA may have for the property.

Response: Agreed; the document will be searched electronically and all references to USACE 2000a or 2000b will be changed to other documents that are part of the administrative record.

Comment 3: Section 2.1.1. I disagree with the procedure used to determine the STC for total soil. It is possible that future land use could cause chemicals to be brought to the surface, however mixing between the surface and subsurface would occur in the process. It would be preferable to expand the data set for total soil and combine the surface soil data set with that for subsurface. A model for mixing would be best for developing the future land use exposure point concentrations, but development of the 95% UCL of the mean for the whole data set is another alternative.

Response: The reviewer disagrees with the approach taken for COPC selection and STC development for total soil, and suggested two alternatives for developing STCs, each of which is evaluated below:

The first alternative is to develop a model that combines surface and subsurface soil. USACE and the IT team agree that this would be the preferred approach if surface and subsurface soil were well blended. This, however, is unlikely to be the case. Consider, for example, constructing a building with a walk-out basement on a sloped lot. At completion, the soil at the surface at the low (walk-out) end is likely to be predominantly subsurface soil, reflecting the depth of soil excavated for the basement (8 to 12 feet). The soil at the high end, possibly the main entrance to the building, is likely to be predominantly surface soil, particularly if little finish grading was required. It is likely that a receptor may spend more time at one end of the building or the other, thereby being exposed predominantly to either surface or subsurface soil, but not a perfect blend of the two. The model suggested by the reviewer does not address this likelihood.

The second alternative is to simply combine surface and subsurface soil into one data set. This would be the preferred approach if surface and subsurface contamination were homogeneously distributed as well as perfectly blended. The likelihood of this happening, however, is all but nihil, in which case the larger data set created by the combination would simply yield smaller UCL estimates, reducing the conservatism of the evaluation without reducing any of the uncertainty. Also, either surface or subsurface soil could be over-represented in the mix, depending on the number of samples taken of each.

It should be noted that the approach for selecting COPCs and estimating STCs for total soil used in the document reflects considerable dialogue between OEPA, USACE and IT. While it is true that excavation and grading would cause some mixing of surface and subsurface soil, mixing would not result in a perfect blend as discussed above, which is the major justification for the approach that was taken. The approach taken is appropriately conservative, given the uncertainty about the future development and use of the site, and the potential for exposure predominantly to surface or subsurface soil.

Another important advantage of the approach taken, specifically requested by the OEPA risk assessor for PBOW, is that the contamination contributed by either surface or subsurface soil alone is not obscured by combining the data sets. Further action, if necessary, can be targeted efficiently to address whichever soil horizon gives rise to the problem. For example, if PAHs were found to be risk-drivers requiring remediation, and it could be shown that concentrations exceeding cleanup levels were present only in surface soil, remediation could be limited to surface soil, greatly increasing efficiency and potentially reducing cost. However, If the data had been combined, it would be impossible to distinguish separately the contribution from surface and subsurface soil, in which case it may appear necessary to remediate soil to a much greater depth, thereby reducing efficiency and increasing cost with no advantage in protection of human health.

Although the reviewer disagreed with the approach taken and offered two alternatives, she identified no technical errors with the current method. Regretfully, she had not been privy to the discussions on which the approach taken was based. Respectfully, the USACE and IT decline to follow either of the reviewer's suggestions and will retain the original method.

Comment 4: **Section 2.1.1. Stating that the usefulness of the risk assessment is improved by using the total soil approach described in the text should not be true. Any good designer would evaluate the data to determine contours for excavation. Further, it is not clear what is meant by the term "..improves the economy..".**

Response: One of the purposes of the risk assessment is to characterize the site and provide as much useful information as possible to all stakeholders, including the public. The USACE and IT feel that the approach taken provides maximum information. Agreed; any good designer would evaluate the analytical data and the spatial distribution of contaminants to determine contours for excavation. However, being able to compare cleanup levels with STCs developed separately for surface

and subsurface soil may facilitate the design process. The term "...improves the economy..." refers to limiting remediation to the soil horizon (surface or subsurface) requiring action, as discussed in the penultimate paragraph of the response to the previous comment. We agree, however, that the sentence is not clear and will be deleted.

Comment 5: **Section 2.1.4, end of first paragraph. The text makes it sound as though the detections of DNT in the creek will not be addressed at all since their source is not in the TNT Area. Recommend adding the Area or OU under which they will be addressed.**

Response: Agreed that the paragraph in question is not clear; it was intended to describe a hypothetical situation to demonstrate the proper application of background data. Clarification will be improved by dividing the paragraph into two. The new paragraph will begin at the 11th line, "In addition, any class of organic compound...." The next two sentences will be revised as follows: "For example, consider the hypothetical situation in which concentrations of 2,4-DNT in the water in a creek meandering across TNT Area A are comparable to upgradient concentrations. In this case it is probably appropriate to conclude that 2,4-DNT is not a site-related chemical." Because the situation is hypothetical, there is no need to mention an area or OU under which 2,4-DNT in surface water will be addressed.

Comment 6: **Section 3.1.3 and subsections. When discussing the exclusion of pathways the term is used; "..are not quantified separately ?". The intent of the term is not clear. Recommend just stating that the exposure pathways are not quantified.**

Response: Agreed.

Comment 7: **Section 5.4.1 and 5.4.2. It is not appropriate for risk assessments to make risk management decisions. Text is included in both of these sections which recommends the use of residential risk-based remedial concentrations for residential reuse at the site because it "provides the more conservative evaluation.". Text recommending remediation goals should be deleted. Similarly, using the term "unacceptable" in regards to the risk estimated by the assessment is inappropriate. This is more of a risk management term and should be replaced with terms such as "..above the CERCLA risk range..".**

Response: The reviewer takes exception to what she perceives as inappropriately making risk management decisions in two ways: (1) recommending to adopt the RBRCs for the on-site resident as the proposed cleanup levels because this provides the more conservative evaluation (Sections 5.4.1, 5.4.2), and (2) declaring cancer risk estimates above 1E-4 to be unacceptable. Each will be addressed separately.

The USACE and IT strongly agreed that it is inappropriate for risk assessors to make risk management *decisions*. Risk assessors, however, may be in a better position than policy makers and other stakeholders to make risk management

suggestions based on professional judgement. In fact, a risk assessment is largely the application of professional judgement to protocol. However, we appreciate the reviewer bringing the phrase in question to our attention. Upon further reflection, it appears that a stronger defense than "more conservative evaluation" can be made for adopting the RBRCs for the on-site resident as the cleanup levels; i.e., the on-site resident is the most intensely exposed receptor. Therefore, the sentences in question in Sections 5.4.1 and 5.4.2 will be revised as follows: "It is suggested that the RBRCs developed for the on-site resident be adopted as the basis for the proposed cleanup levels for TNT Area (A or C), because the on-site resident is the most highly exposed of all plausible receptors for the site. Cleanup levels sufficiently protective for the most highly exposed receptor are sufficiently protective for all receptors." The suggestion to base cleanup levels on the most highly exposed receptor still contains an element of judgement that could be construed as risk management.

The use of the term "unacceptable" to describe cancer risk above 1E-4 is not so much the exercise of risk management as it is the expression of OEPA policy, as described in the last paragraph in Section 5.1. The inclusion of OEPA policy in this place in the document conforms to the desire of OEPA as expressed in comments on previous risk assessments for PBOW.

Comment 8: **Section 6.0, Sampling and Analytical Limitations. Regarding the high TNT hit; recommend adding discussion of why an outlier analysis was not performed.**

Response: The decision not to perform an outlier analysis is a matter of protocol as described in the first paragraph in Section 2.2.1. Concern arises not so much from including the high hit in the data set as from uncertainty regarding other unsampled locations that may contain high concentrations.

Comment 9: **Section 6.0, Selection of Hypothetical Receptors and Potential Exposure Pathways. Recommend adding text which discusses the pathways that were not quantified and how their exclusion affects uncertainty.**

Response: Please see response to Comment 10 below.

Comment 10: **Section 6.0, Selection of Hypothetical Receptors and Potential Exposure Pathways. Recommend adding the likelihood of the future land uses that were evaluated.**

Response: The USACE and IT appreciate Comments 9 and 10, which identify two serious omissions from the uncertainty analysis and provide the opportunity to correct the oversight. The paragraph in question will be revised and expanded as follows:

"The exposure scenarios chosen for evaluation address plausible receptors for the current and projected future site uses previously described. Although the specific uses to which the sites may be put are not entirely certain, the general categories (industrial, recreational, residential) are comprehensive and fairly standard. The

receptor scenarios selected for evaluation include the most intensely exposed for each general site-use category; therefore, uncertainty regarding the specific uses has no meaningful effect on interpretation of the RA. For example, the groundskeeper represents the upper bound on exposure for any industrial application. The indoor worker represents the upper bound on any worker indoor exposure, particularly relevant for VOCs that may gain entrance to a building from subsurface soil. The construction worker represents the upper bound on short-term exposure to soil, regardless of the nature or final product of a construction project. The hunter represents a plausible scenario for recreational site use and indirect (food-chain) exposure. Finally, the on-site resident represents the upper bound for residential site use. In fact, the resident is generally considered to represent the upper bound for any standard site use.

"Another source of uncertainty in the receptor scenarios is the decision not to quantify intake or uptake from certain exposure routes. For example, inhalation of VOCs in outdoor air that volatilized from subsurface soil by the groundskeeper, indoor worker and hunter is not quantified. It is assumed that overlying soil would attenuate emissions and that the large volume of outdoor air and natural air currents would dilute concentrations in the breathing zone to toxicologically insignificant levels. This assumption is based on considerable experience with volatilization models, and is consistent with the assumption applied by EPA (2000) in developing PRGs for soil. Although VOCs were identified in subsurface soil at TNT Areas A and C, their concentrations were below RBSCs, further reducing concern that a potentially significant exposure pathway was not evaluated.

"As another example, the groundskeeper and hunter are not evaluated for exposure to surface water or sediment, even though these receptors spend most of their time outdoors. Since contact with surface water would not be part of their normal activities, it is assumed that any exposure would be sporadic and would not readily lend itself to quantification. Also, such exposures should be viewed as repeated acute rather than chronic, which does not fit the EPA (1989) paradigm or the toxicity values developed for an RA. Finally, exposure to surface water is evaluated for the construction worker and on-site resident, who are expected to be more regularly exposed. Therefore, the decision not to evaluate surface water exposure for the groundskeeper and hunter is not seen as a significant source of uncertainty affecting the results or interpretation of the RA.

"The indoor worker is not evaluated for inhalation of airborne dust or VOCs from surface soil, or for dermal contact with surface soil, because these exposure routes are expected to be less significant than incidental ingestion, which is quantified. The decision not to quantify inhalation and dermal exposure imparts a non-conservative bias to the RA. However, inhalation and dermal contact are quantified for the groundskeeper, who is more intensely exposed by these routes. Risk estimates for the groundskeeper from inhalation exposure were negligible (Tables B.1-1, B.2-1). Therefore, it is assumed that inhalation exposure would be negligible for the indoor worker as well, and that the decision not to quantify this route had no meaningful effect on the outcome of the RA or its interpretation.

"The situation with dermal exposure is not so clear. Dermal risk estimates for the groundskeeper were significant at TNT Area C (Table B.2-1), although more than five-fold less than risk estimates for incidental ingestion. Although it is expected that the intensity of dermal exposure to soil would be much less for an indoor worker than an outdoor worker, dermal exposure parameters have not been developed for the indoor worker with which to test this assumption. Therefore, the decision not to evaluate dermal exposure represents a source of uncertainty that cannot be quantified.

"The construction worker and on-site resident are not evaluated for inhalation of VOCs from surface water or incidental ingestion of surface water, because these exposure routes are expected to be less significant than dermal exposure, which is quantified. The decision not to quantify inhalation and incidental ingestion imparts a non-conservative bias to the RA. However, concentrations of VOCs are less than EPA (2000) PRGs for tap water, which address inhalation in an indoor setting. Therefore, it is assumed that the decision not to quantify inhalation of VOCs for the construction worker and on-site resident had no meaningful effect on the outcome of the RA or its interpretation. The situation with incidental ingestion is not so clear. Although it is expected that the potential for incidental ingestion would be very low in a wading scenario, and far less significant than dermal uptake, exposure parameters for incidental ingestion have not been developed with which to test this assumption. Therefore, the decision not to evaluate incidental ingestion represents a source of uncertainty that cannot be quantified.

"The hunter is not evaluated for inhalation of dust from surface soil because this receptor is expected to spend most of his time on vegetated soil, and because inhalation exposure is expected to be far less than incidental ingestion of soil, which is quantified. However, inhalation is quantified for the groundskeeper, who is more intensely exposed. Risk estimates for the groundskeeper from inhalation exposure were negligible (Tables B.1-1, B.2-1). Therefore, it is assumed that inhalation exposure would be negligible for the hunter as well, and that the decision not to quantify this route had no meaningful effect on the outcome of the RA or its interpretation."

Comment 11: Section 6.0, Toxicity Assessment. Text needs to be added which discusses uncertainty associated with the use the toxicity value for 2,4/2,6-DNT mixture for the individual isomers.

Response: Agreed; the following will be added before the last paragraph under ***Toxicity Assessment*** in Section 6.0:

"Uncertainty regarding the cancer and noncancer toxicity values for the DNTs deserves special mention. The oral SF of 6.8E-1 per mg/kg-day for the 2,4-/2,6-mixture was applied to either isomer and total DNT. The SF was developed from a study with a mixture containing approximately 98 percent 2,4-DNT and 2 percent 2,6-DNT (EPA, 2001a). Other studies, however, suggest that the 2,6-

isomer is the more potent carcinogen, and 2,4-DNT alone was placed in cancer weight-of-evidence Group D – not classifiable as to carcinogenicity to humans. Application of the SF to 2,6-DNT alone seems to be a reasonable extension of the empirical data. Application of the SF to 2,4-DNT alone, however, may impart an unnecessarily conservative bias to the RA. On the other hand, it seems the prudent thing to do, especially considering that the 2,4-isomer constituted 98 percent of the mixture on which the SF is based. Application of the SF to the 2,4-isomer had a significant effect on the numerical results of the RA, because 2,4-DNT was a cancer risk driver for construction worker and on-site resident exposure to total soil at TNT Area A, and on-site resident exposure to total soil at TNT Area C. It had no effect on the interpretation of the RA because other chemicals (PCBs, 2,6-DNT, benzo[a]pyrene) were also identified as cancer risk drivers.

"The oral RfD for 2,4-DNT is 2E-3 mg/kg-day and the oral RfD for 2,6-DNT is 1E-3 mg/kg-day. Casual comparison of the oral RfD values suggests that the 2,6-isomer is slightly more toxic than the 2,4-isomer. The empirical data, however, suggest the opposite. This apparent discrepancy is an artifact of the lesser quality of the overall data base for the 2,6-isomer, necessitating the use of a 30-fold larger uncertainty factor in derivation of the RfD. Obviously, application of the oral RfD for 2,6-DNT to total DNT imparts a slightly conservative bias to the RA. However, the 2-fold difference between the oral RfD values for the two isomers is well within the level of uncertainty generally associated with RfDs. Furthermore, total DNT was not a noncancer risk driver for any receptor/medium combination. Therefore, application of the oral RfD for 2,6-DNT to total DNTs had no significant effect on the outcome or interpretation of the RA."

Comparison of Dinitrotoluene Results by GC/MS and HPLC Methods for Plumbrook Ordinance Works (PBOW)– 9154

Patricia A. Berrier, Senior Chemist

The semivolatile analysis results (Method 8270C – GC/MS) and nitoraromatic explosives analysis results (Method SW 8330 - HPLC) were compared for PBOW sample AA00426. The comparison focused on the results for 2,4 – Dinitrotoluene and 2,6 – Dinitrotoluene by both methods. The results obtained by Method 8270C were substantially higher than those reported by Method 8330. No errors or unusual data problems were observed in the results from either method. Several specific differences between the methods that could result in disparate results were evaluated including:

- Method and instrumentation differences
- Sample heterogeneity
- Sample aliquot size and selection prior to sample preparation in the laboratory
- Compounding of error based on dilution of highly concentrated samples

Method 8270C utilizes GC/MS instrumentation. The GC provides compound separation, identification, and quantification based on retention times. The MS detector provides positive confirmation of the compound by generating a mass spectrum. Method 8330 utilizes HPLC to separate, identify and quantify compounds. Confirmation is achieved by a second run utilizing a second detector or column.. The report for Method 8330 showed that 2,4- and 2,6-DNT co-elute, and were reported together as 2,4-DNT. Method 8270C achieves separation of these two isomers and allows each compound to be quantitated individually. GC/MS has the added advantage of providing positive compound identification by generating a mass spectrum

Sample heterogeneity is always a concern with soil samples. The lab received more than one container for sample AA00426 according to the Chain-of-Custody. One container was labeled for Semivolatiles by Method 8270C and another container for Method SW 8330. Even if the soils were thoroughly mixed during sampling, it is quite possible that laboratory subsamples from different containers will differ in sample concentration. An RPD of 50% is generally quite acceptable for soil sample duplicates. It was not noted in the package whether the sample was course grained, fine grained or whether there was other non-homogeneous material mixed in the sample(s). Looking at the package, there was no indication of sample mishandling or other problems associated with sample preservation, packaging, shipping or receipt by the laboratory.

The initial step in the analysis process for both methods is the selection of a subsample for preparation. The laboratory selects subsamples from the sample container. In this case, 2.0 grams of soil were subsampled for Method SW 8330 and 30.01 grams for Method 8270C. Sample heterogeneity would be a significant source of difference here based on the difference in aliquot size.
The final sample extracts for the sample were analyzed at sample dilutions of 1:4000 and 1:200 for Method 8270C and Method 8330, respectively. This means any inaccuracy resulting from sample heterogeneity or subsample aliquot heterogeneity would be multiplied by factors of 4000

and 200. It becomes readily apparent that even small disparities are significantly compounded in highly concentrated samples requiring dilution of the extract.

It was noted during a review of the data packages that there was no spike recovery in the Matrix Spike or Matrix Spike Duplicate for the Method 8330 analysis. Surrogate recoveries were extremely low, approximately 5% and 16% in Method 8330. The matrix spike/matrix spike duplicate internal standards were outside the control limits for the undiluted Method 8270C analysis. The 1:1000 matrix spike results for Method 8270C were qualified ED, causing the results to be rejected because they were outside the calibration range and the spikes were diluted out. No spikes were recovered for the 1:4000 Method 8270C reanalysis. These types of problems in QC samples are indicative of sample matrix problems that yield significant variability in sample results. This variability is exacerbated when the large multipliers associated with sample dilutions are applied to the results. Laboratory control samples batched, prepped and run with each method showed acceptable recoveries, confirming that the QC problems were associated with the sample matrix and not the analytical procedure.

A review of the raw data including chromatograms and mass spectra did not reveal any problems. The instrument tunes were acceptable. Initial and continuing calibrations were recalculated and were found to be in agreement for response factors and % RSD's.

IT recommends using the results for 2,4 DNT and 2,6 DNT reported by Method 8270C. The co-elution of these two compounds in Method 8330 makes it impossible to assign a value to each compound individually. However, the Method 8270Cresults should be estimated because there was no surrogate recovery, no matrix spike/matrix spike duplicate recoveries and large RPD's. Any sample variability inherent in the difficult matrix was compounded by the large sample dilution. Neither method yielded data that would be definitive with respect to concentration; however it is clear from both samples that significant concentrations of 2,4- and 2,6-DNT are present in the sample.

Response to Comments
U. S. Army Center for Health Promotion and Preventive Medicine
Draft Baseline Ecological Risk Assessment Work Plan
Remedial Investigations and Feasibility Studies
TNT Area A and TNT Area C,
Plum Brook Ordnance Works, Sandusky, Ohio
June 2001

Comments received from L. Tannenbaum dated September 7, 2001.

Comment 1: **Page ES-1, Executive Summary. There is no Executive Summary for the latter half of Volume III (i.e., Volume IIIb, the ecological risk assessment for TNT Area C) corresponding to this one. Also, considering that the first sentences of the Executive Summary fully acknowledge that the baseline risk assessment is actually a "screening-level ecological risk assessment", references throughout the document should only be to potential for risk having been estimated, and potential for unacceptable risk to have been identified.**

Recommendation: Consider either supplying a separate Executive Summary for the risk assessment for TNT Area C, or broaden the present Executive Summary to address both TNT areas.

Modify the text throughout the document, changing references to "risk" to "potential for risk". As an example, in the fourth sentence of the Executive summary, add the words "potential for" before "unacceptable adverse risks". Regarding that change, consider removing the apparent redundancy ("unacceptable" and "adverse").

Response: An executive summary of TNT Area C was prepared for inclusion in the report. It is possible it was left out of your copy. The revised report will be sure to include executive summaries for each site. The term "potential" will be added to the text where appropriate, in order to reinforce the "screening-level" nature of the assessment.

Comment 2: **Page 1-1, Section 1.0, Introduction. Seemingly the third paragraph's mention of no ground water having been collected, is an indication that ground water is an irrelevant medium for direct evaluations within an ecological risk assessment (as opposed to the text's identification of relevant media). Is this the case? The text of pages 3-9 and 3-10 seems to give another impression – that the non-evaluation of ground water is due to samples not being available (thereby precluding an assessment) and ground-water discharge to surface water not being suspected.**

Recommendation: Modify the text here and on page's 3-9 and 3-10 to explain that ground-water samples are irrelevant in aquatic assessments

altogether. Indicate that whether or not ground-water discharge to surface water is occurring, the appropriate sampling to conduct is of the water body (surface water and sediment) potentially receiving the discharge.

Response: Text will be modified as recommended.

Comment 3: **Pages 2-5 and 2-6, Section 2.1.5, Species Inventory. Is there any particular reason for the Former PBOW being referred to in these pages as a "station"? Also, it might be prudent to underscore that the species reporting here is only for the "station" or installation proper, and <u>not</u> for TNT Area A, the area under evaluation. (Note: same is true of the text of pages 2-5 and 2-6 of Volume IIIb.)**

<u>Recommendation</u>: Please address the query regarding the term "station". Consider augmenting the text so as to indicate that TNT Area A-specific, B-specific species lists are not being provided here.

Response: The term "station" will be changed to "former PBOW." The text will be augmented so as to indicate that TNT Area A- and Area C-specific species lists are not being provided, but are for the installation proper.

Comment 4: **Page 2-16, Section 2.2.6, Summary of COPEC Selection. Two modifications of the various bullet points would assist the text.**

<u>Recommendation</u>: Please change "UCL" (of the arithmetic mean) to "<u>95%</u> UCL". Please reword the next-to-last bullet as: "rationale for selection or rejection of the COPEC", since this is consistent with the text that follows the bullet point list.

Response: Modifications will be performed as recommended.

Comment 5: **Page 2-20, Section 2.3.2, Aquatic Receptors. Seemingly the term "foraging factor" here is being used interchangeably with "area use factor". Is this the case?**

<u>Recommendation</u>: Please have the text indicate that for aquatic systems, "foraging factor" is the same as the "area use factor" of terrestrial systems.

Response: Text will be changed as recommended.

Comment 6: **Page 3-8, Section 3.1, Soil Exposure Pathway. The second sentence is actually making two assumptions. In addition to assuming that the trees translocate soil-borne contaminants, the text is also implying/assuming that the leaves fed on by the deer have contaminants in them. The latter may not be true.**

Recommendation: Although caveats regarding plant translocation of soil-bored contaminants are discussed in the Section's third paragraph, consider acknowledging the additional assumption discussed in the comment.

Response: The additional assumption will be added to the text as recommended.

Comment 7: Page 4-2, Section 4.2, Development of Reference Toxicity Values. The Wentsel et al. reference is not the (original) source of the information provided in Figure 4-1.

Recommendation: Please indicate here and at the base of Figure 4-1 that the source is: Ford, K.L., Applehans, F.M., and R. Ober. Development of Toxicity Reference Values for Terrestrial Wildlife, *in* HMCL/Superfund '92 Conference & Exhibition Proceedings, Hazardous Materials Control Resources Institute, Greenbelt, MD (1992).

Response: The original reference will be added to the text and figure as follows: "Ford et al. (1992) in Wentsel et al. (1996), and Ford et al. (1992) will be added to the reference list. IT requests a copy of the Ford et al. (1992) reference.

Comment 8: Page 5-1, Section 5.1, Terrestrial Plant Impact Assessment. What purpose is served in comparing soil source term concentrations with available plant benchmark concentrations, when the text here and elsewhere states that no signs of vegetative stress were noted?

Recommendation: Consider addressing the comment's point by elaborating the text here and in the corresponding text of Volume IIIb.

Response: Although no signs of vegetative stress were noted during the field reconnaissance, these site visits only provided a limited snapshot of vegetative conditions. The screening against available plant benchmarks provides additional information on potential phytotoxicity. No text change performed.

Comment 9: Page 5-3, Section 5.3, Predictive Risk Estimation for Terrestrial and Aquatic Wildlife. The text here needs to acknowledge several critical limitations of HQs. Note that the limitations are factual in nature and should override what a given agency or group "considers" HQs of any magnitude to represent.

Recommendation: Please expand the text here (and in the corresponding locations of Volume IIIb) to indicate that HQs are not measures of risk, are not population–based statistics, and are not linearly-scaled statistics. Have the added text note that an HQ above 1.0, even exceedingly so, does not guarantee that there is even one individual expressing the toxicological effect associated with a given chemical to which it is exposed. Consider referencing Tannenbaum, 2001. Human and Ecological Risk Assessment, Volume 7, No.1, pages 217-219, and Bartell, S.M., 1996. Ecological/Environmental Risk Assessment Principles and Practice. In: Kolluru, R., Bartell, S., Pitblado, R.

et al. (eds), Risk Assessment Management Handbook, pages 4.27 –4.28, 10.29-10.33. McGraw-Hill, NY, when acknowledging that HQs are only multiplicatives of a benchmark, and not a measure of risk. See Comment #10.

Response: Text will be revised as recommended. IT requests copies of the referenced citation pages.

Comment 10: Page 5-6, Section 5.5, Risk Description. The text's recommendation with regard to the NOAEL- and LOAEL-based HQS is that for those exceeding 1.0, additional study is recommended. Another critical point is overlooked.

Recommendation: Incorporate into the "Risk Description" and "Conclusions and Recommendations" sections that the HQ values produced are toxicologically impossible (i.e., they should mean that the site is devoid of animals being chemicals are acutely toxic), suggesting that there is more wrong functionally with the HQ statistic than there is with the site condition.

Response: Acute toxicity cannot be generally assessed, as only chronic toxicity data were used in the assessment. While it is obvious that the HQ statistic overestimates potential risks to wildlife at the site, we do not have enough information to state that the HQ values are "toxicologically impossible." Even though the unusually elevated HQs do not translate into the site being devoid of animal life, this finding does not support the suggestion that we may disregard the HQ approach. If there is an alternative to the HQ approach we may recommend, or a follow-on technique that we believe is more scientifically defensible, we may wish to present it in the document.

Response to USACE Nashville District (CELRN) Comments on the Draft Volume II -- Baseline Human Health Risk Assessment and the Draft Volume III – Ecological Risk Assessment TNT Areas A and C Remedial Investigation Former Plum Brook Ordnance Works Sandusky, Ohio

References: *September 18, 2001, e-mail with technical review comments from Lannae Long (CELRN) to Linda Ingram (CELRN).*

October 17, 2001, e-mail with CELRN responses to IT responses to the September 18, 2001 comments.

Comments for TNT A and C RI Volume II:

Comment 1: Section 2.3, page 2-16, para. 1 and 2: Provide rationale for PCB selection or de-selection. Was it RBSC or lack of detections etc?

Response: Agreed; in fact, the same criticism could be applied to the nitroaromatics and PAHs in the first paragraph (which begins on page 2-15), and to bis(2-ethylhexyl)phthalate and PAHs in the second paragraphs. The paragraphs in question will be revised as follows:

"Twenty-one metals were detected in the 10 on-site sediment samples from Lindsey Ditch (Table 2-8); however, no metals were selected as COPCs when soil background data were used to screen for site-related chemicals. Although the concentration of lead exceeds its BSC in soil, suggesting that a site-related contribution from surrounding soil had occurred, the MDC is well below the RBSC and it is concluded that lead in on-site sediment does not pose a threat to human health. Six nitroaromatics were identified in 1 to 7 samples. The MDC of total DNT (0.576 mg/kg) exceeded the sum of the MDCs for 2,4- and 2-6-DNT (0.147 mg/kg + 0.0844 mg/kg = 0.2314 mg/kg); therefore, the analytical result for total DNT was used instead of the results for the individual isomers. Concentrations of the nitroaromatics were all below their respective RBSCs so that none were selected as COPCs. Aroclor 1260 was the only PCB identified in on-site sediment; its MDC exceeded its RBSC and it was selected as a COPC. SVOCs, identified in 1 to 2 samples, include 1 phthalate ester and 7 PAHs. Only one PAH, benzo(a)pyrene, was selected as a COPC because its MDC exceeded its RBSC. Three VOCs were identified in 1 to 7 samples at concentrations well below their RBSCs; none were selected as COPCs.

"Twenty metals were detected in the 5 off-site sediment samples from Plum Brook (Table 2-9); however, no metals were selected as COPCs when soil background data were used to screen for site-related chemicals. Nitrobenzene was identified as the only nitroaromatic in off-site sediment. Its MDC was below the RBSC and the compound was not selected as a COPC. Aroclor 1260 was the

only PCB identified in on-site sediment; its MDC was below the RBSC and it was not selected as a COPC. SVOCs, identified in 1 to 4 samples, include 1 phthalate ester and 16 PAHs. Five PAHs had MDCs greater than their RBSCs and were selected as COPCs. Two VOCs were identified in 2 to 4 samples at concentrations well below their RBSCs; none were selected as COPCs."

Comment 2: **Section 3.1.2.1, page 3-6, para. 1: An additional rationale is that surface water is intermittent, which adds to the sporadic nature of contact to surface water.**

Response: Agreed; the last sentence of the paragraph in question will be revised as follows:

"It is assumed that any contact with the intermittent surface water or sediment in the streams..."

Comment 3: **Section 5.2, Lead, last para.: Replace the paragraph with the following: The second common exposure scenario addresses adult exposures to lead in soil. The method focuses on the estimation of blood lead concentrations in fetuses carried by women exposed to lead in soil. The method is based on a probability model for blood lead levels in adult women exposed to lead in soil, coupled with an estimated constant of proportionality between fetal and maternal blood lead levels, a geometric mean fetal blood lead concentration and empirically determined geometric standard deviation (U.S. EPA 1999). The statistical terms used in the method permit an equation to be used to establish an average adult blood lead concentration such that a fetus has not more than a 5 percent probability of blood lead concentrations exceeding 10 ug/dL. The risk assessment is considered to pass if the average adult blood lead level does not predict and excess of 5 percent probability that fetal blood lead levels exceed 10 ug/dL.**

U.S. EPA 1999. Use of the TRW Interim Adult Lead Methodology in Risk Assessment. Pat Van Leeuwen, EPA Region 5, Paul White ORD/NCEA.

Response: The reviewer suggests replacing the original paragraph describing the adult blood lead model, but mentions no technical deficiencies or errors in the original text, and gives no reason for the suggested change. The suggested replacement paragraph does not differ materially from the one it is intended to replace, except that it fails to address two common miss-applications of the model:

- The adult blood lead model should only be used for those sites where exposure of a young child is not plausible.
- Average rather than upper-bound values should be used in the model.

These potential miss-applications are addressed in the original paragraph.

The following is offered to capture the strengths of both the original paragraph and the reviewer's suggested revision:

"The second common exposure scenario addresses adult exposure, and is generally used where direct exposure of a young child is implausible, such as the work place (EPA, 1996b). The EPA (1996b) adult blood lead model is used for this purpose. The method focuses on estimating blood lead concentrations in the unborn children of women exposed to lead in soil. The method is based on a lognormal probability model for blood lead levels in women exposed to lead in soil, coupled with a proportionality constant that relates the blood lead level of the unborn child and the mother. An empirically determined geometric standard deviation of blood lead levels is used in a statistical term to estimate an average maternal blood lead level such that the unborn child has not more than a 5 percent probability of blood lead concentration exceeding the cutoff of 10 μg/dL. Average values must be used for soil lead concentration and the exposure variables as explained for the IEUBK. The risk assessment is considered to pass if the average blood lead level estimated for the mother results in not more than 5 percent probability of the blood lead level of the unborn child exceeding 10 μg/dL."

CELRN Response: **Comment 3 for TNT A and C RI Volume II: The response is unacceptable.**

Section 5.2, Lead, last paragraph: Replace the paragraph with the following to guarantee acceptable terminology.:

The second common exposure scenario addresses adult exposures to lead in soil in nonresidential exposure scenarios (U.S. EPA 1996). The method focuses on the estimation of blood lead concentrations in fetuses carried by women exposed to average concentrations of lead in soil (U.S. EPA 1999). The method is based on a probability model for blood lead levels in adult women exposed to lead in soil, coupled with an estimated constant of proportionality between fetal and maternal blood lead levels, a geometric mean fetal blood lead concentration and empirically determined geometric standard deviation (U.S. EPA 1999). The statistical terms used in the method permit an equation to be used to establish an average adult blood lead concentration such that a fetus has not more than a 5 percent probability of blood lead concentrations exceeding 10 ug/dL (U.S. EPA 1996). The risk assessment is considered to pass if the average adult blood lead level does not predict and excess of 5 percent probability that fetal blood lead levels exceed 10 ug/dL, as interpreted by the TRW for the established cleanup goal to limit childhood risk of exceeding 10 ug/dL to 5% (U.S. EPA 1994, 1996).

U.S. EPA 1994. Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. OSWER Washington D.C.

U.S. EPA 1996. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risk Associated with Adult Exposures to Lead in Soil. Pat Van Leeuwen, EPA Region 5, Paul White ORD/NCEA.

U.S. EPA 1999. Use of the TRW Interim Adult Lead Methodology in Risk Assessment. Pat Van Leeuwen, EPA Region 5, Paul White ORD/NCEA.

Response: Agreed. IT has revised the document by replacing the original paragraph with the paragraph provided by the reviewer above.

Comment 4: Table 2-1: Define general chemistry.

Response: The following will be added as a definition at the bottom of Table 2-1: "General Chemistry limited to percent solids."

Comment 5: Table 2-5, chromium and thallium: The MDCs exceed both background and RBSCs. The 95% UCLs doe not exceed either screening level. Either include chromium and thallium in the list of COPCs, or add additional text in the risk assessment work plan and Section 2.1.5 of the RI Vol. II, stating the rationale for de-selection of these two chemicals.

Response: Please see footnote "e" in Table 2-5. The "N (d)" designation for chromium and thallium in the "COPC?" column indicates that the Mann-Whitney U test demonstrated that the site data set is equivalent to the background data set, and refers the reader to Appendix A where the results of the Mann-Whitney U test are presented and interpreted. Also, the second paragraph in Section 2.3.1 (results of the data evaluation for TNT Area A) discusses the interpretation of the Mann-Whitney U test. It would be inappropriate to discuss the matter further in Section 2.1.5, which describes risk-based screening.

Comment 6: Table 5s: Significant figures should be considered for total HI and risk value presentation.

Response: As explained in the second paragraph in Section 5.4, risk estimates in the calculation tables are presented in scientific notation rounded to two places to the right of the decimal to facilitate review. Discussions in the text round risk estimates to one significant figure (or the nearest integer) to reflect the uncertainty about these values. Consideration was given to similarly rounding the total ILCR and HI rows of the risk summary tables as suggested by the reviewer. However, there was concern that rounding in the tables could confuse a lay person attempting to replicate the figures, or worse, that rounding could appear to reflect manipulation of the data, particularly if the reader looks at tables before reading the explanation provided in Section 5.4 of the text. It was decided not to change the risk summary tables for these reasons.

Comments for TNT A and C RI Volume III:

Appendix E, Mallard Duck: what is the home range and migratory schedule?

Response: The following information will be added to Appendix E:

"The typical home range of the mallard is from 540 to 620 hectares (ha) for adult female and male birds, respectively, for wetlands and river habitat in Minnesota (USEPA, 1993). For the current ERA, an average home range of 580 ha was used. The typical migration schedule is from mid-March through mid-May for the spring migration. The fall migration typically starts in mid-October, and peaks in November (USEPA, 1993)."

Response to Ohio Environmental Protection Agency Comments
on the Draft
Volume III -- Ecological Risk Assessment
TNT Areas A and C Remedial Investigation
Former Plum Brook Ordnance Works
Sandusky, Ohio

Ecological Risk Assessment Specific Comments:

Comment 1: **Section 2.2.1 Data Organization, page 2-9 and Section 3.1 Exposure Analysis, Soil Exposure Pathway, page 3-8: The rationale for selecting the soil interval of 0-6 feet should be included in this discussion. The reasoning for this interval is not apparent in the report at this stage. This information would help the reader understand why this interval was selected.**

Response: Text will be added that states the following: "The 0-6 foot depth interval was selected for three primary reasons, (1) to maintain consistency with other PBOW ecological risk assessments (e.g., TNT Area B and the Red Water Ponds) that used this depth interval; (2) to include potential exposure to the shrew, a representative burrowing insectivorous mammal; and (3) to increase the size of the total soil data base by including samples collected from a depth interval of 4-6 feet. Although the shrew itself may not actually burrow to a depth of six feet, there may be other burrowing mammals that do burrow this deep."

Comment 2: **Section 2.2.6 Summary of COPEC Selection, page 2-16: Explain how samples with elevated detection limits were handled in the ecological risk assessment when developing exposure point concentration for ecological receptors.**

Response: Text will be added that states: "All non-detect sample results, including samples with elevated detection limits, were treated numerically as one-half of the analytical detection limit when calculating the 95% UCL. If a constituent was selected as a COPC, the exposure point concentration was the 95% UCL or the maximum dectected concentration, whichever was lower."

Comment 3: **Section 7.0 Conclusions and Recommendations, page 7-1, last sentence in first paragraph: The acceptable risk level (ARL) for ecological risk is defined as the following:**

I) Environmental Hazard Quotient (EHQ), or environmental hazard

index (EHI) where appropriate of less than or equal to one (rounded to one significant figure); and,

ii) No other observed significant adverse effects on the health or viability of the local individuals or populations of species are identified.

If both criteria (I and ii above) are not exceeded, then the site is highly unlikely to present significant risks to endpoint species and a recommendation for no further ecological investigations should be made. If any criterion (I or ii above) is exceeded, then the site could present significant risks to endpoint species and a recommendation to move to the next step should be made. In this instance, the analyses should identify:

(1) the COPECs that clearly pose risks below the ARL and thus require no further action,
(2) the COPECs that currently constitute risks above the ARL and thus should be subject to remediation,
(3) the COPECs that may or may not pose a significant ecological risk but, because of elevated uncertainty, should also be subject to further investigation, monitoring, and/or remediation.
COPECs in (2) or (3) above are termed ecological contaminants of concern (ECOCs) and are the focus of either further investigations or remedial actions.

Therefore, based on the criteria stated above and on the results of risk evaluation based on NOAEL-based hazard index results for aquatic receptors, Ohio EPA does believe a recommendation for no further action on impacted sediment and surface water can be made based only on this information as presented in this report.

Response: Based on the above definition of ARLs, the NOAEL-based HI results for aquatic receptors suggest a recommendation of no further action for impacted sediment and surface water cannot be made based only on the information presented in the report (as HIs are above 1.0). However, based on the report discussion of limited aquatic habitat, no observed significant adverse effects on the health or viability of the local individuals or populations of species, and LOAEL-based HIs, the following recommendations were presented in Section 5.5 of the reports (Risk Descriptions):

TNT Area A: Based on uncertainties associated with estimating COPEC concentrations in aquatic insects, the limited amount and low quality of aquatic habitat at the site, and the relatively low hazard estimates using the LOAEL-based approach, neither remedial action or further study is recommended for surface

water and sediment at the site.

TNT Area C: Based on uncertainties associated with estimating COPEC concentrations in aquatic insects, and the limited amount and low quality of aquatic habitat at the site, remedial action is not recommended for surface water and sediment at the site at this time. However, given the elevated hazard estimates, additional study is recommended.

These recommendations for TNT Areas A and C may be merged with the Section 7 Conclusions and Recommendations.

OEPA's definitions of ARLs and when to progress to the next step do not take into account uncertainties and conservative approaches used in ERA process, habitat size, and habitat quality. When these important factors are taken into consideration, no further action appears to be a supportable conclusion for surface water and sediment at TNT Area A.

Final
Volume 3 - Ecological Risk Assessment

TNT Area A and C Remedial Investigations
Former Plum Brook Ordnance Works
Sandusky, Ohio

Prepared for:

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IT Project Nos. 807111 and 807112

Revision 1

November 2001

Volume 3 - Ecological Risk Assessment

TNT Area A Remedial Investigation
Former Plum Brook Ordnance Works
Sandusky, Ohio

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Revision 1

November 2001

Table of Contents

Page

List of Tables iii
List of Figures iv
List of Appendices vi
List of Acronyms vii
Executive Summary ES-1
1.0 Introduction 1-1
2.0 Problem Formation 2-1
2.1 Ecological Site Description 2-1
2.1.1 General Site Background 2-1
2.1.2 Surface Water 2-3
2.1.3 Wetlands 2-3
2.1.4 Vegetative Communities 2-3
2.1.5 Species Inventory 2-5
2.1.6 Threatened and Endangered Species Information 2-7
2.2 Selection of Chemicals of Potential Ecological Concern 2-9
2.2.1 Data Organization 2-10
2.2.2 Descriptive Statistical Calculations 2-11
2.2.3 Frequency of Detection 2-13
2.2.4 Natural Site Constituents (Background and Essential Nutrients) 2-13
2.2.5 Comparison to Risk-Based Screening Ecotoxicity Values 2-15
2.2.6 Summary of COPEC Selection 2-16
2.3 Selection of Assessment Receptors 2-17
2.3.1 Terrestrial Receptors 2-19
2.3.2 Aquatic Receptors 2-20
2.4 Ecological Endpoint (Assessment and Measurement) Identification 2-21
2.4.1 Assessment Endpoints 2-22
2.4.2 Measurement Endpoints 2-24
2.5 Ecological Site Conceptual Model 2-24

Table of Contents *(Continued)*

Page

3.0 Exposure Characterization 3-1
3.1 Exposure Analysis 3-1
3.2 Exposure Characterization Summary 3-10
4.0 Ecological Effects Characterization 4-1
4.1 Selection of Literature Benchmark Values 4-1
4.2 Development of Reference Toxicity Values 4-1
5.0 Risk Characterization 5-1
5.1 Terrestrial Plant Impact Assessment 5-1
5.2 Aquatic Biota Impact Assessment 5-1
5.3 Predictive Risk Estimation for Terrestrial and Aquatic Wildlife 5-3
5.4 Uncertainty Analysis 5-4
5.5 Risk Description 5-6
6.0 Risk Summary and Identification of Preliminary Remedial Action Objectives 6-1
7.0 Conclusions and Recommendations 7-1
8.0 References 8-1

List of Tables

Number	Title	Follows Tab
2-1	Vegetative Community Types	
2-2	Common and/or Frequent Vascular Plant Species Observed at TNT Area A	
2-3	Mammals Observed On Site and Likely to be Found in Erie County, Ohio	
2-4	Birds Observed On Site and/or Likely to be Breeding in Erie County, Ohio	
2-5	Reptiles Observed On Site and Likely to be Found at Plum Brook Ordnance Works	
2-6	Amphibians Observed On Site and Likely to be Found at Plum Brook Ordnance Works	
2-7	Fish Observed On Site at Plum Brook Ordnance Works	
2-8	TNT Area A Sample List	
2-9	Background Concentrations of Metals in Soil	
2-10	Statistical Summary and COPEC Selection of Surface Soil Sample Analyses	
2-11	Statistical Summary and COPEC Selection of Total Soil Sample Analyses	
2-12	Statistical Summary and COPEC Selection of Surface Water Sample Analyses	
2-13	Statistical Summary and COPEC Selection of Sediment Sample Analyses	
2-14	Assessment and Measurement Endpoints and Exposure Delineation	
3-1	Data Used to Model Exposure in the Indicator Wildlife Species	
3-2	Octanol-Water Partition Coefficients for Organic Chemicals of Potential Ecological Concern	
3-3	Fate and Transport Factors for Inorganic Chemicals of Potential Ecological Concern	
3-4	BCF Selection, Sediment to Invertebrate BCF	
3-5	BAF Selection, Soil to Invertebrate BAF	
4-1	NOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern	
4-2	LOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern	
4-3	Uncertainty Factors for Ecological RTV Extrapolations	
5-1	Terrestrial Plant Impact Assessment	
5-2	Aquatic Biota Surface Water Impact Assessment	
5-3	Summary of Surface Water Field Parameters	
5-4	Aquatic Biota Sediment Impact Assessment	
5-5	Terrestrial Receptors NOAEL-based Hazard Index Summary for TNT Area A	
5-6	Terrestrial Receptors LOAEL-based Hazard Index Summary for TNT Area A	

List of Tables *(Continued)*

Number	Title	Follows Tab
5-7	Aquatic NOAEL-based Hazard Index Summary for TNT Area A	
5-8	Aquatic LOAEL-based Hazard Index Summary for TNT Area A	
5-9	Uncertainty Analysis	

List of Figures

Number	Title	Follows Tab
2-1	Site Photographs (Nos. 1-2)	
2-2	Site Photographs (Nos. 3-4)	
2-3	Site Photographs (Nos. 5-6)	
2-4	Site Photographs (Nos. 7-8)	
2-5	Vegetative Communities, TNT Area A	
2-6	Simplified Terrestrial Food Web Conceptual Site Model	
2-7	Simplified Aquatic Food Web Conceptual Site Model	
4-1	Procedural Flow Chart for Deriving Reference Toxicity Values from Class-Specific Toxicity Data	

List of Appendices

Appendix A	Vascular Plant Species Observed On Site
Appendix B	Letter from Botanical Expert
Appendix C	Compilation of Risk-Based Screening Ecotoxicity Values
Appendix D	Ecological Toxicity Profiles
Appendix E	Assessment Receptor Profiles (ARP)
Appendix F	Glossary of Terms (Ecological)
Appendix G	Ecological Risk Characterization Spreadsheets
Appendix H	Application of Essential Nutrients in Ecological Risk Assessment

List of Acronyms

AOC	area(s) of concern
ARP	assessment receptor profile
BAF	bioaccumulation factor
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
BTAG	Biological Technical Assistance Group
COPEC	chemical(s) of potential ecological concern
CT	central tendency
DNAP	Ohio Division of Natural Areas and Preserves
DNT	dinitrotoluene
EDQL	ecological data quality levels
Eh	redox potential
ESBSNP	Erie Sand Barrens State Nature Preserve
EPA	U.S. Environmental Protection Agency
ESCM	ecological site conceptual model
FCM	food-chain multiplier
H_o	null hypotheses
HQ	hazard quotient
IT	IT Corporation
LC_{50}	lethal concentration for 50 percent of population
LD_{50}	lethal dose for 50 percent of population
LOAEL	lowest observable adverse effects level
MDC	maximum detectable concentration
mg/kg	milligrams per kilogram
msl	mean sea level
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observable adverse effects level
NWI	National Wetland Inventory
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
OME	Ontario Ministry of the Environment and Energy

List of Acronyms *(continued)*

PAH	polycyclic aromatic hydrocarbons
RME	reasonable maximum exposure
PBOW	Plum Brook Ordnance Works
PEM	palustrine emergent wetlands
PSS	palustrine shrub/shrub wetland
RBSEV	risk-based screening ecotoxicity value
RTE	rare, threatened, or endangered
RTEC	Registry of Toxic Effects Concentrations
RTV	reference toxicity value
SQL	sample quantitation limit
TF	transfer factor
TNT	trinitrotoluene
UCL	upper confidence limit
USFWS	U.S. Fish and Wildlife Service
UTL	upper tolerance limit
WQC	water quality criteria

Executive Summary

A baseline ecological risk assessment was performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases within trinitrotoluene Area A at the former Plum Brook Ordnance Works in Sandusky, Ohio. The results of the baseline ecological risk assessment contribute to the overall characterization of the site and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives, if necessary. The primary objective of the assessment was to determine whether the potential for unacceptable risks are posed to ecological receptors as a result of potential hazardous substance releases. This objective was met by characterizing the ecological communities in the vicinity of the site, determining the particular hazardous substances being released from the site, identifying pathways for receptor exposure, and estimating the magnitude and likelihood of potential risk to identified receptors. The assessment addresses the potential for adverse effects to the vegetation, wildlife, aquatic life (aquatic macro-invertebrates), endangered and threatened species, and wetlands or other sensitive habitats associated with the site.

Vegetative communities at the site were classified during two site reconnaissance trips. The three largest community types observed at the site were upland old fields, shrub thicket, and successional woods. The existing Engineering Building area is considered a disturbed or developed area. Wetland communities identified included shrub/shrub wetland, and small wet meadows and marshes. Vegetative stress attributable to chemicals was not observed at the site, even at the trinitrotoluene hot spots. The site reconnaissance documented the following threatened or endangered species of plants at the site:

- Fringed gentian (*Gentianopsis crinita*) - Ohio potentially threatened species
- Bayberry (*Myrica pensylvanica*) - Ohio endangered species.

Based on site reconnaissance information, it does not appear that significant ecological threats exist at the site, as there was no definitive absence of biota or animal life in areas expected to support these ecological components.

A comparison was made between the maximum detected concentrations of chemicals in sampled media and the risk-based screening ecotoxicity values for ecological endpoints of concern. Chemicals that exceeded the screening values, or for which no screening values were available, were retained as "chemicals of potential ecological concern" and were assessed further. Fourteen chemicals of potential ecological concern were selected for surface soil, eighteen were selected for total soil, nineteen were chosen for surface water, and twenty one were chosen for sediment. For these chemicals, exposure point concentrations were estimated using the 95 percent upper confidence limit methodology.

Seven representative receptor species that are expected or possible at the site were selected as indicator species for the potential effects of the chemicals of potential ecological concern. The seven species selected included the deer mouse, short-tailed shrew, Eastern cottontail rabbit, marsh wren, white-tailed deer, raccoon, and red-tailed hawk. Two aquatic representative receptors were selected, including the raccoon (also considered as a terrestrial receptor) and the mallard.

The assessment endpoints for the site were the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds. Measurement assessment endpoints, or measurable responses to stressors, included lowest observed adverse effect levels and no observed adverse effect levels, collectively termed "toxicity endpoint values." In addition, critical effect values for surface water, sediment, and soil were also selected as measurement endpoints.

The assessment developed an estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to chemicals that are present at or migrating from the site, considering both current and reasonably plausible future use of the site. The exposure assessment was conducted by linking the magnitude (concentration) and distribution (locations) of the chemicals detected in the media sampled during the investigation, evaluating pathways by which chemicals could be transported through the environment, and determining the points at which organisms found in the study area could contact chemicals. For terrestrial and aquatic receptors, the calculation of exposure rates relied upon determination of an organism's exposure to chemicals measured in surface water, sediment, and/or soil, and on transfer factors used for food-chain

exposure. Both literature values, and site-specific values from Red Water Pond studies at Plum Brook Ordnance Works, were used as transfer factors for food-chain exposure.

The risk characterization phase integrated information on exposure, exposure-effects relationships, and defined or presumed target populations. This resulted in a determination of the likelihood, severity, and characteristics of adverse effects to environmental stressors present at the site. Qualitative and semiquantitative approaches were taken to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to chemicals. Potential adverse affects to terrestrial plants were qualitatively assessed by comparing plant toxicity benchmarks with chemical concentrations. Potential adverse impacts to aquatic biota were qualitatively assessed by comparing surface water and sediment quality criteria for the protection of aquatic life with surface water and sediment chemical concentrations.

For the semiquantitative predictive assessment, reference toxicity values and exposure rates were calculated and were used to generate hazard quotients, by dividing the receptor exposure rate for each chemical by the calculated reference toxicity values. Hazard quotients are a means of estimating the potential for adverse effects to organisms at a contaminated site, and for assessing the potential that toxicological effects will occur among site receptors.

Soil chemical impacts to terrestrial plants were estimated to be generally insignificant, except for perhaps elevated levels of 2,4,6-trinitrotoluene, lead, and zinc. No vegetative stress was observed on site. Potential surface water chemical impacts to aquatic biota were of most concern for carbon disulfide, aluminum, barium, calcium, copper, iron, silver, and zinc. Potential sediment chemical impacts for aquatic biota were of most concern for Aroclor-1260, lead, mercury, and nickel. Considerations of small sample size suggested that these findings should be confirmed based on additional sampling before any remedial actions are considered. In addition, limited aquatic habitat at the site reduces the concern for impact to aquatic biota, and low dissolved oxygen, elevated turbidity, and other nonchemical stressors measured in surface water suggests that overall water quality is poor. Terrestrial receptors (especially mice, rabbits, shrews, raccoons, and wrens) were predicted to incur elevated hazards from exposure to Aroclor-1260, lead, 2,4,6-trinitrotoluene, and calcium in soil, based on both no observed adverse effect level- and lowest observed adverse effect level-based hazard quotient approaches. As calcium is an essential nutrient, it is unlikely this inorganic is a true risk driver in site soils. Based on

uncertainties of toxicity, and on the fact that no rare, threatened, or endangered wildlife species have been confirmed at the site, remedial actions solely to address ecological concerns are not warranted at this time for soil. However, as estimated hazards were above 1,000 for some receptors using the no observed adverse effect level-based approach, and above 100 for some receptors using the lowest observed adverse effect level-based approach, additional study is recommended. Alternatively, if human health risks or hazards are unacceptable and chemical-specific human health preliminary remediation goals are being developed for the site, these remediation goals may be evaluated to (1) determine if they are also protective of the environment; or (2) determine if they will reduce the estimated baseline ecological hazards by a significant amount.

Aquatic receptors were predicted to have elevated hazards from exposure to Aroclor-1260, 2,4,6-trinitrotoluene, 2-amino-4,6-dinitrotoluene, mercury, and fluoranthene in sediment, based on both no observed adverse effect level- and lowest observed adverse effect level-based hazard quotient approaches. Although hazards were estimated to be between 50 and 100 for the mallard and raccoon using the no observed adverse effect level-based approach, when the lowest observed adverse effect level-based approach was used, estimated hazards dropped to 10 or less. Based on uncertainties associated with estimating chemical concentrations in aquatic insects, the limited amount and low quality of aquatic habitat at the site, and the relatively low hazard estimates using the lowest observed adverse effect level-based approach, neither remedial action or further study is recommended for surface water and sediment at the site.

1.0 Introduction

A baseline ecological risk assessment (BERA) has been performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases within trinitrotoluene (TNT) Area A at the former Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio. The results of the BERA contribute to the overall characterization of the site and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives, if necessary. The BERA has been performed following the Ohio Environmental Protection Agency (OEPA)-approved work plan (IT, 2001a) that was based on general guidelines of the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel, et al., 1996), with secondary guidance from *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (U.S. Environmental Protection Agency [EPA], 1997), and *Region 5 Biotechnical Assistance Group (BTAG) Ecological Risk Assessment Guidance Bulletin No. 1* (EPA, 1996a).

The primary objective of the BERA is to determine whether the potential for unacceptable risks are posed to ecological receptors as a result of potential hazardous substance releases. This objective is met by characterizing the ecological communities in the vicinity of the site, determining the particular hazardous substances being released from the site, identifying pathways for receptor exposure, and estimating the magnitude and likelihood of potential risk to identified receptors. The BERA addresses the potential for adverse effects to the vegetation, wildlife, aquatic life (aquatic macro-invertebrates), endangered and threatened species, and wetlands or other sensitive habitats associated with the site.

Concentrations of chemicals have been measured in relevant environmental media including soil, surface water, and sediment. No groundwater data have been collected for the TNT Area A site, however, groundwater data are irrelevant for use in aquatic assessments as surface water data are used to assess aquatic exposure. Using available concentration data, IT Corporation (IT) has performed a BERA, including a problem formulation (Section 2.0); an exposure characterization (Section 3.0); an ecological effects characterization (Section 4.0); a risk characterization (Section 5.0); a risk summary and identification of preliminary remedial action objectives (Section 6.0); and conclusions and recommendations (Section 7.0). References are presented in Section 8.0.

IT has evaluated the chemicals of potential ecological concern (COPEC), the ecosystems and receptors at risk, the ecotoxicity of the contaminants known or suspected to be present, and observed or anticipated ecological effects. This evaluation has been conducted in two steps: (1) a screening assessment step and (2) a predictive assessment step. Ecological endpoints to be addressed in both steps have been identified. The results and conclusions of the screening assessment determine whether a predictive assessment is required. The criteria by which a predictive assessment is needed have been formalized as null hypotheses (H_o) to be accepted (in which case a predictive assessment is not needed) or rejected (in which case a predictive assessment is needed).

2.0 Problem Formulation

The screening assessment H_0 are stated as follows:

- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **viable habitat** for potential ecological receptors.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **potential ecological receptors**.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **potential exposure pathways**.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **potential chemical stressors**.

If one or more of these H_0 are accepted, a predictive assessment is not triggered. All four H_0 must be rejected for a predictive assessment to be triggered. The first three H_0 are tested with the results of the ecological site description (Section 2.1). The fourth H_0 hypothesis is tested with the results of COPEC selection (Sections 2.2 and 2.3).

If a predictive assessment is triggered, terrestrial and aquatic ecological conceptual site models are developed, as appropriate, and additional problem formulation tasks are performed, as described in Sections 2.4 to 2.6.

2.1 Ecological Site Description

This ecological site description section includes a general discussion of site background and areas of concern (AOC), surface water resources, wetlands, vegetative communities, a species inventory, and a discussion on threatened and endangered species.

2.1.1 General Site Background

PBOW, approximately 6,453 acres in size, is located within the Eastern Lake Plains physiographic region of the Eastern Huron/Erie Lake Plain Ecoregion (Lafferty 1979; Omernik, 1986). This region is generally characterized as containing flat plains as the predominant land-surface form and as having a dominant natural vegetation of elm and ash in undisturbed areas. Approximately two-thirds of Erie County was once covered by a glacial lake that produced

features such as beach ridges and wave-cut cliffs. Much of the region is poorly drained due to the flat topography and low stream gradients. Many of the wetlands adjacent to Lake Erie in this region have been preserved by various federal, state, and private organizations (Peterjohn and Rice, 1991), thereby providing important wetland habitat for wildlife.

Across PBOW, the land slopes gently to the north-northeast towards Lake Erie. Elevations range from 675 feet above mean sea level (msl) at the southwest edge of the site to 625 feet msl in the northern portion of the property at Bogart Road, resulting in an average slope of approximately 0.3 percent. The Lake Plains region itself is over 69 percent cropland, 2.7 percent pasture land, and 10.5 percent forest (Ohio Department of Natural Resources [ODNR], 1985). However, since the Trojan Power Company (the previous PBOW owner) acquired the site in the early 1940s and removed the land from agricultural production, undeveloped portions of the former PBOW have become second generation forest and open fields. This has resulted in PBOW becoming an island of forest and open fields within a sea of agricultural land in north central Ohio.

TNT Area A, approximately 110 acres in size, is relatively flat with a few low hummocks. Elevations at the site range from a low of 633 feet along the northern boundary of the site to 660 feet on the southern side of TNT Area A. The native overburden and the soil found at most of the boring locations at TNT Area A consists predominantly of glacial derived silt overlying silty clay. The upper few feet of the silts and clays in the vicinity of TNT Area A have been grouped into the Hornell-Fries-Colwood Soil Association (Soil Conservation Services, 1971). The Hornell-Fries-Colwood soils are characterized as moderately deep to deep, somewhat poorly to very poorly drained soils formed in glacial till and lacustrine sediments over shale bedrock (ODNR, 1994; IT, 1996). The depth of overburden soils at TNT Area A range from approximately 4 to 5 feet in the southern portion of the site to depths greater than 10 feet in the north. The base of the overburden consists of weathered shale.

Surface water drains off the site to the north except in the vicinity of dinitrotoluene (DNT) Sweating & Graining House, Building 192 where surface water drains to the south. A topographic high (former railroad tracks) divides the location of Building 192 from the rest of TNT Area A. Based on site reconnaissance performed by IT ecologists on September 11 through 13, 2000 and May 21, 2001, a photographic record of the site was prepared and is presented in Figures 2-1 through 2-4. Prior to arrival at the site, IT personnel obtained relevant information on the site, including topographic maps; township, county, or other appropriate maps; and

determined the location of potential ecological units such as streams, creeks, ponds, grasslands, forest, and wetlands on or near the site. Additionally, the 1994 biological inventory of PBOW (National Aeronautics and Space Administration [NASA], 1995), which identifies and shows the locations of threatened and endangered species at PBOW, was reviewed. IT personnel completed a checklist similar to EPA's checklist for ecological assessment/sampling (EPA, 1997); also, information from this checklist was used to complete Section 2.0 herein. The location of known or potential contaminant sources affecting the site and the probable gradient of the pathway by which contaminants may be released from the site to the surrounding environment were identified. IT personnel used the reconnaissance to evaluate the site for more subtle clues of potential effects from contaminant release.

2.1.2 Surface Water

Surface water on the northern side of the site drains to ditches that are tributary to Lindsley Ditch, which flows to the north of the site and eventually into Plum Brook. Surface water in the area of Building 192 flows south, turns east, and eventually drains into Lindsley Ditch. Given the nature of the surface waters at the site, they are not likely to support significant populations of forage fish due to their shallow depth and intermittent nature.

2.1.3 Wetlands

According to the National Wetland Inventory (NWI) Maps for the area (U.S. Fish and Wildlife Services [USFWS], 1977), there are no designated wetlands at the TNT Area A site. It should be noted that the accuracy of NWI maps are limited, especially in relatively flat landscapes (such as PBOW) because minor depressions often contain isolated wetlands not easily identified through air photo interpretation (the process used by the USFWS in preparing NWI maps). As discussed in the following section, small wetland areas do exist at the site.

2.1.4 Vegetative Communities

Vegetative communities at the site were classified during the site reconnaissance trips using the 16 possible community types presented in Table 2-1. The three largest community types observed at the site were upland moderate and early old field (OFM, OFE), early shrub thicket (ESU), and moderate successional woods (FRM), as shown in Figures 2-1 through 2-4. The existing Engineering Building area is considered a disturbed or developed area (DEV). Wetland communities identified included palustrine shrub/shrub wetland (PSS), and small wet meadows

and marshes (classified as palustrine emergent wetlands [PEM]) (Photo Nos. 4 and 5 in Figures 2-2 and 2-3, respectively).

The general habitat figure (Figure 2-5) presents the type and extent of biological communities within the site. The most common plant species found in the five major vegetative communities are as follows:

Upland Old Field (OFM, OFE)
redtop
Canada thistle
crownvetch
fescue
grass-leaved goldenrod
sorrel
panic grass
mountain mint
blackberry
dewberry
foxtail grass
Canada goldenrod
horse nettle

Shrub Thickets (ESU)
black willow
blackberry
black raspberry
cottonwood
dogwoods
Tatarian honeysuckle

Successional Woods (FRM)
green ash
black cherry
Tatarian honeysuckle
Virginia knotweed
white snakeroot

Wet Meadows and Marshes (PEM)
grass-leaved goldenrod
black willow
broad leaved cattail
rushes
green bulrush

water plantain
rice cutgrass

Scrub/Shrub Wetlands (PSS)
shrubby dogwoods
green ash
sedges

Each of these habitat types can be expected to support different wildlife species assemblages; however, given the close proximity of the habitats to each other, many of the species (discussed below) would be expected to spend some amount of time within each community type for foraging, resting, and loafing activities, depending on the season.

During the site reconnaissance, the study area was examined for vegetative stress, including looking for plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage. Vegetative stress attributable to chemicals was not observed at TNT Area A, even at the TNT hot spots near Buildings 112 and 146 (Photo Nos. 6 through 8 in Figures 2-3 and 2-4). A few locations were devoid of vegetation, however, these areas occurred in disturbed areas where trenches were installed and backfilled during soil sampling (see bare areas in Photo Nos. 6 and 7 in Figures 2-3 and 2-4, respectively). Potential adverse impacts of chemical stressors on plant growth are discussed further in Section 5.1. Based on site reconnaissance information, it does not appear that significant ecological threats exist at the site, as there is no definitive absence of biota or animal life in areas expected to support these ecological components.

2.1.5 Species Inventory

Based on information from ODNR (1995) and collected during the site reconnaissance, species lists were prepared for plants, mammals, birds, reptiles, amphibians, and fish (Tables 2-2 through 2-7). Unless noted on the tables, the species listed in Tables 2-3 through 2-7 are for the former PBOW, and not TNT Area A itself.

Of the 365 plant species documented at the 6,453 acre former PBOW by the ODNR (Appendix A), 73 of the common or frequently observed species at the site are listed in Table 2-2.

Of the 43 species of mammals that may be found in the region based on species range maps, white-tailed deer were observed onsite during site reconnaissance (Table 2-3). Numerous deer

tracks were also observed during the site reconnaissance. Other mammals observed included cottontail rabbit and raccoon. It is likely that other species are present but were not observed due to the short duration of the field visits.

Of the 129 species of birds that may be found in the region based on species range maps, 105 species (81 percent) have been recorded at the former PBOW by the ODNR during their multi-year studies (Table 2-4). Thirteen bird species were documented at TNT Area A during the site reconnaissances performed by IT. Of the species recorded by the ODNR, 49 were neotropical migrants and would not be expected to nest at the former PBOW. ODNR (1995) notes that of the top 50 bird species recorded at the former PBOW, only 6 were ground nesters and 3 others occasionally nest on the ground, suggesting that ground nesters are having problems at the former PBOW. Burning practices used by NASA at the former PBOW, as well as the large deer population that feeds on much of the ground cover, limits the ground cover available for nesting birds and results in increased predation for these species (ODNR, 1995). It should be noted that NASA has recently altered its burning practices, burning approximately one-third of the former PBOW lands every year, rather than one-half of the lands as was performed in the past (Peecook, 1998). The 15 most abundant bird species recorded at the former PBOW by the ODNR included American robin; red-winged blackbird; European starling; song sparrow; common grackle; field sparrow; American goldfinch; indigo bunting; blue jay; common yellowthroat; brown-headed cowbird; house wren; gray catbird; northern cardinal; and cedar waxwing.

Of the 14 species of reptile that may be found in the region based on species range maps, ten species (71 percent) have been observed at the former PBOW, including turtles and snakes (ODNR, 1995; Table 2-5). During the site reconnaissance no reptiles were observed.

Of the 10 species of amphibians that may be found in the region based on species range maps, nine species (90 percent) have been observed at the former PBOW (ODNR, 1995; Table 2-6), including salamanders, toads, and frogs. During the site reconnaissance a leopard frog was observed.

According to ODNR (1995), a combination of electro shocking and seining was conducted during the field investigation that identified fourteen species of fish at PBOW. Species observed included suckers, sunfish, minnows, sticklebacks, and bullheads (Table 2-7). However, none are expected at TNT Area A given the limited surface water habitat.

In addition to the above wildlife, additional species observed during site reconnaissance included ants (active ant mounds), yellow jackets, honey bees, cicadae, monarch butterfly, Japanese beetles, and unidentified moth species.

2.1.6 Threatened and Endangered Species Information

According to an Ohio Division of Natural Areas and Preserves (DNAP) review of their natural heritage maps and files (Woischke, 1998), there are records of legal status threatened or endangered species within a 2-mile radius of the site. These species include the following:

- Sedge wren (*Cistothorus platensis*) - endangered
- Dwarf bulrush (*Lipocarpha micrantha*) - threatened
- Twisted yellow-eye-grass (*Xyris torta*) - threatened
- Field sedge (*Carex conoidea*) - threatened
- Least St. John's-wort (*Hypericum gymnanthum*) - endangered
- Flat-leaved rush (*Juncus platyphyllus*) - endangered
- Bushy aster (*Aster dumosus*) - threatened.

In addition, based on information contained in ODNR (1995), there are several species of threatened or endangered plants, potentially threatened plants, and threatened or endangered birds that have been recorded at PBOW, as follows:

- Grove sandwort (*Arenaria lateriflora*) - threatened
- Thin-leaved sedge (*C. cephaloidea*) - endangered
- Ashy sunflower (*Helianthus mollis*) - threatened
- Prairie false indigo (*Baptisia lactea*) - potentially threatened
- Broad-winged sedge (*C. alata*) - potentially threatened
- Round-fruited hedge-hyssop (*Gratiola virginiana*) - potentially threatened
- Tall St. John's wort (*H. majus*) - potentially threatened
- Virginia meadow beauty (*Rhexia virginica*) - potentially threatened
- Tall nut rush (*Scleria triglomerata*) - potentially threatened
- Lance-leaved violet (*Viola lanceolata*) - potentially threatened
- Winter wren (*Trogoldytes troglodytes*) - endangered
- Cattle egret (*Bublucus ibis*) - endangered
- Black-crowned night heron (*Nycticorax nycticorax*) - threatened
- Trumpeter swan (*Cygnus buccinator*) - endangered
- Upland sandpiper (plover) (*Bartramia longicauda*) - threatened
- Indiana bat (*Mytolis sodalis*) - endangered.

Furthermore, wild white lettuce - a species considered extinct in Ohio but common in prairie states - was recently found on site, although more than a mile from TNT Area A (Peecook,

1998). Based on the results of the site reconnaissance, no threatened or endangered species were found in TNT Area A, except for a few plant species, discussed in the next paragraph.

The site reconnaissance included detailed searches performed by a highly qualified botanist subcontractor during the late summer and spring site visits. After a careful evaluation, IT's subcontractor botanist documented the following threatened or endangered species of plants at TNT Area A (Figure 2-1 and Appendix B):

- Fringed gentian (*Gentianopsis crinita*) - Ohio potentially threatened species
- Bayberry (*Myrica pensylvanica*) - Ohio endangered species.

Although a potential specimen of *Carex houghtoniana* was initially recorded (a currently undocumented sedge in the State of Ohio, and if confirmed, would likely be placed on the State list of threatened and endangered species), further evaluation by a sedge expert determined that the species was actually *Carex pellita*, a common species found through the State (Appendix B).

None of the threatened or endangered bird species, with the possible exception of the sedge wren (also called the short-billed marsh wren) and the black-crowned night heron, would typically be expected to be found at the site. The winter wren, cattle egret, trumpeter swan, and upland sandpiper are all considered rare visitors or migrants at the former PBOW (ODNR, 1995), and have not been documented nesting within 1-mile of the site (Woischke, 1998).

Six sedge wren nesting sites were documented in the ODNR DNAP's data base for an area near the Pentolite Road Red Water Ponds area in old grassy field habitat during 1994 (Woischke, 1998). In the June 1994 sighting, eight sedge wrens were observed near the Pentolite Road Red Water Ponds and two were observed near the West Area Red Water Ponds, with 24 territorial birds and several fledglings identified at the PBOW (ODNR, 1995). Sedge wrens, an Ohio endangered species, have a preferred breeding habitat that consists of wet meadows, grassy marshes, and old grassy fields (Peterson, 1947) and moist grasses and sedge marshes or wet meadows with scattered low bushes (Bent, 1948). These habitat types are limited at TNT Area A, although there are a few wetland areas (Figure 2-5). Sedge wrens are very sporadic nesters, and birds may not arrive at a breeding colony until July or August and nesting continues into September (Trautman and Trautman, 1968). Draining of marshes has eliminated considerable

breeding habitat in Ohio and many recent colonies have been located in wet meadows and hayfields and have disappeared after these fields have been mowed (ODNR DNAP information).

The black-crowned night heron, an Ohio threatened species, is a regular visitor at ponds, streams, and ditches within the former PBOW, however, it does not nest at the former PBOW (ODNR, 1995; Woischke, 1998). The species is typically found near water and wetlands, and since the early 1980s there has been a nesting colony of approximately 100 pairs located on an island in Sandusky Bay approximately 10 miles north northwest of the study area (Peterjohn and Rice, 1991).

The Indiana bat has not been documented at the site, and is generally not expected in the area based on the fact that its preferred habitat (e.g., caves along streams or trees with exfoliated bark) is not present at TNT Area A. Trees with exfoliated bark, such as shagbark or shellbark hickory, are rare or not present at the site, thereby providing little bat roosting habitat (Appendix A).

With the exception of the Erie Sand Barrens State Nature Preserve (ESBSNP), there are no existing or proposed state nature preserves or scenic rivers near the site, and ODNR is unaware of any unique ecological sites, geological features, breeding or nonbreeding animal concentrations, champion trees, or state parks, forests, or wildlife areas within a 2-mile radius of the site (Woischke, 1998). The ESBSNP is located southwest of TNT Area A. The 32-acre preserve is a remnant sand beach of Lake Warren, the fifth ancestral Lake Erie, that supports many species of threatened and endangered plant species such as field sedge, Least St. John's wort, dwarf bullrush, twisted yellow-eyed-grass, flat-leaved rush, bushy aster, and Virginia meadow beauty. Many of the preserve's rare plant species thrive in open wind-swept conditions such as those found on the sand barrens. The DNAP actively manages the preserve to ensure that the open wind-swept areas remain and do not become overgrown with woody vegetation.

2.2 Selection of Chemicals of Potential Ecological Concern

A list of TNT Area A media samples is presented in Table 2-8. From the chemical results of samples on this list, IT has identified a subset of chemicals detected at the site that have data of good quality and are not naturally occurring or a result of nonsite sources. These chemicals are also present at sufficient frequency, concentration, and location to pose a potential risk to ecological receptors. Examples of screening criteria that have been used include the following: analytical detection limit; frequency of detection less than 5 percent; comparability with

background (Table 2-9); and comparison with risk-based screening ecotoxicity values. This selection process is described in more detail in the following subsections.

2.2.1 Data Organization

The data for each chemical have been sorted by medium. For ecological impacts, soil from 0 to 6 feet have been considered. The 0 to 6 feet depth interval was selected for three primary reasons, (1) to maintain consistency with other PBOW ecological risk assessments (e.g., TNT Area B and the Red Water Ponds) that used this depth interval; (2) to include potential exposure to the shrew, a representative burrowing insectivorous mammal; and (3) to increase the size of the total soil data base by including samples collected from a depth interval of 4 to 6 feet. Although the shrew itself may not actually burrow to a depth of 6 feet, there may be other burrowing mammals that do burrow this deep. Chemicals which are not detected at least once in a medium have not been included in the risk assessment. Available background data have been determined for each medium. Sources of background information include data from previous investigations.

The analytical data may have qualifiers from the analytical laboratory quality control or from the data validation process that reflect the level of confidence in the data. Some of the more common qualifiers and their meanings are (EPA, 1989):

- U - Chemical was analyzed for but not detected; the associated value is the sample quantitation limit.
- J - Value is estimated, probably below the contract-required quantitation limit.
- R - Quality control indicates that the data are unusable (chemical may or may not be present).
- B - Concentration of chemical in sample is not sufficiently higher than concentration in the blank (using five-times, ten-times rule).

"J" qualified data are used in the risk assessment; "R" and "B" qualified data are not. The handling of "U" qualified data (nondetects) is described in Section 2.2.2.

Occasionally, chemicals were analyzed under two different analytical programs. For example, the DNTs were analyzed by EPA Method 8330 for nitroaromatics as well as EPA Method 8270B for semivolatile organic compounds. EPA Method 8330 returns concentration values for total

DNT, but does not return isomer-specific data. EPA Method 8270B, on the other hand, returns concentrations for 2,4- and 2,6-DNT isomers, but does not return a value for total DNT. For each medium evaluated it was necessary to choose the results provided by one analytical method, rather than both to avoid double-counting and overestimating ecological hazard. Therefore, a rationale was developed to ensure that the most appropriate choice is consistently made.

Examination of the raw data (TNT Area A: Volume 1 *Report of Findings*, Part 2, Appendix D; TNT Area C: Volume 1 *Report of Findings*, Part 3, Appendix D) reveals that concentrations reported for total DNT sometimes exceed the sum of concentrations of the 2,4- and 2,6-isomers. In other cases, the sum of the concentrations of the 2,4- and 2,6-isomers exceeds the concentration reported for total DNT. No explanation is immediately apparent for this inconsistency, but it is clear that the analytical results from one given method cannot be selected for use in all cases because the full potential for hazards may be overlooked. Therefore, the method that yields the more conservative result is selected for each medium on an individual basis. In other words, the minimum detectable concentration (MDC) for total DNT is compared with the sum of the MDCs for 2,4- and 2,6-DNT. The method yielding the larger value is used.

2.2.2 Descriptive Statistical Calculations

Because of the uncertainty associated with characterizing contamination in environmental media, both the mean and the 95 percent upper confidence limit (UCL) of the mean have been estimated for each chemical in each medium of interest (Tables 2-10 through 2-13) . In general, "outliers" are included in the calculation of the UCL because high values in environmental data are seldom true statistical outliers. Inclusion of outliers increases the overall conservatism of the risk estimate, and the likelihood of rejecting the H_0 (i.e., there are no chemical stressors at the site).

Datasets have been tested for normality and lognormality based on the Shapiro-Wilk test (EPA, 1992a). Statistical analysis has been performed on all detected chemicals. If statistical tests support the assumption that the dataset is normally distributed, the UCL for a normal distribution is calculated. If the statistical analysis shows the data to be lognormally distributed, the UCL is calculated for a lognormal distribution. If a dataset passes both the normal and lognormal distribution tests, the distribution with the best fit is selected.

The UCL is calculated for a normal distribution as follows (EPA, 1992b):

$$UCL = \bar{x} + t_{1-\alpha, n-1} \; x \; (s/\sqrt{n}) \qquad \text{Eq. 2.1}$$

where:

$\bar{x}$ = sample arithmetic mean
t = critical value for student's t distribution
$1-\alpha$ = 0.05 (95 percent confidence limit for a one-tailed test)
n = number of samples in the set
s = sample standard deviation.

The UCL is calculated for a lognormal distribution as follows (Gilbert, 1987):

$$UCL = e^{\left(\bar{y} + (0.5 \cdot s_y^2) + \left[H_{0.95} \cdot \frac{s_y}{(n-1)^{0.5}}\right]\right)} \qquad \text{Eq. 2.2}$$

where:

$\bar{y}$ = $\sum y/n$=sample arithmetic mean of the log-transformed data, y = ln x
s_y = sample standard deviation of the log-transformed data
n = number of samples in the data set
$H_{0.95}$ = value for computing the one-sided 95 percent UCL on a lognormal mean from standard statistical tables (Land, 1975).

A nonparametric confidence limit is used when the data set fits neither a normal or a lognormal distribution. The nonparametric UCL is estimated as the 95 percent UCL rank order on the arithmetic mean of the dataset. It is estimated by ranking the data observations from smallest to largest. The arithmetic mean is converted to a percentile by interpolation. The rank order of the observation selected as the UCL is estimated from the following equation (Gilbert, 1987):

$$u = p(n + 1) + Z_{1-\alpha} \sqrt{np(1 - p)} \qquad \text{Eq. 2.3}$$

where:

u = upper confidence limit
p = percentile corresponding to the arithmetic mean
n = number of samples in the set
α = confidence limit; 95 percent
$Z_{1-\alpha}$ = normal deviate variable.

Analytical results are presented as "nondetects" ("U" qualifier) whenever chemical concentrations in samples do not exceed the detection or quantitation limits for the analytical procedures for those samples. Generally, the detection limit is the lowest concentration of a chemical that can be "seen" above the normal, random noise of an analytical instrument or analytical method. To apply the previously mentioned statistical procedures to a dataset with nondetects, a concentration value must be assigned to nondetects. Nondetects are assumed to be present at one-half the sample quantitation limit (SQL), although judgement is used in those cases where matrix interference or other phenomena drive the SQL unusually high. In the current assessment, all nondetect sample results including samples with elevated detection limits, were treated numerically as one-half of the analytical detection limit when calculating the 95 percent UCL. The UCL or MDC, whichever is smaller, is selected as the source-term concentration, and is understood to represent a conservative estimate of average for use in the risk assessment or in various transport models used to estimate exposure-point concentrations.

2.2.3 Frequency of Detection

Chemicals that are detected infrequently may be artifacts in the data that may not reflect site-related activity or disposal practices. These chemicals have not been included in the risk evaluation. Generally, chemicals that are detected only at low concentrations in less than 5 percent of the samples from a given medium are dropped from further consideration, unless their presence is expected based on historical information about the site. For the current assessment, nitroaromatics have not been dropped as COPECs as this group of constituents is site related. Chemicals detected infrequently at elevated concentrations as compared with applicable risk-based thresholds may identify the existence of "hot spots" and have been retained in the evaluation, unless other information exists to suggest that their presence is unlikely to be related to site activities.

2.2.4 Natural Site Constituents (Background and Essential Nutrients)

Chemical concentrations have been compared to background concentrations as an indication of whether a chemical is present from site-related activity or as natural background. This comparison is generally valid for inorganic chemicals, but not for organic chemicals, because inorganic chemicals are naturally occurring and most organic chemicals, besides polycyclic aromatic hydrocarbons (PAH), are not. Statistical techniques are used as tools to aid the exercise of professional judgement in resolving site-related issues for metals, since metals are naturally

present in most environmental media. The statistical techniques generally involve comparing the site data with background data.

The first statistical technique is the development of an upper tolerance limit (UTL) for background, and comparing the MDC with the UTL. Chemicals with MDCs less than the background UTL are eliminated from further consideration. If the MDC exceeds the UTL, the chemical is retained as a COPEC, or a more rigorous statistical analysis may be performed. The more rigorous statistical analysis would consist of comparing the site and background datasets to determine if both are drawn from the same population. The Wilcoxon Rank Sum test is often used for this purpose. For the current BERA, this more rigorous statistical analysis was not performed.

The UTL was calculated as follows:

$$UTL = \overline{X} + k(a) \qquad \text{Eq. 2.4}$$

where:

UTL	=	upper tolerance limit (confidence factor of 0.95 and coverage of 95 percent)
$\bar{x}$	=	arithmetic mean
a	=	standard deviation
k	=	tolerance factor

The same equation is used to estimate the UTL for lognormal distributions, but the data are log-transformed before the arithmetic mean and standard deviation are calculated.

As recommended by OEPA, if the estimated UTL was greater than the MDC, the MDC was used as the default background screening concentration. In addition, if the data were shown to be neither normal nor lognormal, a nonparametric distribution was assumed and the MDC was selected as the background UTL. Results are presented in Table 2-9. Background surface water results were not available. For background sediment, background soil values were used, as the shallow ditches at TNT Area A most likely accumulate sediment as a result of overland runoff from site soils.

It must be understood that statistical analysis is only a tool to aid the exercise of professional judgement. Site data from uncontaminated areas with concentrations at the high end of background may "fail" statistical testing because of the limitations of sample size, i.e., the full range of actual background and site variation was not captured. Statistical testing is based on absolute values, but the approximately 20 metals generally analyzed together constitute only approximately 4 to 5 percent of a given sample. Apparently high values of one or more metals may arise from a diminished amount of other constituents in soil, e.g., silica or organic matter, that may be more abundant in background areas. Therefore, it may be necessary to normalize the metal concentrations in site and background data before performing comparisons. However, for the current BERA, this additional analysis was not performed.

Essential nutrients such as calcium, chloride, iodine, magnesium, phosphorus, potassium and sodium (McDowell, 1992) were eliminated as COPEC only if their MDC did not exceed the background level, or they were infrequently detected (e.g., < 5 percent). Potential toxicity of these nutrients has been considered (Section 4.0).

2.2.5 Comparison to Risk-Based Screening Ecotoxicity Values

A comparison has made between MDCs of chemicals in sampled media and the risk-based screening ecotoxicity value (RBSEV) for ecological endpoints following recommendations received from OEPA and as discussed in EPA Region V BTAG Bulletin No. 1 (EPA, 1996a). Chemicals that exceeded the RBSEVs, or for which no RBSEV are available, have been retained as COPECs. The following RBSEVs, or RBSEV hierarchy (as noted) have been used for the ecological evaluation:

- ***Soil.*** Soil screening values have been selected using the following hierarchy: (1) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et. al. 1997a); (2); *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process* (Efroymson, Suter, and Will, 1997b); (3) *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants* (Efroymson et. al. 1997c); and (4) *Ecological Data Quality Levels* (EDQL) (EPA, 1999). It should be noted that effects on heterotrophic processes may not be relevant to ecological receptors of concern at the site.

- ***Groundwater.*** If groundwater is known to impact surface water at the site, surface water RBSEVs will be used, as presented below.

- ***Surface Water.*** The lowest surface water screening value has been selected from the following three sources: (1) Ohio EPA Water Quality Criteria (WQC) for the protection of aquatic life; (2) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et. al. 1997a); and (3) *Ecological Data Quality Levels* (EDQL) (EPA, 1999). Use of a hierarchy has not been used because this type of approach would potentially eliminate important surface water COPECs due to the fact that OEPA WQC do not consider food-chain effects.

- ***Sediment.*** Sediment screening values have been selected using the following hierarchy: (1) *Ecological Data Quality Levels* (EDQL) (EPA, 1999); (2) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et. al. 1997a); and (3) *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* (Ontario Ministry of the Environment and Energy [OME]; 1993).

Nonchemical stressors have also been assessed, using available surface water data collected on pH, turbidity, conductivity, dissolved oxygen (DO), redox potential (Eh), and temperature.

The results of the screening of the selected COPECs with RBSEV for ecological endpoints of concern are presented in Tables 2-10 through 2-13. COPECs are only selected for further consideration in the BERA if the MDC exceeded the available RBSEV. If no RBSEV was available, the constituent was carried forward for consideration in the BERA, unless it was within background or less than 5 percent occurrence. Note: Appendix C presents a compilation of the RBSEVs for each medium, and shows the final values that are used in the screening assessment.

2.2.6 Summary of COPEC Selection

Tables 2-10 through 2-13 have been prepared for each medium with the following information:

- Chemical name
- Frequency of detection
- Arithmetic mean of site concentrations
- Range of detected concentrations
- Range of detection limits
- Statistical distribution
- 95 percent UCL of the arithmetic mean
- Background screening criterion, if available
- Risk-based screening criterion, if available
- COPEC selection conclusion: YES or NO

- Rationale for selection or rejection of the COPEC
- Source-term exposure concentration that was used in the BERA.

Footnotes in the tables provide the rationale for selecting or rejecting a chemical as a COPEC. An evaluation of all of the constituents that were eliminated for further consideration was performed to determine whether any should be reinstated as COPECs due to other considerations. Examples of these exceptions include: potential break-down products; chemicals known to have been used on site historically; chemicals with detection limits greater than the RBSEV; and chemicals with high bioconcentration and/or bioaccumulation factors. Based on this evaluation, no additional COPECs are recommended. Although several constituents had some samples with elevated detection limits (e.g., PAHs and di-n-butylphthalate in soil samples SO-012 [Sample AA0426] and SO-279 [Sample AA0450]; bis(2-ethylhexyl)-phthalate in sediment sample SD-09 [Sample AA1009]); in general, detection limits were acceptable. The treatment of non-detect results is discussed in Section 2.2.2.

Fourteen COPECs have been selected for surface soil, eighteen have been selected for total soil, nineteen have been chosen for surface water, and twenty-one have been chosen for sediment. As discussed at the beginning of Section 2.0, given this selection of potential chemical stressors, and on the finding that viable habitat, potential receptors, and potential exposure pathways exist at the site, a predictive assessment is triggered. Chemicals not eliminated using the screening procedures previously presented are considered final COPECs and have been quantitatively evaluated in the predictive BERA. The relevant and important physical, chemical, and toxicological properties of the identified COPEC risk drivers have been reviewed from the scientific literature and are presented as COPEC profiles in Appendix D.

2.3 Selection of Assessment Receptors

IT has selected assessment receptors for evaluation during the predictive BERA. In order to focus the exposure characterization portion of the BERA on species or components that are the most likely to be affected, given the toxicological and mobility characteristics of the COPECs, and on those COPECs that, if affected, are most likely to produce greater effects in the on-site ecosystem, IT has focused the selection process on species, groups of species, or functional groups, rather than higher organization levels such as communities or ecosystems. Site biota are organized into major functional groups. For terrestrial communities, the major groups are plants and wildlife, including terrestrial invertebrates, mammals, and birds. For aquatic and/or wetland communities, the major groups are flora and fauna, including vertebrates (water fowl and fish),

aquatic invertebrates, and wetland/terrestrial mammals. Species presence at the site was determined during a literature review and during the site reconnaissance (Section 2.1.5 and 2.1.6) prior to identification of target receptor species.

Primary criteria for selecting appropriate assessment receptors included, but were not limited to, the following.

- The assessment receptor will have a relatively high likelihood of contacting chemicals via direct or indirect exposure.
- The assessment receptor will exhibit marked sensitivity to the COPECs given their mode of toxicity, propensity to bioaccumulate, etc.
- The assessment receptor will be a key component of ecosystem structure or function (e.g., importance in the food web, ecological relevance).
- The assessment receptor may be listed as rare, threatened, or endangered (RTE) by a governmental organization; or the receptor will consist of critical habitat for RTE species. Based on the availability of species-specific data, a RTE surrogate species may be selected (Section 2.3.1).

Additional criteria for selection of assessment receptors was used to identify species that offer the most favorable combination of characteristics for determining the implications of on-site contaminants. These criteria included: (1) limited home range; (2) role in local nonhuman food chains; (3) potential high abundance and wide distribution at the site; (4) sufficient toxicological information available in the literature for comparative and interpretive purposes; (5) sensitivity to COPECs; (6) relatively high likelihood of occurrence on site following remediation (if required); (7) suitability for long-term monitoring; (8) importance to the stability of the ecological food-chain or biotic community of concern; and (9) relatively high likelihood that they will be present at the site or that habitats present at the site could support the species.

It is important that sufficient toxicological information is available in the literature on the receptor species, or that a closely related species may be selected. While the ecological communities at the site have species with many desirable characteristics for use as receptor species, not all of these species have been used extensively for toxicological testing.

2.3.1 Terrestrial Receptors

Seven representative receptor species that are expected or possible in the area of TNT Area A (Section 2.1) were selected as indicator species for the potential effects of COPECs. These indicator species represent two classes of vertebrate wildlife (mammals and birds) and a range of both body size and food habits, including herbivory, omnivory, and carnivory. Note: potential impacts to terrestrial plants are considered in Section 5.1. The seven species selected include the deer mouse (*Peromyscus maniculatus*) (small, omnivorous mammal), short-tailed shrew (*Blarina brevicauda*) (small, insectivorous mammal), Eastern cottontail rabbit (*Sylvilagus floridanus*) (medium-sized herbivorous mammal), marsh wren (*Cistothorus palustris*) (small insectivorous bird), white-tailed deer (*Odocoileus virginianus*) (large herbivorous mammal), raccoon (*Procyon lotor*) (medium-sized omnivorous mammal), and red-tailed hawk (*Buteo jamaicensis*) (large, carnivorous bird). The marsh wren was selected as a surrogate for the sedge wren, an Ohio endangered species that has been documented in the general area and a species that may be expected on site given the availability of some preferred nesting habitat.

The deer mouse, shrew, Eastern cottontail, and wren represent the prey base for the larger predators of the area (represented by the red-tailed hawk). A terrestrial food web is presented in Figure 2-6. Many of these species have limited home ranges, particularly the deer mouse, cottontail, shrew, and marsh wren, which make them particularly vulnerable to exposure from site contaminants. All of the selected terrestrial receptor species have a potential high abundance and wide distribution at the site; also, sufficient toxicological information (with the exception of some bird species) is available in the literature for comparative and interpretive purposes. In addition, all of the selected species are likely to occur after site remediation (if risk management decisions require it). All species are considered important to the stability of the local ecological food chain and biotic community. Finally, all the selected species have readily-available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (EPA, 1993).

Larger mammal species were generally not selected as sensitive receptors due to their large home ranges; however, the far-ranging red-tailed hawk was retained due to its unique role as a top predator in the food chain and the white-tailed deer was retained due to its high abundance at the site. Smaller birds were generally not included because most are migratory. The potential risk to species with larger home ranges and migratory avian species will be included within the predicted risks to the selected terrestrial indicator receptors. Area use factors were conservatively set to 100 percent for the mouse, shrew, rabbit, wren, and raccoon, due to their

relatively small home ranges (Section 3.1). However, for the deer and hawk, the area use factor was set at 0.09 and 0.05 (or 9 and 5 percent), respectively, based on these two species' relatively large home ranges (518 and 842 hectares, or 1,280 and 2,081 acres, respectively), compared with the size of the site (approximately 110 acres, Figure 2-5).

Results of the assessment receptor selection process are presented in detailed biological and ecological descriptions called assessment receptor profiles (ARP). Additionally, the biologically relevant criteria used to select the seven terrestrial assessment receptors are discussed and summarized in the ARP (Appendix E).

2.3.2 Aquatic Receptors

The only aquatic habitats at the site include the surface water on the northern side of the site that drains to ditches that are tributary to Lindsley Ditch and surface water in the area of Building 192 that flows south, turns east, and eventually drains into Lindsley Ditch, in addition to small isolated PSS wetlands and small wet PEM (Photo Nos. 4 and 5 in Figures 2-2 and 2-3, respectively). Exposure to aquatic organisms within the water bodies and/or wetlands is assumed to occur via direct exposure to contaminants in the water column and via ingestion of benthic invertebrates as well as littoral and pelagic prey exposed to contaminants in surface water and sediment. Note: potential effects to macroinvertebrates and phytoplankton (algae) have been assessed using available surface water and sediment quality criteria for the protection of aquatic life (Section 5.2). Potential uptake through the food chain is evaluated for two representative receptors, including the raccoon (also considered as a terrestrial receptor) and the mallard (*Anas platyrhynchos*) (medium-sized aquatic omnivore).

Aquatic organisms represent some of the prey base for aquatic receptors (represented by the mallard and raccoon). A food web is presented in Figure 2-7. The selected receptor species have relatively small home ranges, which makes them particularly vulnerable to exposure to site contaminants. Foraging factors were set to 20 percent for both of the aquatic receptors evaluated in this BERA because of the limited amount of surface water and sediment at the site (less than about 1 acre, Section 2.1.2). It should be noted that the term 'foraging factor" is similar to the term "area use factor" that is used for terrestrial receptors. Both of the selected aquatic receptor species have been documented near the site (Section 2.1), have a potential high abundance and wide distribution at the site, and sufficient toxicological information (with the exception of the mallard bird species) is available in the literature for comparative and interpretive purposes. In

addition, both of the selected species are likely to occur after site remediation (if risk management decisions require it), and both are important to the stability of the local ecological food-chain and biotic community. Finally, the selected species have readily available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (EPA, 1993).

Results of the assessment receptor selection process are presented in detailed biological and ecological descriptions known as ARPs. The biological relevant criteria used to select the aquatic assessment receptors are discussed and summarized in the ARPs (Appendix E).

2.4 Ecological Endpoint (Assessment and Measurement) Identification

The protection of ecological resources, such as habitats and species of plants and animals, is a principal motivation for conducting the BERA. Key aspects of ecological protection are presented as policy goals. These are general goals established by legislation or agency policy that are based on societal concern for the protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and government agency policies (e.g., CERCLA, National Environmental Policy Act). Other legislation includes the Endangered Species Act 16 U.S.C. 1531-1544 (1993, as amended) and the Migratory Bird Treaty Act 16 U.S.C. 703-711 (1993, as amended). To determine whether these protection goals are met at the site, assessment and measurement endpoints have been formulated to define the specific ecological values to be protected and to define the degree to which each may be protected.

Unlike the human health risk assessment process, which focuses on individual receptors, the BERA focuses on populations or groups of interbreeding nonhuman, nondomesticated receptors. In the BERA process, the risks to individuals are assessed only if they are protected under the Endangered Species Act, are species that are candidates for protection, or are species that are considered rare.

Given the diversity of the biological world and the multiple values placed on it by society, there is no universally applicable list of assessment endpoints. Suggested criteria that may be considered in selecting assessment endpoints suitable for a specific ecological risk assessment are: (1) ecological relevance; (2) susceptibility to the contaminant(s); (3) accessibility to prediction and/or measurement; and (4) definable in clear, operational terms (Suter, 1993). Selected assessment endpoints should reflect environmental values that are protected by law, are

critical resources, or have relevance to ecological functions that may be impaired. Both the entity and attribute are identified for each assessment endpoint.

Assessment endpoints are inferred from effects to one or more measurement endpoints. The measurement endpoint is a measurable response to a stressor that is related to the valued attribute of the chosen assessment endpoint. It serves as a surrogate attribute of the ecological entity of interest (or of a closely related ecological entity) that can be used to draw a predictive conclusion about the potential for effects to the assessment endpoint. Information gained during the site reconnaissance was used to assist in the selection of assessment and measurement endpoints. These endpoints, formal expressions of the environmental values to be protected (Suter, 1993), have been used to focus the goals of the BERA (Table 2-14).

Measurement endpoints for this BERA are based on toxicity values from the available literature and not statistical or arithmetic summaries of actual field or laboratory observations or measurements. When possible, receptors and endpoints have been concurrently selected by identifying those that are known to be adversely affected by chemicals at the site based on published literature. COPECs for those receptors and endpoints have been identified by drawing on the scientific literature to obtain information regarding potential toxic effects of site chemicals to site species. This process ensures that a conservative approach is taken in selecting endpoints and evaluating receptors that are likely to be adversely affected by the potentially most toxic chemicals at the site.

2.4.1 Assessment Endpoints

The assessment endpoints for the TNT Area A are stated as "the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds." The corresponding H_0 for each of the assessment endpoints is stated as: "the presence of site contaminants within soil, surface water, sediment, vegetation, and prey will have no effect on the survival or reproductive capabilities of terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds."

Assessment receptor species were selected based on the likelihood of finding the species at the TNT Area A. Historical information, the site reconnaissance (performed September 11 through 13, 2000 and May 21, 2001), and the availability of toxicological data were used to select terrestrial and aquatic receptor species. These receptors species are depicted in food web models (Figures 2-6 and 2-7). Food web models are simplified versions of the possible movement of contaminants through the food chain present or potentially present at the site. Due to lack of data for all possible species, key species have been selected to represent broad classes, or guilds.

The food web conceptual site models were developed to illustrate how the selected terrestrial and aquatic species are ecologically linked within food webs. One species was used to represent each of the major trophic levels and habitats at the site. The decision was made not to complicate the food web models with detailed species selection at the base of the food web (*i.e.* specific terrestrial/benthic invertebrates or aquatic vertebrates). Thus, generic terrestrial invertebrates, benthic invertebrates, and aquatic invertebrates were used to represent the bottom of the food chain. For terrestrial invertebrates and plants, partitioning coefficients and simple empirical uptake models were employed to estimate COPEC concentrations within tissues (Section 3.0). These tissue concentrations were then used as input values for exposure to higher trophic level receptors through the dietary ingestion route. Brief life-history descriptions for the selected area receptor species are provided in Appendix E.

All trophic levels may be exposed to COPECs, either by direct exposure to contaminated abiotic media or through ingestion of lower trophic level food items. Primary producers (plants) absorb COPECs (as well as nutrients) from soil and/or water. Through abiotic processes COPECs can adsorb to the sediment and detritus particles. When these particles settle and become part of the benthic substrate they may also become a source of COPECs to benthic communities. Various species of aquatic biota fulfill the role of aquatic herbivorous (feeding on aquatic plants and suspended detritus) and predatory invertebrates (feeding on benthic invertebrate species). The combination of COPEC bioconcentration from water, ingestion of contaminated prey, and generally restricted ranges for aquatic organisms provides ideal conditions for significant bioconcentration of COPECs. For this reason the mallard was included in the aquatic food web as a top trophic-level omnivore capable of bioaccumulating COPECs. In terrestrial species bioconcentration occurs in plants and invertebrates, and higher food chain receptors bioaccumulate COPECs through the ingestion of food items.

2.4.2 Measurement Endpoints

Measurement endpoints are frequently numerical expressions of observations (*e.g.* toxicity test results or community diversity indices) that can be compared statistically to detect adverse responses to a site contaminant. Examples of typical measurement endpoints include mortality, growth or reproduction in toxicity tests; individual abundance; species diversity; and the presence or absence of indicator data in field surveys of existing impacts (EPA, 1997).

For assessments, measurable responses to stressors may include lowest observed adverse effect levels (LOAEL), no observed adverse effect levels (NOAEL), lethal concentration to 50 percent (LC_{50}) of the test population, lethal dose to 50 percent (LD_{50}) of the test population, or effective concentration for 20 percent of the test population, collectively termed "toxicity endpoint values" (see Section 4.2 for further explanation). In addition, critical effect values for surface water, sediment, and soil were selected as measurement endpoints (Table 2-14). The most appropriate measurement endpoints were chosen based on exposure pathways as well as ecotoxicity of the contaminant.

2.5 Ecological Site Conceptual Model

IT has prepared pictorial representations of potential exposure. These food web pictorials (Figures 2-6 and 2-7) and accompanying text presented in Section 3.1, clarify the representations that are the ecological site conceptual models (ESCM). The ESCMs trace the contaminant pathways through both abiotic components and biotic food web components of the environment. The ESCMs present all potentially complete exposure pathways. The ESCMs have been used as a tool for judging the appropriateness and usefulness of the selected measurement endpoints in evaluating the assessment endpoints, and for identifying sources of uncertainty in the exposure characterization.

3.0 Exposure Characterization

IT has developed an estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to COPECs that are present at or migrating from the site, considering both current and reasonably plausible future use of the site. Exposure characterization is critical in further evaluating the risk of compounds identified as COPECs during the selection process (Section 2.3). The exposure assessment has been conducted by linking the magnitude (concentration) and distribution (locations) of the contaminants detected in the media sampled during the investigation, evaluating pathways by which chemicals may be transported through the environment, and determining the points at which organisms found in the study area may contact contaminants.

3.1 Exposure Analysis

IT has performed an exposure analysis, which combines the spatial and temporal distribution of the ecological receptors with those of the COPEC to evaluate exposure. The exposure analysis focuses on the chemical amounts that are assumed to be bioavailable, and the means by which the ecological receptors are exposed (e.g., exposure pathways). The focus of the analysis is dependent on the assessment receptors being evaluated as well as the assessment and measurement endpoints.

Ecological routes of exposure for biota may be direct (bioconcentration) or through the food web via the consumption of contaminated organisms (biomagnification). Food web exposure can occur when terrestrial or aquatic fauna consume contaminated biota. Examples of food web exposure include animals at higher trophic levels consuming plants or animals that bioaccumulate contaminants. The concepts of bioconcentration, bioaccumulation, and biomagnification are used throughout this document. Definitions describing their application are presented in the Glossary of Terms (Appendix F). Direct exposure routes include dermal contact, absorption, inhalation, and ingestion. Examples of direct exposure include animals incidentally ingesting contaminated soil or sediment (e.g., during burrowing or dust-bathing activities); animals ingesting surface water; plants absorbing contaminants by uptake from contaminated sediment or soil; and the dermal contact of aquatic organisms with contaminated surface water or sediment.

Contamination of biota could result from exposure to one or more COPEC. Bioavailability is an important contaminant characteristic that influences the degree of chemical-receptor interaction. Bioavailable compounds are those that a receptor can take in from the environment. Bioavailability of a chemical is a function of several physical and chemical factors such as grain size and organic carbon content.

Exposure pathways consist of four primary components: source and mechanism of contaminant release, transport medium, potential receptors, and exposure route. A chemical may also be transferred between several intermediate media before reaching the potential receptor. All of these components have been addressed within this BERA. If any of these components are not complete, then contaminants in those media do not constitute an environmental risk at that specific site. As discussed in Section 2.3, however, these four components are complete for all sampled site media. The major fate and transport properties associated with typical site contaminants are presented in subsequent sections. These properties directly affect a contaminant's behavior in each of the exposure pathway components.

For terrestrial faunal receptors, calculation of exposure rates relies upon determination of an organism's exposure to COPECs found in surface water, surface soil, and on transfer factors used for food-chain exposure. Exposure rates for terrestrial wildlife receptors are based solely upon ingestion of contaminants from these media and from consumption of other organisms. Given the scarcity of data available for wildlife dermal and/or inhalation exposure pathways, potential risk from these pathways has not been estimated. In addition, dermal and inhalation pathways are generally considered to be incidental for most species, with the possible exception of burrowing animals and dust-bathing birds.

The first step in estimating exposure rates for terrestrial wildlife involves the calculation of food ingestion and drinking water intake rates for site receptors. EPA (1993) includes a variety of exposure information for a number of avian and mammalian species. Information regarding feeding and watering rates, and dietary composition are available for many species, or may be estimated using allometric equations (Nagy, 1987). Data have also been gathered on incidental ingestion of soil, and are incorporated for the receptor species. This information is summarized in Table 3-1.

Algorithms have been evaluated for calculating exposure for terrestrial vertebrates that account for exposure via ingestion of contaminated water, incidental ingestion of contaminated soil, ingestion of plants grown in contaminated soil, and prey items. Singular algorithms have been developed for soil to plant uptake and for animal bioaccumulation (transfer factors).

The basic equation for estimating dose through the dietary pathway is:

$$D_p = \sum_{k=1}^{m} (C_k \cdot F_k \cdot I_k)/W \qquad \text{Eq. 3.1}$$

where:

D_p = the potential average daily dose (milligram per kilogram per day [mg/kg-day])
C_k = the average COPEC concentration in the kth food type (mg/kg dry weight)
F_k = the fraction of the kth food type that is contaminated
I_k = the ingestion rate of the kth food type (kg dry weight/day)
W = the body weight of the receptor (kg wet weight).

For aquatic faunal receptors, the calculation of exposure rates depends on the determination of the contaminant concentration in water and sediment, and on food-chain multipliers, bioconcentration factors (BCF), and bioaccumulation factors (BAF). If appropriate, an evaluation can be made of the time each organism spends associated with surface water or sediment pore water in order to modify exposure rates; however, this refined approach was not used in the current BERA.

Literature values for animal-specific sediment ingestion have been used if available. However, such values generally are not available in the literature. Where sediment ingestion rates could not be found, the animal-specific incidental soil ingestion rate is used for sediment ingestion as well, if the receptor's life history profile suggests a significant aquatic component (e.g., raccoons' use of surface water in foraging activities).

For species exposed to organic contaminants found in sediment, calculations have been performed to quantify interstitial (pore) water contaminant concentrations given a known sediment concentration. Suter's (1993) algorithm to calculate pore water concentrations for nonionic organic chemicals was used, as follows:

$$\text{Pore water concentration (milligrams per liter)} = (SC)/[(F_{oc})\ (K_{oc})] \qquad \text{Eq. 3.2}$$

where:

SC = sediment concentration (mg/kg)
F_{oc} = fraction organic carbon in sediment (kg organic carbon/kg sediment)
K_{oc} = chemical-specific organic carbon partition coefficient liter per kilogram [L\kg])

For sediment, K_{ow} values (Table 3-2) have been converted to K_{oc} values (EPA, 1996b) as follows:

$$\log K_{oc} = 0.00028 + (0.983 \times \log K_{ow}) \qquad \text{Eq. 3.3}$$

where:

K_{ow} = the octanol water partition coefficient.

This equation was chosen because it is the best fit for important site-related compounds, such as semivolatile nonionizing organic compounds.

F_{oc} values for sediment have been set at 0.067, based on sediment samples collected from the West Area Road Red Water Pond (IT, 2000). To estimate inorganic partitioning from sediment to pore water, K_d values (Table 3-3; with units of L/kg) were used instead of F_{oc} and K_{oc}. It should be noted that estimates of COPEC concentrations in sediment pore water were set at the calculated value using the appropriate K_{oc} or K_d value, or were set at a specific COPEC's published solubility in water, whichever was lower. This approach was necessary as some of the estimated pore-water concentrations could exceed typical solubility values because partitioning may be inaccurate for COPECs with elevated sediment concentrations. For TNT Area A, estimated pore water concentrations did not appear to be unusually elevated, and estimated pore water concentrations were used, as opposed to literature solubility values.

Adjustments were considered for potential biomagnification of contaminants through aquatic trophic levels. Food- chain multipliers (FCM), derived by EPA (1995), have been used to assess the possibility of contaminant magnification through site receptors, particularly fish. The FCMs are multiplied by chemical-specific BCFs to obtain BAFs. Assessments may use either laboratory-measured BCF values obtained from the scientific literature or aquatic biota BCFs calculated for organic compounds using the following equation (EPA, 1995):

$$BCF = K_{ow} \qquad \text{Eq. 3.4}$$

where:

K_{ow} = chemical-specific octanol/water partition coefficient.

When possible, K_{ow} values for appropriate COPEC have been obtained from the literature or from databases, and are presented in Table 3-2.

The BCF is dependent upon a chemical-specific K_{ow} that relates to a chemical's tendency to partition to a polar versus nonpolar solution. EPA has established a relationship between the K_{ow} and the FCM such that as the K_{ow} increases, the FCM increases correspondingly. However, for trophic level 2, FCMs are set at 1.0 (EPA, 1995), and sediment-dwelling aquatic invertebrates are assumed to generally function as secondary trophic level feeders within the aquatic habitats at TNT Area A. The EPA guidance also notes that for chemicals for which no K_{ow} is available, and for which no BCF can be estimated, a default FCM of 1.0 should be used. Thus, for inorganics not thought to biomagnify and/or for which no literature value is available, this value of 1.0 has been used.

As an alternative to literature- or K_{ow}-related BCFs, site-specific BCFs were preferentially selected, where available, for sediment-to-invertebrate bioaccumulation estimates. Site-specific BCFs (Table 3-4) are from 28-day bioaccumulation studies performed using the invertebrate species *Lumbriculus variegatus* and sediment samples collected from PBOW Redwater Ponds (RWP) (IT, 2001b). It should be noted that site-specific BCFs, derived by dividing COPEC tissue concentrations by COPEC sediment concentrations, were calculated and presented two different ways in IT (2001b). Both reasonable maximum exposure (RME) and central tendency (CT) site-specific BCFs were estimated in IT (2001b), with the RME BCFs based on all tissue concentration results, even if blank related, and the CT BCFs were based on blank-corrected tissue results. For this BERA the RME BCFs were conservatively selected over the CT BCFs, as they were numerically greater for some COPECs.

In addition to the aquatic food web, FCMs are also related to an organism's trophic status as predator/prey, producer/consumer, etc. in the terrestrial food web. Although exposures of terrestrial floral and faunal receptors are significant considerations for many hazardous waste sites, well accepted models for predicting the fate of many contaminants in terrestrial systems are less

developed. Trophic level compartments and transfer between compartments based on uptake, storage, and loss processes are not as well defined in terrestrial systems as in aquatic systems. In addition, the relationship between K_{ow} and bioconcentration is less well delineated by trophic level in terrestrial ecosystems. For the current BERA, soil-to-plant and food-to-muscle BAFs (or transfer factors [TF]) were estimated for organic constituents using the log K_{ow} relationships developed by Travis and Arms (1988), as presented below, with calculated transfer factors presented in the hazard calculation spreadsheets in Appendix G.

$$\log Tf_{soil\text{-}to\text{-}plant} = 1.588 - 0.578(\log K_{ow})$$
$$\log Tf_{food\text{-}to\text{-}muscle} = -7.735 + 1.033(\log K_{ow}).$$

Soil-to-insect BAFs were initially based on log K_{ow} relationships developed by Connell and Markwell (1990). For organic COPECs in soil invertebrates, the transfer factor was derived from the following equation developed by Connell and Markwell (1990) for bioaccumulation in earthworms:

$$BAF = \frac{y_L \cdot K_{ow}^{b-a}}{x \cdot f_{oc}} \qquad \text{Eq. 3.5}$$

where:

BAF = the bioaccumulation factor (unitless)
y_L = the fractional lipid content of the organism
K_{ow} = the octanol/water partition coefficient
(b-a) = a nonlinearity constant
x = a proportionality constant
f_{oc} = the fractional organic carbon content in the soil.

Although derived from earthworm data, the values for the nonlinearity constant (0.05) and proportionality constant (0.66) were applied to modeling uptake in soil invertebrates. Because of differences in integument, it is expected that the uptake by earthworms will generally be greater than that of invertebrates such as insects. Therefore, these factors are expected to yield conservative estimates of invertebrate uptake. The lipid content in insects was estimated at 3.1 percent fresh weight (Taylor, 1975), which is 7.9 percent of dry weight, using a value of 61 percent water content in beetles (EPA, 1993), calculated as follows:

$$\frac{0.031}{(1 - 0.61)} = 0.079 \; or \; 7.9 \; percent$$

The fraction of organic carbon in the soil was estimated to be 0.01, or 1 percent, as site-specific soil f_{oc} data were not available. This default value was based on information related to fate and transport data for organic constituents, as presented in *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA, 1998). Except where literature-derived values are available, the soil-to-invertebrate transfer factors for inorganics were assumed to be 1. Table 3-3 presents the soil-to-plant and initial soil-to-invertebrate transfer factors estimated for the inorganic COPECs. The COPECs in this table are limited to those that were not dropped during the screening assessment (Section 2.2.6). Transfer factors estimated using the Connell and Markwell method for organic COPECs are presented as calculated/literature values in Table 3-5.

As an alternative to literature- or Connell and Markwell-calculated BAFs, site-specific BAFs were preferentially selected, where available, for soil-to-invertebrate bioaccumulation estimates. Site-specific BAFs (Table 3-5) are from 28-day bioaccumulation studies performed using the earthworm species *Eisenia foetida* and soil samples collected from PBOW Red Water Ponds (IT, 2001b). It should be noted that site-specific BAFs, derived by dividing COPEC tissue concentrations by COPEC soil concentrations, were calculated and presented two different ways in IT (2001b), as was done for aquatic uptake estimates. Both RME and CT site-specific BAFs were estimated in IT (2001b), with the RME BAFs based on all tissue concentration results, even if blank related, and the CT BAFs were based on blank-corrected tissue results. For this BERA the RME BAFs were conservatively selected over the CT BAFs, as they were numerically greater for some COPECs.

Tissue concentrations in vertebrate prey species were estimated from the daily intake of the COPECs through the use of transfer factors for beef. The regression equation developed by Travis and Arms (1988) was used to derive food-to-beef transfer factors for the organic COPECs based on the log K_{ow} value of the chemical of concern. Transfer factors for the inorganic COPECs were taken from International Atomic Energy Agency (1994), National Council on Radiation Protection and Measurements (1989), Ma (1982), and Baes, et al. (1984), as shown in Table 3-3. A weighted total of the concentrations of COPEC intakes (including ingested soil and

surface water) was then used in the calculation of tissue concentrations in prey species and the dietary exposure rate in all selected receptor assessment species, as follows:

$$\frac{\text{Total intake of soil, water, plants, and/or invertebrates (in mg COPEC/day)} \times \text{Food-to-Tissue TF}}{0.32 \times \text{Total food and soil intake (in kg mass/day)}}$$

A conversion factor of 0.32 was used to convert wet weight tissue concentrations to dry weight values, given that the water content of mammals and passerine birds is reported to be 68 percent (Table 4-1 in EPA, 1993).

Media-Specific Exposure Pathways. Exposure to four categories of environmental media are addressed in this BERA, as discussed in the following subsections.

Soil Exposure Pathway. Soil exposure pathways are potentially important for terrestrial plants and animals at the site. For non-burrowing animal exposure, soil samples obtained from a depth of 0 to 2 feet have been considered, as this would be the point of exposure. Although the OEPA-approved work plan (IT, 2001a) states surfaces soils will consist of the 0 to 1 foot depth interval, there were essentially no soil samples collected from this depth interval (Table 2-8), therefore, surface soil was redefined as 0 to 2 feet. For burrowing animals such as the shrew, soil samples obtained from a depth of 0 to 6 feet have been considered.

For deep-rooted plant exposure, soil samples taken from 0 to 6 feet have been considered because most feeder roots are located within this depth. Thus, the white-tailed deer is assumed to ingest leaves of trees translocating COPECs from subsoils (Figure 2-6). It should be noted that this assumes not only that trees translocate soil-borne contaminants, but also that tree leaves available to deer have contaminants in them as well.

Environmental conditions such as soil moisture, soil pH, and cation exchange capacities significantly influence whether potential soil contaminants remain chemically bound in the soil matrix or whether they can be chemically mobilized (in a bioavailable form) and released for plant absorption. Generally, neutral to alkaline soils (soil pH of 6.5 or greater) restrict the absorption of toxic metals, making pathway completion to plants difficult. Literature values for soil-to-plant transfer rates for inorganic soil contaminants have been used (Table 3-3).

Sediment Exposure Pathway. Sediment consists of materials precipitated or settled out of suspension in surface water or native soils underlying flowing or standing surface water bodies. Potential contaminant sources for sediment include buried or stored waste, and contaminated surface water, groundwater, and soil. The release mechanisms include surface water runoff, groundwater discharge, and airborne deposition. Potential receptors of chemicals in contaminated sediment include aquatic flora and fauna. Direct exposure routes for contaminated sediment include contact by benthic-dwelling organisms such as amphipod invertebrates, uptake by aquatic flora and ingestion by aquatic fauna. Indirect exposure pathways from sediment include consumption of bioaccumulated contaminants by consumers in the food chain. Chemical bioavailability of many nonpolar organic compounds (e.g., polychlorinated biphenyls and pesticides) decreases with increasing concentrations of total organic carbon in the sediment; however, these compounds can still bioaccumulate up the food chain (Landrum and Robbins, 1990).

Surface Water Exposure Pathway. Surface water represents a potential transport medium for COPECs. Potential sources for contaminated surface water include: buried or stored waste, stored or spilled fuel, contaminated soil and groundwater, and deposition of airborne contaminants. The release mechanisms include surface runoff, leaching, and groundwater seepage. Potential receptors of contaminated surface water include terrestrial and aquatic fauna and aquatic flora. Exposure routes for contaminated surface water include ingestion by terrestrial fauna, and uptake and absorption by aquatic flora and fauna. Consumption of bioaccumulated contaminants constitutes a potential indirect exposure pathway for faunal receptors. Piscivorous receptor's exposure to fish has not been quantified due to the lack of fish habitat at the site. Chemical bioavailability of some metals and other chemicals is controlled by water hardness, pH, and total suspended solids.

Groundwater Exposure Pathway. Groundwater represents a potential transport medium for COPECs. Potential contaminant sources for groundwater include contaminated soil, and buried or stored waste. The release mechanism for contaminants into groundwater is direct transfer of contaminants from waste materials to water as water passes through the materials.

Groundwater itself is not an exposure point. However, contaminant transport along the shallow groundwater pathway would be considered an exposure route to aquatic life, wetlands, and some wildlife where the groundwater discharges to surface water. This pathway is of importance to

aquatic and wetland receptors if groundwater is found to be discharging to surface water. A groundwater assessment was not included in this BERA because no groundwater samples were collected, and even if they were, surface water samples collected at this potential point of exposure would be more appropriate to use. In addition, groundwater discharge to surface water at TNT Area A is not suspected, based on existing data.

3.2 Exposure Characterization Summary

The estimated chemical intakes for each exposed receptor group under each exposure pathway and scenario are presented in the risk characterization spreadsheets in Appendix G. These intake estimates are combined with the COPEC toxicity values, discussed in the following section, to derive estimates and characterize potential ecological risk. The uncertainties associated with the estimation of chemical intake are discussed in Section 5.4. The basis for each uncertainty has been identified, with the degree of uncertainty estimated qualitatively (low, medium, or high) or quantitatively, and the impact of the uncertainty estimated qualitatively (overestimate or underestimate, as appropriate).

4.0 Ecological Effects Characterization

The ecological effects characterization includes the selection of literature benchmark values and the development of reference toxicity values.

4.1 Selection of Literature Benchmark Values

IT has consulted appropriate sources for literature benchmark values, such as (1) *Toxicological Benchmarks for Wildlife* (Sample, et al., 1996); *Development of Toxicity Reference Values for Conducting Ecological Risk Assessments at Naval Facilities in California* (Engineering Field Activity, West, 1998); *Review of the Navy - EPA Region 9 BTAG Toxicity Reference Values for Wildlife* (CH2M-Hill, 2000); and (2) LD_{50} values from data bases such as the Registry of Toxic Effects Concentrations (RTEC) (extrapolated to chronic NOAEL or LOAEL values using recommended Tri-Service [Wentsel et al., 1996] uncertainty factors). The level of effort has been limited to documents that summarize the available ecotoxicological information and does not consist of a review of the primary toxicological literature (i.e., IT has not reviewed details of toxicity test conditions to determine validity of the tests performed).

4.2 Development of Reference Toxicity Values

IT has developed or determined reference toxicity values (RTV) for the site. These RTVs focus on the growth, survival, and reproduction of species and/or populations. Empirical data is available for the specific receptor-endpoint combinations in some instances. However, for some COPECs, data on surrogate species and/or on endpoints other than the NOAEL and LOAEL had to be used. The NOAEL is a dose of each COPEC that will produce no known adverse effects in the test species. The NOAEL was judged to be an appropriate toxicological endpoint since it would provide the greatest degree of protection to the receptor species. In addition, the LOAEL was used as a point of comparison for decision-making for risk management purposes. In addition, in instances where data are unavailable for a site-associated COPEC, toxicological information for surrogate chemicals had to be used. Safety factors are used to adjust for these differences and extrapolate risks to the site's receptors at the NOAEL and/or LOAEL endpoint. This process is described in the following paragraphs.

Toxicity information pertinent to identified receptors has been gathered for those analytes identified as COPECs. Because the measurement endpoint ranges from the NOAEL to the LOAEL, preference has been given to chronic studies noting concentrations at which no adverse

effects were observed and ones for which the lowest concentrations associated with adverse effects were observed. As previously noted, where data are unavailable for the exposure of a receptor to a COPEC, data for a surrogate chemical (e.g., benzo[a]pyrene for other PAHs) have been gathered for use in the BERA.

Using the relevant toxicity information, RTVs have been calculated for each of the COPECs. RTVs represent NOAELs and LOAELs with safety factors incorporated for toxicity information derived from studies other than no-effects or lowest-effects studies.

RTVs have been calculated using safety factors specified in Ford et al. (1992) and reported in Wentsel, et al. (1996) and shown in Figure 4-1, and summarized in Tables 4-1 and 4-2 for NOAEL and LOAEL TRVs, respectively. Interclass toxicity extrapolations were not performed as physiological differences between classes are too great to be addressed with the use of simplistic safety factors. Separate factors are used to account for extrapolation to the no effects or lowest-effects endpoints, for study duration (Tables 4-1 and 4-2), and for extrapolation across taxonomic groups (e.g., species, genus, family, order), as shown in Table 4-3 for the receptors used in this BERA. Although additional safety factors may be employed for endangered species, no endangered species were selected as representative receptors and these additional safety factors were not required. Because NOAELs and LOAELs for the selected wildlife receptor species are based on NOAELs and LOAELs from test species, the latter are converted to NOAELs and LOAELs specific to the selected wildlife receptors using a power function of the ratio of body weights, as described by Sample, et al. (1996). A body weight scaling factor of 0.25 was used for mammals, whereas a body weight scaling factor of 0 was used for birds, making the $NOAEL_w$ or $LOAEL_w$ for birds the same as the $NOAEL_T$ or $LOAEL_T$, as shown below:

$$N/LOAEL_W = N/LOAEL_T \left(\frac{BW_T}{BW_W} \right)^s \qquad \text{Eq. 3.6}$$

where:

$N/LOAEL_W$	=	the no observed adverse effect level or lowest observed adverse effect level for the wildlife indicator species (mg/kg-day)
$N/LOAEL_T$	=	the no observed adverse effect level or lowest observed adverse effect level for the test species (mg/kg-day)
BW_T	=	the body weight of the test species (kg)

BW_W	=	the body weight of the wildlife indicator species (kg)
s	=	a body weight scaling factor (s = 1/4 for mammals and s = 0 for birds).

Test species body weights (BW_T) used for COPEC RTVs are contained in the risk characterization spreadsheets presented in Appendix G.

These factors were used together to derive a final adjusted RTV, as shown in the risk characterization spreadsheets (Appendix G). Reference toxicity threshold value uncertainties are discussed in Section 5.4.

Exposure rate RTVs provide a reference point for the comparison of toxicological effects upon exposure to a contaminant. To complete this comparison, receptor exposures to site contaminants are calculated, or as in the case of plant receptors, exposure is estimated using the soil concentration (Section 5.1).

The potential toxicity of essential nutrients is assessed in detail in Appendix H, with maximum tolerance levels presented for several essential nutrients.

The equilibrium partitioning approach has been used by the EPA and OME in the preparation of sediment quality criteria for the protection of aquatic life. These criteria have been used, as available, to assess sediment risks to aquatic receptors.

5.0 Risk Characterization

The risk characterization phase integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is a determination of the likelihood, severity, and characteristics of adverse effects to environmental stressors present at a site. Qualitative and semiquantitative approaches have been taken to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to COPECs. Potential adverse affects to terrestrial plants have been qualitatively assessed by comparing plant toxicity benchmarks with COPEC concentrations. Potential adverse impacts to aquatic biota have been qualitatively assessed by comparing surface water and sediment quality criteria for the protection of aquatic life with surface water and sediment COPEC concentrations.

For the semiquantitative predictive assessment, RTVs and exposure rates have been calculated and are used to generate hazard quotients (HQ) (Wentsel, et al., 1996), by dividing the receptor exposure rate for each contaminant by the calculated RTV. HQs are a means of estimating the potential for adverse effects to organisms at a contaminated site, and for assessing the potential that toxicological effects will occur among site receptors.

5.1 Terrestrial Plant Impact Assessment

To assess the potential impact of COPEC concentrations in surface soil on terrestrial plant species, the source-term concentrations from TNT Area A were compared with available benchmark concentrations developed for the protection of terrestrial plants. As shown in Table 5-1, only three benchmarks were exceeded by the COPEC source-term concentrations (for 2,4,6-trinitrotoluene, lead and zinc). It should be noted, however, that benchmarks were not readily available for some of the COPECs retained for the predictive BERA. Based on site reconnaissances performed, no signs of vegetative stress were noted (Section 2.1.4).

5.2 Aquatic Biota Impact Assessment

To assess the potential impact of COPEC concentrations in surface water and sediment on aquatic biota, the source-term concentrations from the TNT Area A were compared with available benchmark concentrations developed for the protection of aquatic life. As shown in Table 5-2, surface water COPEC concentrations for carbon disulfide, aluminum, barium, cadmium, calcium, cobalt, copper, iron, manganese, silver, and zinc exceeded some or all of the available benchmarks for the protection of aquatic life. As up to four different benchmarks are used for the surface water assessment, a weight-of-evidence approach may be taken, with more

significant impacts being predicted as the number of surface water benchmarks that are exceeded increases. Thus, for TNT Area A, elevated concentrations of cadmium, cobalt, and manganese are less of a concern because only one surface water benchmark out of three was exceeded. The eight other COPECs had a source-term concentration that exceeded at least 50 percent of the available benchmarks. It is important to note that the limited number of surface water samples collected at the TNT Area A resulted in the maximum measured concentration being used in many cases as the source-term concentration (Table 2-12). It is possible that additional sampling would result in different conclusions for the impact assessment. It is also important to note that surface water is limited at TNT Area A, and is not a major habitat type.

Potential nonchemical stressors in surface water were evaluated by reviewing the field parameter data presented in Table 5-3 for the eight monitored surface water sample locations. Eh ranged from -56.9 to 169 millivolts (mV) and is a measure of oxidation-reduction potential. As DO levels approach zero, Eh is expected to drop, with lower (and negative) values representing reducing conditions. Surface water pH ranged from 7.52 to 8.35 standard units, showing slightly alkaline waters. Specific conductivity, a measure of dissolved particles, ranged from about 0.31 to 1.22 microseimens per centimeter. Turbidity readings ranged from 0 to 157 nephelometric turbidity units. DO ranged from 0.02 to 4.35 milligrams per liter (mg/L). DO levels below about 5 mg/L are generally unacceptable for sensitive species of fish. Temperatures ranged from 16.6 to 22.75 degrees Celsius. Overall, nonchemical data suggest poor surface water quality, particularly related to low DO, highly reducing conditions, and elevated dissolved and suspended solids, as represented by elevated conductivity and turbidity readings, respectively. This finding is not unexpected given the intermittent flow and shallow characteristics of the small drainage ditches at TNT Area A.

As shown in Table 5-4, sediment COPEC concentrations for eleven constituents detected in TNT Area A sediment exceeded at least one available benchmark developed for the protection of aquatic biota. Only four COPECs, however, (e.g., Aroclor-1260, lead, mercury, and nickel), had a source-term concentration that exceeded at least 50 percent of the available benchmarks. It is important to note that the limited number of sediment samples collected at the TNT Area A resulted in the maximum measured concentration being used in many cases as the source-term concentration (Table 2-13). It is possible that additional sampling would result in different conclusions for the impact assessment. It is also important to note that aquatic habitat is limited at TNT Area A, and is not a major habitat type. It should also be noted that EPA Region 5 (1996a) BTAG recommends that National Oceanic and Atmospheric Administration (NOAA)

effects range-low and effects range-medium benchmarks only be used when freshwater benchmarks are unavailable, as NOAA benchmarks are primarily for marine environments. Discounting of the NOAA benchmarks, however, would not significantly change the previous findings.

5.3 Predictive Risk Estimation for Terrestrial and Aquatic Wildlife

IT has estimated the risk associated with TNT Area A. The risk estimation has been performed through a series of quantitative HQ calculations that compare receptor-specific exposure values with RTVs. The HQs are compared to HQ guidelines for assessing the risk posed from contaminants. HQs less than or equal to 1 represent no probable risk; HQs from 1 up to, but less than 10, represent a low potential for environmental effects; HQs from 10 up to, but less than 100, represent a significant potential that effects could result from greater exposure; and HQs greater than 100 represent the highest potential for expected effects (Wentsel, et al., 1996). It should be noted that OEPA considers HQs greater than 1.0 to be potentially significant. It should also be noted that HQs are not measured of risk, are not population-based statistics, and are not linearly-scaled statistics, and therefore an HQ above 1, even exceedingly so, does not guarantee that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Tannenbaum, 2001; Bartell, 1996).

The simple HQ ratios have been summed to provide conservative hazard index estimates for all chemicals and exposure pathways for a given receptor. The following criterion may be used to determine if HQ summation is appropriate and scientifically defensible: for a given receptor, only HQs for those chemicals that have a similar mode of toxicological action should be summed. While individual contaminants may affect distinct target organs or systems within an organism, classes of chemicals may act in similar ways, thus being additive in effect. The summation of HQs into a hazard index was performed, in part, to determine whether or not individual COPEC HQs should be segregated based on dissimilar modes of toxicological action. If a risk driver resulted in an HQ greater than approximately 10 to 100, segregation of other COPECs by mode of toxicological action would not be necessary.

Conservative NOAEL-based hazard indices (summed HQs) for terrestrial receptors at TNT Area A were estimated to be 814 for the deer mouse, 224 for the cottontail rabbit, 849 for the shrew, 1,421 for the marsh wren, 753 for the raccoon, 59 for the white-tailed deer, and 6 for the red-tailed hawk (Table 5-5). COPECs from soil, not surface water, were risk drivers for all of the evaluated terrestrial receptors. Major soil risk drivers, listed in decreasing order of concern,

included Aroclor-1260, lead, 2,4,6-TNT, and calcium.. Important routes of exposure included invertebrate and plant intake and, for the hawk, predation of shrew and wren (Table 5-5).

Conservative LOAEL-based hazard indices (summed HQs) for terrestrial receptors at TNT Area A were estimated to be 101 for the deer mouse, 44 for the cottontail rabbit, 92 for the shrew, 148 for the marsh wren, 92 for the raccoon, 10 for the white-tailed deer, and 0.6 for the red-tailed hawk (Table 5-6). COPECs from soil, not surface water, were risk drivers for all of the evaluated terrestrial receptors. Major soil risk drivers, listed in decreasing order of concern, included Aroclor-1260, lead, 2,4,6-TNT, and calcium. Important routes of exposure included invertebrate and plant intake and, for the hawk, predation of shrew and wren (Table 5-6).

Conservative NOAEL-based hazard indices (summed HQs) for aquatic receptors at the TNT Area A were estimated to be 51 for the mallard and 86 for the raccoon (Table 5-7). It should be noted that both terrestrial and aquatic hazards have been estimated for the raccoon as it exhibits a combined terrestrial and aquatic lifestyle, and hazards may be summed for this receptor. COPECs from sediment, and not surface water, were risk drivers for both the raccoon and the mallard receptor. Major sediment risk drivers, listed in decreasing order of concern, included Aroclor-1260, 2,4,6-TNT, 2-amino-4,6-DNT, mercury, and fluoranthene. The most important route of exposure was aquatic invertebrate intake (Table 5-7).

Conservative LOAEL-based hazard indices (summed HQs) for aquatic receptors at the TNT Area A were estimated to be 6 for the mallard and 10 for the raccoon (Table 5-8). It should again be noted that both terrestrial and aquatic hazards have been estimated for the raccoon and hazards may be summed for this receptor. COPECs from sediment, and not surface water, were risk drivers for both the raccoon and the mallard receptor. Major sediment risk drivers, listed in decreasing order of concern, included Aroclor-1260, mercury, and 2,4,6-TNT. The most important route of exposure was aquatic invertebrate intake (Table 5-8).

5.4 Uncertainty Analysis

The results of the BERA are influenced to some degree by variability and uncertainty. In theory, investigators might reduce variability by increasing sample size of the media or species sampled. Alternatively, uncertainty within the risk analysis can be reduced by using species-specific and site-specific data (i.e., to better quantify contamination of media, vegetation, and prey through: direct field measurements, toxicity testing of site-specific media, and field studies using site-specific receptor species). Detailed media, prey, and receptor field studies are costly; thus, the

preliminary predictive analyses of risk has been conducted to limit the potential use of these resource-intensive techniques to only those COPECs that continue to show a relatively high potential for ecological risk. Since assessment criteria were developed based on conservative assumptions, the results of the screening and predictive assessments err on the side of conservatism. This has the effect of maximizing the likelihood of accepting a false positive (Type I error: the rejection of a true H_0) and simultaneously minimizing the likelihood of accepting a true negative (Type II error: the acceptance of a false H_0).

A number of factors contribute to the overall variability and uncertainty inherent in ecological risk assessments. Variability is due primarily to measurement error; laboratory media analyses and receptor study design are the major sources of this kind of error. Uncertainty, on the other hand, is associated primarily with deficiency or irrelevancy of effects, exposure, or habitat data to actual ecological conditions at the site. Species physiology, feeding patterns, and nesting behavior are poorly predictable; therefore, all toxicity information derived from toxicity testing, field studies, or observation will have uncertainties associated with them. Laboratory studies conducted to obtain site-specific, measured information often suffer from poor relevance to the actual exposure and uptake conditions on site (i.e., bioavailability, exposure, assimilation, etc., are generally greater under laboratory conditions as compared to field conditions). Calculating an estimated value based on a large number of assumptions is often the only alternative to the accurate (but costly) method of direct field or laboratory observation, measurement, or testing. Finally, habitat- or site-specific species may be misidentified if, for example, the observational assessment results are based on only one brief site reconnaissance.

The uncertainty analysis is presented in Table 5-9 and lists some of the major assumptions made for the BERA; the direction of bias caused by each assumption (i.e., if the uncertainty results in an overestimate or underestimate of risk); the likely magnitude of impact (quantitative [percent difference], or qualitative [high, medium, low, or unknown]); and, if possible, a description of recommendations for minimizing the identified uncertainties if the BERA progresses to higher level assessment phases (EPA, 1992b). The uncertainty analysis identifies and, if possible, quantifies the uncertainty in the individual preliminary scoping assessment, problem formulation, exposure and effects assessment, and risk characterization phases of this BERA. Based on this uncertainty analysis, the most important biases, that may result in an overestimation of risk, include the following:

- Assuming that COPECs are 100 percent bioavailable

- Using some laboratory-derived or empirically-estimated partitioning and transfer factors to predict COPEC concentrations in plants, invertebrates, prey species, and sediment pore water

- Inclusion of sample outliers in the estimation of exposure point concentrations for risk drivers

- Use of the hazard quotient method to estimate risks to populations or communities.

It should be noted that many of the maximum concentrations of COPECs measured in surface water and sediment were used as source-term concentrations due to the limited number of samples, and an additional sampling effort could potentially reduce the hazard estimate. It should also be mentioned that there are significant uncertainties associated with estimating COPEC concentrations in macroinvertebrates.

5.5 Risk Description

As part of the risk description, IT has completed the following: (1) summarized the ecological risk associated with the site; and (2) interpreted the ecological significance, which describes the magnitude of the identified risks and the accompanying uncertainty. The effect of additional data or analyses on uncertainty has also been discussed. A weight-of-evidence approach has been used to interpret the ecological significance of the findings.

Soil COPEC impacts to terrestrial plants are estimated to be generally insignificant, except for perhaps elevated levels of 2,4,6-TNT, lead, and zinc (Section 5.1). No vegetative stress was observed on site. Potential surface water COPEC impacts to aquatic biota are of most concern for carbon disulfide, aluminum, barium, calcium, copper, iron, silver, and zinc (Section 5.2). Potential sediment COPEC impacts on aquatic biota are of most concern for Aroclor-1260, lead, mercury, and nickel (Section 5.2). Considerations of small sample size suggest these findings should be confirmed based on additional sampling before any remedial actions are considered. In addition, limited aquatic habitat at the site reduces the concern for impact to aquatic biota, and low DO, elevated turbidity, and other nonchemical stressors measured in surface water suggests overall water quality is poor. Terrestrial receptors (especially mice, rabbits, shrews, raccoons, and wrens) are predicted to incur elevated hazards from exposure to Aroclor-1260, lead, 2,4,6-TNT, and calcium in soil, based on both NOAEL- and LOAEL-based hazard quotient approaches (Section 5.3). As calcium is an essential nutrient, it is unlikely this inorganic is a true risk driver in site soils. Based on uncertainties of toxicity, and on the fact that no wildlife RTE species have been confirmed at the site, remedial actions solely to address ecological concerns are not warranted at this time for soil. However, as estimated hazards are above 1,000 for some

receptors using the NOAEL-based approach, and above 100 for some receptors using the LOAEL-based approach, additional study is recommended. Alternatively, if human health risks or hazards are unacceptable and chemical-specific human health preliminary remediation goals (PRG) are being developed for the site, these PRGs may be evaluated to (1) determine if they are also protective of the environment; or (2) determine if they will reduce the estimated baseline ecological hazards by a significant amount.

Aquatic receptors are predicted to have elevated hazards from exposure to Aroclor- 1260, 2,4,6-TNT, 2-amino-4,6-DNT, mercury, and fluoranthene in sediment, based on both NOAEL- and LOAEL-based hazard quotient approaches (Section 5.3). Although hazards are estimated to be between 50 and 100 for the mallard and raccoon using the NOAEL-based approach, when the LOAEL-based approach is used, estimated hazards drop to 10 or less. Based on uncertainties associated with estimating COPEC concentrations in aquatic insects, the limited amount and low quality of aquatic habitat at the site, and the relatively low hazard estimates using the LOAEL-based approach, neither remedial action or further study is recommended for surface water and sediment at the site.

6.0 Risk Summary and Identification of Preliminary Remedial Action Objectives

IT has summarized ecological risk associated with releases from the site (Section 5.5). This summary is supported by tasks performed during the previous sections. Additionally, IT has made recommendations for further risk investigation for impacted soils at the site. IT has not developed site-specific remedial action objectives for the site at this time due to previously discussed uncertainties associated with the BERA (Section 5.4).

7.0 Conclusions and Recommendations

Only the data, results, and conclusions of the various preliminary scoping and predictive assessment phases are described in this section. No recommendations concerning types of remedial actions to be conducted are given other than to present the specific remedial action objectives, if any. Conclusion and recommendations are derived from the risk assessment and are based on the responses to the assessment hypotheses. The predictive assessment results are summarized and presented in Tables 5-1 through 5-8. The predictive assessment suggests potential adverse impacts to terrestrial wildlife, especially mice, rabbits, shrews, raccoons, and birds like the march wren, for modeled contact with the hazard drivers (Aroclor-1260, lead, and 2,4,6-TNT) in surface soil. The predictive assessment suggests minor potential adverse impacts to aquatic wildlife, however, as aquatic habitat at the site is quite limited in areal extent, and is of poor intrinsic quality, no further action is recommended for impacted site surface water and sediment.

The predictive assessment results may serve as the foci of discussions with risk managers and regulatory agencies concerning the potential need for additional assessment at PBOW TNT Area A to reduce the uncertainty in the estimate of ecological risk, as summarized in Table 5-9. It is very important to note that many conservative assumptions and modeling approaches were used in the predictive assessment, and actual hazards to wildlife may be orders of magnitude lower than predicted herein.

8.0 References

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TABLES

Table 2-1

Vegetative Community Types
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Community Type	Definition
AGRI	Agricultural areas including crop fields, pastures, and fallow fields
DIST	Disturbed or developed areas
MOW	Mowed areas
OFE	Early old field (herbaceous vegetation only)
OFM	Moderate old field (some shrubs/saplings)
OFL	Late old field (up to 50 percent shrub/sapling cover)
ESU	Early successional/shrub thicket (mostly shrubs, few saplings)
MSU	Moderate successional/shrub thicket (shrubs and saplings dominant)
LSU	Late successional/shrub thicket (saplings most abundant with some trees)
FRE	Early forest (young trees with early successional species, red maple, ashes, elms, etc., most dominant)
FRM	Moderate forest (larger trees regardless of species or younger trees with late successional species)
FRL	Late forest (mature forest with climax species such as sugar maple, beech, oaks, etc., with established subcanopy and understory)
OW	Open water
PEM	Palustrine, emergent wetlands (marshes and wet meadows)
PSS	Palustrine, scrub/shrub wetlands (wetlands dominated by shrubs and saplings)
PFO	Palustrine, forested wetlands (all wooded wetlands)

Table 2-2

Common and/or Frequent Vascular Plant Species Observed at TNT Area A Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 3)

Plant Species	TNT Area A
American stinging nettle	common
American water horehound	frequent
Arrow-leaved aster	frequent
Black raspberry	common
Black willow	common
Blackberry	common
Black-eyed Susan	frequent
Boneset	frequent
Box elder maple	frequent
Broad-leaved cattail	frequent
Broom sedge	frequent
Bull thistle	frequent
Calico aster	frequent
Canada bluegrass	frequent
Canada goldenrod	common
Canada thistle	common
Carex blanda	frequent
Carex rosea	frequent
Catnip	frequent
Common milkweed	frequent
Cottonwood	common
Crown-vetch	common
Dewberry	common
Dogbane	frequent
English plantain	frequent
Fescue	common

Table 2-2

Common and/or Frequent Vascular Plant Species Observed at TNT Area A Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 3)

Plant Species	TNT Area A
Garlic mustard	frequent
Grass-leaved goldenrod	common
Gray dogwood	frequent
Gray goldenrod	common
Great lobelia	frequent
Green ash	common
Green foxtail grass	common
Green-headed cone flower	frequent
Hairy panic-grass	common
Horse nettle	common
Horsetail	frequent
King-devil	frequent
Marsh fern	frequent
Musk thistle	frequent
Narrow-leaved cattail	frequent
Narrow-leaved mountain-mint	common
Nodding foxtail-grass	common
Panic grass	frequent
Pin oak	frequent
Poison ivy	frequent
Purple vervain	frequent
Quack grass	frequent
Redtop	common
Riverbank grape	frequent
Rough-leaved dogwood	frequent
Self-heal	frequent

Table 2-2

Common and/or Frequent Vascular Plant Species Observed at TNT Area A Plum Brook Ordnance Works, Sandusky, Ohio

(Page 3 of 3)

Plant Species	TNT Area A
Sensitive fern	frequent
Slender gerardia	frequent
Sorrel	common
Southern agrimony	frequent
Southern broad-leaved enchanter's nightshade	frequent
Sycamore	frequent
Tall ironweed	frequent
Tall white beard-tongue	frequent
Tatarian honeysuckle	common
Timothy	frequent
Umbrella sedge	frequent
Virginia knotweed	common
White heath aster	frequent
White sweet clover	frequent
White snake root	common
White vervain	frequent
Wild black cherry	common
Wild carrot	frequent
White strawberry	frequent
Yarrow	frequent
Yellow nutgrass	frequent
Total Species Documented (common, frequent, occasional, and/or rare)	172
Total Common or Frequent Species Documented	73

For scientific names and habitat, as well as occasional and/or rare species, see Appendix A.

Table 2-3

Mammals Observed On Site and Likely to be Found in Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site [a]
Didelphidae	*Didelphis virginiana*	Virginia opossum	
Talpidae	*Condylura cristata*	star-nosed mole	
	Parascalops breweri	hairy-tailed mole	
	Scalopus aquaticus	Eastern mole	
Verspertilionidae	*Myotis keenii*	Keen's bat	
	M. lucifugus	little brown bat	
	M. sodalis	Indiana bat **(E)**	
	Eptesicus fuscus	big brown bat	
	Lasionycteris noctivagans	silver-haired bat	
	Lasiurus borealis	red bat	
	L. cinereus	hoary bat	
	Nycticeius humeralis	evening bat	
	Pipistrellus subflavus	Eastern pipistrelle	
Leporidae	*Sylvilagus floridanus*	cottontail rabbit	X
Sciuridae	*Glaucomys volans*	Southern flying squirrel	
	Marmota monax	woodchuck	
	Sciurus carolinensis	gray squirrel	
	S. niger	fox squirrel	
	Spermophilus tridecemlineatus	thirteen-lined ground squirrel	
	Tamias striatus	Eastern chipmunk	
	Tamiasciurus hudsonicus	red squirrel	
	Blarina brevicauda	short-tailed shrew	
	Cryptotis parva	least shrew	
	Sorex cinereus	masked shrew	
Castoridae	*Castor canadensis*	beaver	
Cricetidae	*Microtus pennsylvanicus*	meadow vole	
	Mus musculus	house mouse	
	Ondatra zibethicus	muskrat	
	Peromyscus leucopus	white-footed mouse	
	P. maniculatus	deer mouse	
	Rattus norvegicus	Norway rat	
	Synaptomys cooperi	Southern bog lemming	
	Zapus hudsonius	meadow jumping mouse	
Procyonidae	*Procyon lotor*	raccoon	X
Mustelidae	*Mephitis mephitis*	striped skunk	
	Mustela frenata	long-tailed weasel	
	M. nivalis	least weasel	
	M. vison	mink	
	Taxidea taxus	badger	
Canidae	*Canis latrans*	coyote	
	Urocyon cinereoargenteus	gray fox	
	Vulpes vulpes	red fox	
Cervidae	*Odocoileus virginianus*	white-tailed deer	X

Mammals likely to be found in Erie County based on information presented in:
Gottschang, J. L., 1981, A Guide to the Mammals of Ohio, Ohio State University Press, 176 pages.
E = Ohio Endangered species.
[a] IT Site Reconnaissance, September 11, 12, 2000 and May 21, 2001.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Ardeidae	*Ardea herodias*	great blue heron	(1) Regular visitor at ponds, streams, and ditches.
	Bublucus ibis	cattle egret **(T)**	(1) Rare visitor in short grass areas
	Butorides striatus	green-backed heron	(1) Confirmed breeder, rare at ponds, streams.
	Casmerodius albus	great egret	(1) Regular visitor at ponds, streams, and ditches.
	Nycticorax nycticorax	black-crowned night heron **(T)**	(1) Regular visitor at ponds, streams, and ditches.
Anserinae	*Branta canadensis*	Canada goose	(1) Confirmed breeder; uncommon around ponds.
Anatinae	*Aix sponsa*	Wood duck	(1) Confirmed breeder, uncommon around ponds.
	Anas discors	blue-winged teal	Confirmed and/or probable breeder in county.
	A. platyrhynchos	mallard	(1) Confirmed breeder, uncommon at ponds, streams.
	A. rubripes	American black duck	(1) Possible breeder, rare at ponds, streams, ditches.
Merginae	*Lophodytes cucullatus*	hooded merganser	Confirmed and/or probable breeder in county.
Accipitrinae	*Accipiter striatus*	sharp-shinned hawk	Confirmed and/or probable breeder in county.
Buteoninae	*Buteo jamaicensis*	red-tailed hawk	(2) Confirmed and/or probable breeder in county.
	B. lineatus	red-shouldered hawk	Confirmed and/or probable breeder in county.
	B. platypterus	broad-winged hawk	Confirmed and/or probable breeder in county.
	Haliaeetus leucocephalus	bald eagle **(E)**	Confirmed and/or probable breeder in county.
Anatidae	*Cygnus buccinator*	Trumpeter swan **(E)**	(1) Rare migrant seen flying toward lake.
Falconinae	*Falco sparverius*	American kestrel	Confirmed and/or probable breeder in county.
Phasianidae	*Colinus virginianus*	Northern bobwhite quail	Confirmed and/or probable breeder in county.
	Phasianus colchicus	ring-necked pheasant	Confirmed and/or probable breeder in county.
Rallidae	*Gallinula chloropus*	common moorhen	Confirmed and/or probable breeder in county.
	Porzana carolina	Sora	Confirmed and/or probable breeder in county.
Cathartidae	*Cathartes aura*	turkey vulture	(2) Possible breeder in county.
Charadriidae	*Charadrius vociferus*	killdeer	(2)Confirmed and/or probable breeder in county.
Scolopacidae	*Actitis macularia*	spotted sandpiper	Confirmed and/or probable breeder in county.
	Bartramia longicauda	upland sandpiper **(T)**	(1) Confirmed breeder, rare in grassy areas.
	Gallinago gallinago	common snipe	Confirmed and/or probable breeder in county.
	Scolopax minor	American woodcock	(1) Confirmed breeder, uncommon in moist woodlots.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 6)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Larinae	*Larus argentatus*	herring gull	(1) Regular visitor.
	L. delawarensis	ring-billed gull	(1) Regular visitor.
Columbidae	*Columba livia*	rock dove	(1) Confirmed breeder, very common.
	Zenaida macroura	mourning dove	(1) Confirmed breeder, very common.
Cuculidae	*Coccyzus americanus*	yellow-billed cuckoo	(1) Confirmed breeder, uncommon in woodlots, shrubs.
	C. erythropthalmus	black-billed cuckoo	(1) Probable breeder, rare in woodlots & shruby areas.
Tytonidae	*Bubo virginianus*	great horned owl	(1) Confirmed breeder, uncommon in woodlots.
	Otus asio	Eastern screech-owl	(1) Confirmed breeder, common in woodlots, shrubs.
	Strix varia	barred owl	Confirmed and/or probable breeder in county.
Caprimulgidae	*Chordeiles minor*	common nighthawk	(1) Possible breeder, rare.
Apodidae	*Chaetura pelagica*	chimney swift	(1) Confirmed breeder, uncommon.
Trochilidae	*Archilochus colubris*	ruby-throated hummingbird	(1) Confirmed breeder, uncommon in woodlots, shrubs.
Alcedinidae	*Ceryle alcyon*	belted kingfisher	(1) Confirmed breeder, rare around ponds, streams.
Picidae	*Colaptes auratus*	Northern flicker	(1) Confirmed breeder, common in woodlots.
	Dryocopus pileatus	pileated woodpecker	Confirmed and/or probable breeder in county.
	Melanerpes carolinus	red-bellied woodpecker	(1) Confirmed breeder, common in mature woods.
	M. erythrocephalus	red-headed woodpecker	(1) Confirmed breeder, uncommon in mature woods.
	Picoides pubescens	downy woodpecker	(1) Confirmed breeder, common in woodlots.
	P. villosus	hairy woodpecker	(1) Confirmed breeder, uncommon in large woodlots.
Tyrannidae	*Contopus virens*	Eastern wood-pewee	(1) Confirmed breeder, very common in large woodlots.
	Empidonax alnorum	alder flycatcher	(1) Possible breeder, rare in shrubby wet areas.
	E. minimus	least flycatcher	(1) Probable breeder, rare in shrubby areas.
	E. traillii	willow flycatcher	(1) Confirmed breeder, very common in shrubby areas.
	E. virescens	Acadian flycatcher	(1) Confirmed breeder, uncommon in mature woodlots.
	Myiarchus crinitus	great crested flycatcher	(1) Confirmed breeder, common in large woodlots.
	Sayornis phoebe	Eastern phoebe	(1) Confirmed breeder, common near stream bridges.
	Tyrannus tyrannus	Eastern kingbird	(1)(2) Confirmed breeder, very common - open shrub area.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

(Page 3 of 6)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Alaudidae	*Eremophila alpestris*	horned lark	(1) Probable breeder, rare in grassland, cultiv. fields.
Hirundinidae	*Hirundo pyrrhonota*	cliff swallow	Confirmed and/or probable breeder in county.
	H. rustica	barn swallow	(1) Confirmed breeder, very common near vacant bldgs.
	Progne subis	purple martin	(1) Probable breeder, rare.
	Riparia riparia	bank swallow	(1) Rare migrant or visitor.
	Stelgidopteryx seripennis	Northern rough-winged swallow	(1) Confirmed breeder, rare along streams, ditches.
	Tachycineta bicolor	tree swallow	(1) Confirmed breeder, rare around ponds.
Corvidae	*Corvus brachyrhynchos*	American crow	(1)(2) Confirmed breeder, very common in woodlots.
	Cyanocitta cristata	blue jay	(1) Confirmed breeder, abundant in woods.
Paridae	*Parus atricapillus*	black-capped chickadee	(1) Confirmed breeder, common in woodlots.
	P. bicolor	tufted titmouse	(1) Confirmed breeder, common in woodlots.
Sittidae	*Sitta carolinensis*	white-breasted nuthatch	(1) Confirmed breeder, uncommon in woodlots.
Troglodytidae	*Cistothorus palustris*	marsh wren	(1) Possible breeder, rare in wetlands with cattails.
	C. platensis	sedge wren **(E)**	(1) Confirmed breeder, common in old grassy fields.
	Thryothorus ludovicianus	Carolina wren	(1) Probable breeder, rare in shrubby areas & woodlots.
	Troglodytes aedon	house wren	(1) Confirmed breeder, abundant in shrubby areas.
	T. troglodytes	winter wren **(E)**	(1) Rare migrant.
Mimidae	*Dumetella carolinensis*	gray catbird	(1)(2) Confirmed breeder, abundant in shrubby areas.
	Mimus polyglottos	Northern mockingbird	(1) Confirmed breeder, rare in shrubby areas.
	Toxostoma rufum	brown thrasher	(1) Confirmed breeder, common in shrubby areas.
Turdidae	*Catharus fuscescens*	veery	(1) Confirmed breeder, uncommon in large woodlots.
	Hylocichla mustelina	wood thrush	(1) Confirmed breeder, very common in large woodlots.
	Sialia sialis	Eastern bluebird	(1)(2) Confirmed breeder, common in openfields & edges.
	Turdus migratorius	American robin	(1)(2) Confirmed breeder, abundant everywhere.
Sylviidae	*Polioptila caerulea*	blue-gray gnatcatcher	(1) Confirmed breeder, uncommon in woodlots.
	Regulus calendula	ruby-crowned kinglet	(1) Rare migrant.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

(Page 4 of 6)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Bombycillidae	*Bombycilla cedrorum*	cedar waxwing	(1)(2) Confirmed breeder, very common everywhere.
Sturnidae	*Sturnus vulgaris*	European starling	(1)(2) Confirmed breeder, abundant everywhere.
Vireonidae	*Vireo bellii*	Bell's vireo	Confirmed and/or probable breeder in county.
	V. flavifrons	yellow-throated vireo	(1) Confirmed breeder, uncommon in mature woodlots.
	V. gilvus	warbling vireo	(1) Confirmed breeder, common in large woodlots.
	V. griseus	white-eyed vireo	(1) Confirmed breeder, uncommon in shrubby areas.
	V. olivaceus	red-eyed vireo	(1) Confirmed breeder, very common in woodlots.
Parulidae	*Dendroica cerulea*	cerulean warbler	(1) Possible breeder, rare in mature woodlots.
	D. dominica	yellow-throated warbler	(1) Confirmed and/or probable breeder in county.
	D. pensylvanica	chestnut-sided warbler	(1) Probable breeder, uncommon in shrubby areas.
	D. petechia	yellow warbler	(1) Confirmed breeder, abundant in shrubby areas.
	D. virens	black-throated green warbler	(1) Possible breeder, rare in mature woodlots.
	Geothylpis trichas	common yellowthroat	(1) Confirmed breeder, abundant in shrub areas, fields.
	Icteria virens	yellow-breasted chat	(1) Confirmed breeder, uncommon in shrubby areas.
	Mniotilta varia	black and white warbler	(1) Possible breeder, rare in mature woodlots.
	Oporornis formosus	Kentucky warbler	(1) Possible breeder, rare in mature woodlots.
	Protonotaria citrea	prothonotary warbler	Confirmed and/or probable breeder in county.
	Seiurus aurocapillus	overbird	(1) Probable breeder, rare in mature woodlots.
	S. motacilla	Louisiana waterthrush	Confirmed and/or probable breeder in county.
	Setophaga ruticilla	American redstart	(1) Probable breeder, rare in shrubby areas & woodlots.
	Vermivora leucobronchialis	Brewster's warbler	(1) Possible breeder, rare in shrubby areas and edges.
	V. pinus	blue-winged warbler	(1) Confirmed breeder, common in shrubby areas.
	Wilsonia citrina	hooded warbler	Confirmed and/or probable breeder in county.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Icteridae	*Agelaius phoeniceus*	red-winged blackbird	(1)(2) Confirmed breeder, abund. in grasslands, streams.
	Dolichonyx oryzivorus	bobolink	(1) Confirmed breeder, uncommon in grasslands.
	Icterus galbula	Northern oriole	(1) Confirmed breeder, uncommon in open woods.
	I. spurius	orchard oriole	(1) Confirmed breeder, common in open woods & edges.
	Molothrus ater	brown-headed cowbird	(1) Confirmed breeder, abundant everywhere.
	Quiscalus quiscula	common grackle	(1) Confirmed breeder, abundant everywhere.
	Sturnella magna	Eastern meadowlark	(1)(2) Confirmed breeder, common in grasslands.
Ploceidae	*Passer domesticus*	house sparrow	(1) Confirmed breeder, uncommon near buildings.
Thraupidae	*Piranga olivacea*	scarlet tanager	(1) Possible breeder, rare on open woods.
	P. ruba ruba	summer tanager	(1) Confirmed breeder, common in mature woodlots.
Fringillidae	*Ammodramus henslowii*	Henslow's sparrow	(1) Probable breeder, rare in old fields.
	A. savannarum	grasshopper sparrow	(1) Confirmed breeder, common in grasslands.
	Cardinalis cardinalis	Northern cardinal	(1) Confirmed breeder, abundant everywhere.
	Carduelis tristis	American goldfinch	(1)(2) Confirmed breeder, abundant in shrubby areas.
	Carpodacus mexicanus	house finch	(1) Confirmed breeder, uncommon around buildings.
	Melospiza georgiana	swamp sparrow	(1) Confirmed breeder, rare in wet fields and ditches.
	M. melodia	song sparrow	(1) Confirmed breeder, abundant everywhere.
	Passerculus sandwichensis	Savannah sparrow	(1) Confirmed breeder, common in grasslands.
	Passerina cyanea	indigo bunting	(1) Confirmed breeder, abundant everywhere.
	Pheucticus ludovicianus	rose-breasted grosbeak	(1) Confirmed breeder, common in woodlots & edges.
	Pipilo erythrophthalmus	rufous-sided towhee	(1) Confirmed breeder, very common in woodlots, edges.
	Pooecetes gramineus	vesper sparrow	(1) Confirmed breeder, uncommon in grassland & fields.
	Spiza amercana	dickcissel	Confirmed and/or probable breeder in county.
	Spizella passerina	chipping sparrow	(1) Confirmed breeder, common in open woods & lawns.
	S. pusilla	field sparrow	(1) Confirmed breeder, abundant in grasslands, shrubs.
	Zonotrichia albicollis	white-throated sparrow	(1) Late migrant, rare.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

[a] Family names from: Peterson, R. T., 1947, *A Field Guide to the Birds*, Sponsored by the National Audubon Society, Houghton Mifflin Company, Boston, Massachusetts.

[b] Peterjohn, B. G. and D. L. Rice, 1991, *The Ohio Breeding Bird Atlas*, The Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio, 416 pages.

[c] E = Ohio Endangered species; T = Ohio Threatened species.

Observation References:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).
(2) IT site reconnaisance at TNT Area A, September 11, 12, 2000 and May 21, 2001.

Table 2-5

Reptiles Observed On Site and Likely to be Found[a] at Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site
Chelydridae	*Chelydra serpentina*	snapping turtle	(1)
Kinosternidae	*Sternotherus odoratus*	musk turtle	
Emydidae	*Chrysemys picta*	painted turtle	(1)
	Emys blandingii	Blanding's turtle	(1)
	Terrapene carolina	box turtle	(1)
Colubridae	*Elaphe vulpina*	fox snake	(1)
	Heterodon platyrhinos	hog-nosed snake	
	Nerodia septemvittata	queen snake	
	N. sipedon sipedon	water snake	(1)
	Opheodrys vernalis	green snake	(1)
	Storeria dekayi	Dekay's brown snake	(1)
	Thamnophis butleri	Butler's garter snake	(1)
	T. sauritus	ribbon snake	
	T. sirtalis	common garter snake	(1)

[a] Pfingsten, R.A. (ODNR, 1994).

References:

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America*, Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

Wright, A. H. and A. A. Wright, 1957, *Handbook of Snakes of the United States and Canada*, Volumes I and II, Comstock Publishing Associates, Ithaca and London, 1105 pages.

Reference for on-site observation:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).
(2) IT Site Reconnaissance, September 11, 12, 2000 and May 21, 2001.

Table 2-6

Amphibians Observed On Site and Likely to be Found[a] at Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site
Ambystomatidae	*Ambystoma texanum*	smallmouth salamander	(1)
	Plethodon cinereus	redback salamander	(1)
Bufonidae	*Bufo americanus*	American toad	(1)
Hylidae	*Acris gryllus*	cricket frog	
	Hyla versicolor	gray treefrog	(1)
	Pseudacris crucifer	spring peeper	(1)
	P. triseriata	chorus frog	(1)
Ranidae	*Rana catesbeiana*	bullfrog	(1)
	R. clamitans	green frog	(1)
	R. pipiens	Northern leopard frog	(1)(2)

[a] Pfingsten, R.A. (ODNR, 1994).

References:

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America*, Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

Pfingsten, R. A. and F. L. Downs (eds.), 1989, *Salamanders of Ohio*, Ohio Biological Survey Bulletin, New Series, Vol. 7, No. 2, 315 pages, 29 pls.

Reference for on-site observation:

(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).
(2) IT Site Reconnaissance, September 11, 12, 2000 and May 21, 2001.

Table 2-7

Fish Observed On Site at Plum Brook Ordnance Works Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site	Habitat[a]
Catostomidae	*Catostomus commersoni*	white sucker	(1)	lotic
Centrarchidae	*Lepomis cyanellus*	green sunfish	(1)	lentic, lotic
	Lepomis species	green sunfish hybrid	(1)	lentic
	L. gibbosus	pumpkinseed sunfish	(1)	lentic
	L. macrochirus	bluegill	(1)	lentic
	Micropterus salmoides	largemouth bass	(1)	lentic
Cyprinidae	*Campostoma anomalum*	central stoneroller	(1)	lotic
	Carassius auratus	goldfish	(1)	lentic
	Luxilus chrysocephalus	striped shiner	(1)	lotic
	Pimephales notatus	bluntnose minnow	(1)	lotic
	P. promelas	fathead minnow	(1)	lotic
	Semotilus atromaculatus	creek chub	(1)	lotic
Gasterosteidae	*Culaea inconstans*	brook stickleback	(1)	lotic
Ichtaluridae	*Ameiurus melas*	black bullhead	(1)	lentic

[a] lotic = flowing water such as brooks, ditches, and creeks.
lentic = still waters such as ponds and lakes.

Reference for on-site observation:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).

Table 2-8

Sample List
TNT Area A, PBOW, Sandusky, Ohio

(Page 1 of 2)

Sample Type	Sample Identification	Depth of Sample (feet)
Surface Soil (0 to 2 feet)	AA0427	0 - 1
	AA0431	1.5 - 2.5
	AA0433	0.7 - 1.7
	AA0434	0.8 - 1.8
	AA0435 (duplicate of AA0434)	0.8 - 1.8
	AA0441	1 - 2
	AA0445	1.5 - 2.5
	AA0446	1 - 2
	AA0447	1.5 - 2.5
	AA0449	1.5 - 2.5
	AA0451	1 - 2
	AA0453	1 - 2
	AA0481	0.5 - 1.5
Total Soil (0 to 6 feet)	AA0426	2 - 3
	AA0427	0 - 1
	AA0428	2 - 3
	AA0429 (duplicate of AA0428)	2 - 3
	AA0431	1.5 - 2.5
	AA0432	2 - 3
	AA0433	0.7 - 1.7
	AA0434	0.8 - 1.8
	AA0435 (duplicate of AA0434)	0.8 - 1.8
	AA0437	2 - 3
	AA0438 (duplicate of AA0437)	2 - 3
	AA0440	2 - 3
	AA0441	1 - 2
	AA0442	2 - 3
	AA0443 (duplicate of AA0442)	2 - 3
	AA0445	1.5 - 2.5
	AA0446	1 - 2
	AA0447	1.5 - 2.5
	AA0448	2 - 3
	AA0449	1.5 - 2.5
	AA0450	2 - 3
	AA0451	1 - 2
	AA0452	2 - 3
	AA0453	1 - 2
	AA0460	4 - 6
	AA0461	4 - 6
	AA0463	4 - 6
	AA0466	4 - 6

Table 2-8

Sample List
TNT Area A, PBOW, Sandusky, Ohio

(Page 2 of 2)

Sample Type	Sample Identification	Depth of Sample (feet)
Total Soil (continued) (0 to 6 feet)	AA0468	4 - 6
	AA0470	4 - 6
	AA0472	4 - 6
	AA0474	4 - 6
	AA0478	4 - 6
	AA0480	2 - 3
	AA0481	0.5 - 1.5
Sediment	AA1001	NA
	AA1002	NA
	AA1003	NA
	AA1004	NA
	AA1011 (duplicate of AA1004)	NA
	AA1005	NA
	AA1006	NA
	AA1007	NA
	AA1008	NA
	AA1009	NA
	AA1010	NA
Surface Water	AA2002	NA
	AA2003	NA
	AAS004	NA
	AA2005	NA
	AA2006	NA
	AA2011 (duplicate of AA2006)	NA
	AA2007	NA
	AA2009	NA
	AA2010	NA

Table 2-9

Background Concentrations of Metals in Soil[a]
TNT Manufacturing Area A, Plum Brook Ordnance Works, Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UTL [b]	Background Screening Criterion [c]
Aluminum	12 / 12	3520 - 15500	NA	L	8.43E+03	2.69E+04	1.55E+04
Antimony	9 / 25	5.9 - 9.3	5.4 - 74	NP	4.68E+00	NA	9.30E+00
Arsenic	23 / 26	2.1 - 36.5	1.2 - 3.7	L	1.08E+01	7.10E+01	3.65E+01
Barium	9 / 12	35.6 - 826	23.2 - 24.7	L	1.16E+02	1.30E+03	8.26E+02
Beryllium	6 / 25	0.57 - 1	0.57 - 1.2	L	5.65E-01	1.17E+00	1.00E+00
Cadmium	0 / 25	NA	0.57 1.2	L	4.49E-01	NA	NA
Calcium	12 / 12	735 - 52300	NA	L	1.13E+04	2.18E+05	5.23E+04
Chromium	25 / 26	4.4 - 29	12.3 - 12.3	NP	1.34E+01	NA	2.90E+01
Cobalt	9 / 12	9.6 - 116	5.8 - 6.2	L	2.26E+01	2.48E+02	1.16E+02
Copper	23 / 26	2.3 - 56.2	2.2 - 2.9	L	1.70E+01	1.47E+02	5.62E+01
Iron	12 / 12	5880 - 234000	NA	L	4.01E+04	3.58E+05	2.34E+05
Lead	26 / 26	1.9 - 48.6	NA	L	1.28E+01	5.13E+01	4.86E+01
Magnesium	12 / 12	629 - 10400	NA	L	3.26E+03	3.08E+04	1.04E+04
Manganese	26 / 26	21 - 13300	NA	L	7.29E+02	3.51E+03	3.51E+03
Mercury	2 / 26	0.085 - 0.085	0.037 - 0.3	L	9.06E-02	5.60E-01	8.50E-02
Nickel	26 / 26	5.4 - 55.1	NA	L	2.28E+01	7.79E+01	5.51E+01
Potassium	11 / 12	579 - 3390	617 - 617	L	1.24E+03	6.08E+03	3.39E+03
Selenium	5 / 25	0.61 - 2	0.57 - 4.9	NP	1.55E+00	NA	2.00E+00
Silver	2 / 26	1.1 - 11.1	1.1 - 1.3	NP	1.00E+00	NA	1.11E+01
Sodium	0 / 12	NA	566 - 663	L	3.03E+02	NA	NA
Thallium	2 / 25	1.2 - 1.3	1.1 - 6.1	NP	1.91E+00	NA	1.30E+00
Vanadium	11 / 12	9 - 40.9	61.7 - 61.7	L	2.48E+01	8.31E+01	4.09E+01
Zinc	26 / 26	6.6 - 655	NA	L	7.30E+01	3.22E+02	3.22E+02

NA = Not applicable; not available.

[a] Data used to determine soil background are based on sampling from IT, 1998, ***Site Investigation of Acid Areas, Plum Brook Ordnance Works, Sandusky, Ohio.***

[b] 95% UTL = 95% upper tolerance limit calculated as described in Section 2.6.4 and rounded to 3 significant figures.

[c] The maximum detected concentration is used as the background screening criterion for nonparametric data sets; for lognormally distributed data sets, the 95% UTL or the maximum detected concentration, whichever is less, is used.

Note: Detection limits from sample 6990 were deleted when calculating results for antimony, beryllium, cadmium, selenium and thallium. The detection limits were elevated by dilution factors which greatly exceed any detected concentration and would bias results unrealistically high.

Table 2-10

Statistical Summary and COPEC Selection of Surface Soil Sample Analyses
TNT Area A, Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution[a]	Arithmetic Mean	95% UCL[b]	Background Screening Criterion[c]	Ecological Screening Criterion[d]	COPEC?[e,f]	Source Term Concentration[g]
Inorganics										
Aluminum	12 - 12	2130 - 9000	NA	N	5.19E+03	6.14E+03	1.55E+04	6.00E+02	N(b)	--
Antimony	7 - 12	0.8 - 3.69	1.28 - 1.49	L	1.72E+00	1.72E+00	9.30E+00	5.00E+00	N(a)(b)	--
Arsenic	11 - 12	2.21 - 8.59	1.17 - 1.17	N	3.80E+00	4.86E+00	3.65E+01	9.90E+00	N(a)(b)	--
Barium	12 - 12	11.1 - 124	NA	L	3.59E+01	5.40E+01	8.26E+02	2.83E+02	N(a)(b)	--
Beryllium	12 - 12	0.16 - 0.671	NA	L	3.37E-01	4.40E-01	1.00E+00	1.00E+01	N(a)(b)	--
Cadmium	9 - 12	0.131 - 1.59	0.64 - 0.745	L	4.90E-01	8.22E-01	NA	4.00E+00	N(a)	--
Calcium	12 - 12	1260 - 125000	NA	L	2.70E+04	1.51E+05	5.23E+04	NA	Y(a)	1.25E+05
Chromium	12 - 12	4.71 - 19.9	NA	L	1.05E+01	1.39E+01	2.90E+01	4.00E-01	N(b)	--
Cobalt	12 - 12	1.54 - 9.9	NA	L	4.28E+00	6.17E+00	1.16E+02	2.00E+01	N(a)(b)	--
Copper	12 - 12	2.06 - 88.4	NA	L	2.48E+01	7.08E+01	5.62E+01	6.00E+01	Y(a)(b)	7.08E+01
Iron	12 - 12	3910 - 22000	NA	L	1.16E+04	1.57E+04	2.34E+05	2.00E+02	N(b)	--
Lead	12 - 12	7.24 - 588	NA	L	1.08E+02	5.64E+02	4.86E+01	4.05E+01	Y(a)(b)	5.64E+02
Magnesium	12 - 12	598 - 10400	NA	L	3.26E+03	6.66E+03	1.04E+04	NA	N(b)	--
Manganese	12 - 12	86.9 - 1370	NA	L	3.16E+02	6.96E-02	3.51E+03	1.00E+02	N(b)	--
Mercury (Inorganic)	7 - 12	0.022 - 0.134	0.035 - 0.04	L	4.20E-02	6.96E-02	8.50E-02	5.10E-03	Y(a)(b)	6.96E-02
Nickel	12 - 12	4.27 - 25.5	NA	L	1.18E+01	1.65E+01	5.51E+01	3.00E+01	N(a)(b)	--
Potassium	12 - 12	245 - 1700	NA	L	6.33E+02	8.93E+02	3.39E+03	NA	N(b)	--
Sodium	12 - 12	99.6 - 381	NA	L	2.00E+02	2.61E+02	NA	NA	Y(a)(b)	2.61E+02
Vanadium	12 - 12	9.06 - 19.9	NA	N	1.46E+01	1.64E+01	4.09E+01	2.00E+00	N(b)	--
Zinc	12 - 12	15.1 - 751	NA	L	1.77E+02	6.42E+02	3.22E+02	8.50E+00	Y(a)(b)	6.42E+02
Nitroaromatics										
1,3,5-Trinitrobenzene	1 - 12	0.373 - 0.373	0.091 - 0.1	U	7.56E-02	3.73E-01		3.76E-01	N(a)	--
2,4,6-Trinitrotoluene	8 - 12	0.245 - 151.5	0.091 - 0.1	L	1.94E+01	1.91E+04		NA	Y(a)	1.52E+02
2,4-Dinitrotoluene[h]	7 - 12	0.0761 - 2.03	0.366 - 0.459	L	3.75E-01	6.65E-01		1.28E+00	Y(a)	6.65E-01
2,6-Dinitrotoluene[h]	4 - 12	0.0529 - 0.694	0.366 - 0.459	L	2.28E-01	3.79E-01		3.30E-02	Y(a)	3.79E-01
2-Amino-4,6-Dinitrotoluene	7 - 12	0.467 - 9.23	0.091 - 0.1	L	1.51E+00	3.39E+01		NA	Y(a)	9.23E+00
2-Nitrotoluene	1 - 12	0.374 - 0.374	0.182 - 0.2	U	1.20E-01	3.74E-01		NA	Y(a)	3.74E-01
4-Amino-2,6-Dinitrotoluene	8 - 12	0.132 - 5.975	0.091 - 0.1	L	1.18E+00	1.59E+01		NA	Y(a)	5.98E+00
Dinitrotoluene	6 - 12	0.188 - 7.36	0.095 - 0.1	L	8.95E-01	6.97E+00		6.50E-01	Y(a)	6.97E+00
Nitrobenzene	1 - 12	0.0713 - 0.0713	0.091 - 0.1	U	5.03E-02	7.13E-02		4.00E+01	N(a)	--
PCBs										
Aroclor 1260	12 - 12	0.00862 - 2.48	NA	L	4.12E-01	6.09E+00		3.71E-01	Y(a)	2.48E+00
Semivolatile Organics										
2-Methylnaphthalene	1 - 12	0.0999 - 0.0999	0.366 - 0.459	U	1.90E-01	9.99E-02		3.24E+00	N(a)	--
Benzo(a)anthracene	3 - 12	0.0496 - 0.295	0.366 - 0.428	N	1.85E-01	2.16E-01		5.21E+00	N(a)	--
Benzo(a)pyrene	4 - 12	0.0424 - 0.218	0.366 - 0.428	U	1.64E-01	2.18E-01		1.52E+00	N(a)	--
Benzo(b)fluoranthene	3 - 12	0.127 - 0.305	0.366 - 0.428	L	1.96E-01	2.20E-01		5.98E+01	N(a)	--
Benzo(g,h,i)perylene	1 - 12	0.0981 - 0.0981	0.366 - 0.459	U	1.90E-01	9.81E-02		1.19E+02	N(a)	--
Benzo(k)fluoranthene	1 - 12	0.158 - 0.158	0.366 - 0.459	N	1.95E-01	2.05E-01		1.48E+02	N(a)	--

Table 2-10

Statistical Summary and COPEC Selection of Surface Soil Sample Analyses
TNT Area A, Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution[a]	Arithmetic Mean	95% UCL[b]	Background Screening Criterion[c]	Ecological Screening Criterion[d]	COPEC?[e,f]	Source Term Concentration[g]
bis(2-Ethylhexyl) phthalate	1 - 12	0.0355 - 0.0355	0.366 - 0.459	U	1.85E-01	3.55E-02		9.26E-01	N(a)	--
Chrysene	3 - 12	0.107 - 0.202	0.366 - 0.428	U	1.82E-01	2.02E-01		4.73E+00	N(a)	--
Di-n-butyl phthalate	1 - 12	0.0729 - 0.0729	0.366 - 0.428	U	1.84E-01	7.29E-02		2.00E+02	N(a)	--
Fluoranthene	2 - 12	0.176 - 0.193	0.366 - 0.428	L	1.93E-01	2.00E-01		1.22E+02	N(a)	--
Indeno(1,2,3-cd)pyrene	1 - 12	0.0996 - 0.0996	0.366 - 0.459	U	1.90E-01	9.96E-02		1.09E+02	N(a)	--
Phenanthrene	2 - 12	0.0633 - 0.0807	0.366 - 0.428	U	1.74E-01	8.07E-02		4.57E+01	N(a)	--
Pyrene	2 - 12	0.153 - 0.175	0.366 - 0.428	N	1.90E-01	1.99E-01		7.85E+01	N(a)	--
Volatile Organics										
2-Butanone	1 - 12	0.0098 - 0.0098	0.01 - 0.016	L	6.37E-03	7.16E-03		8.96E+01	N(a)	--
Acetone	12 - 12	0.0134 - 0.194	NA	L	7.84E-02	1.86E-01		2.50E+00	N(a)	--
Benzene	1 - 12	0.00244 - 0.00244	0.005 - 0.008	L	3.03E-03	3.30E-03		2.50E-01	N(a)	--
Carbon disulfide	2 - 12	0.00267 - 0.00324	0.005 - 0.007	L	2.95E-03	3.15E-03		9.40E-02	N(a)	--
Methylene chloride	12 - 12	0.00398 - 0.107	NA	N	4.96E-02	6.61E-02		1.04E+01	N(a)	--
Toluene	1 - 12	0.00339 - 0.00339	0.005 - 0.008	L	3.11E-03	3.36E-03		2.00E+02	N(a)	--

COPEC - Chemical of Potential Ecological Concern; UCL - Upper Confidence Limit.

mg/kg - milligram per kilogram.

Surface soil is defined by samples taken from 0-2 feet below ground surface. These include four samples from 1.5 - 2.5 feet below ground surface.

[a] L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; U - Data are found to be nonparametric distribution.

[b] Calculated based on statistical distribution indicated (Section 2.2.2).

[c] Background data for constituents in soil as presented in Table 2-9.

[d] Ecological screening criteria for constituents in soil as presented in Appendix C.

[e] N = Chemical is not chosen as a COPEC:

(a) = Maximum detection is less than the Ecological Screening Criterion.

(b) = Maximum detection is less than the Background Screening Criterion.

[f] Y = Chemical is chosen as a COPEC:

(a) = Maximum detection is greater than the Ecological Screening Criterion or no screening criteria is available.

(b) = Maximum detection is greater than the Background Screening Criterion.

[g] Source term concentration represents the minimum of the MDC or the 95% UCL.

[h] Data for Dinitrotoluene, total utilized for assessment since the total of the source term concentration is greater than the total of the source term concentrations for 2,4- and 2,6-DNT.

Table 2-11

Statistical Summary and COPEC Selection of Total Soil Sample Analyses
TNT Area A, Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution[a]	Arithmetic Mean	95% UCL[b]	Background Screening Criterion[c]	Ecological Screening Criterion[d]	COPEC?[e,f]	Source Term Concentration[g]
Inorganics										
Aluminum	31 - 31	1090 - 11700	NA	L	5.63E+03	6.87E+03	1.55E+04	6.00E+02	N(b)	--
Antimony	12 - 31	0.631 - 3.69	1.28 - 2.265	U	1.07E+00	1.19E+00	9.30E+00	5.00E+00	N(a)(b)	--
Arsenic	30 - 31	2.21 - 20.3	1.17 - 1.17	L	5.44E+00	6.99E+00	3.65E+01	9.90E+00	N(b)	--
Barium	31 - 31	9.08 - 124	NA	L	3.60E+01	4.38E+01	8.26E+02	2.83E+02	N(a)(b)	--
Beryllium	31 - 31	0.16 - 0.759	NA	L	3.77E-01	4.39E-01	1.00E+00	1.00E+01	N(a)(b)	--
Cadmium	18 - 31	0.103 - 1.59	0.64 - 0.745	L	4.10E-01	5.13E-01	NA	4.00E+00	N(a)	--
Calcium	31 - 31	1180 - 125000	NA	L	1.90E+04	4.00E+04	5.23E+04	NA	Y(b)	4.00E+04
Chromium	31 - 31	3.09 - 40.3	NA	L	1.12E+01	1.35E+01	2.90E+01	4.00E-01	Y(a)(b)	1.35E+01
Cobalt	31 - 31	0.803 - 15.2	NA	L	4.90E+00	6.30E+00	1.16E+02	2.00E+01	N(a)(b)	--
Copper	31 - 31	2.06 - 88.4	NA	L	1.77E+01	2.39E+01	5.62E+01	6.00E+01	Y(a)(b)	2.39E+01
Iron	31 - 31	3910 - 44800	NA	L	1.37E+04	1.64E+04	2.34E+05	2.00E+02	N(b)	--
Lead	31 - 31	3.15 - 11900	NA	L	5.05E+02	6.24E+02	4.86E+01	4.05E+01	Y(a)(b)	6.24E+02
Magnesium	31 - 31	235 - 19100	NA	L	3.22E+03	4.96E+03	1.04E+04	NA	Y(b)	4.96E+03
Manganese	31 - 31	26.7 - 1370	NA	L	3.02E+02	4.47E+02	3.51E+03	1.00E+02	N(b)	--
Mercury	19 - 31	0.021 - 0.134	0.034 - 0.043	U	3.75E-02	3.36E-02	8.50E-02	5.10E-04	Y(a)(b)	3.36E-02
Nickel	31 - 31	3.26 - 44.1	NA	L	1.41E+01	1.76E+01	5.51E+01	3.00E+01	N(b)	--
Potassium	31 - 31	245 - 3190	NA	L	8.85E+02	1.10E+03	3.39E+03	NA	N(b)	--
Selenium	4 - 31	0.97 - 1.15	1.005 - 1.34	U	6.41E-01	1.22E+00	2.00E+00	2.10E-01	N(b)	--
Silver	1 - 31	0.704 - 0.704	0.6035 - 0.814	U	3.60E-01	7.09E-01	1.11E+01	2.00E+00	N(a)(b)(c)	--
Sodium	31 - 31	96.3 - 433	NA	L	2.04E+02	2.32E+02	NA	NA	Y(a)(b)	2.32E+02
Thallium	1 - 31	1.34 - 1.34	2.045 - 2.71	L	1.17E+00	1.20E+00	1.30E+00	1.00E+00	N(c)	--
Vanadium	31 - 31	6.54 - 24.1	NA	N	1.51E+01	1.64E+01	4.09E+01	2.00E+00	N(b)	--
Zinc	31 - 31	12.8 - 751	NA	L	1.12E+02	1.71E+02	3.22E+02	8.50E+00	Y(a)(b)	1.71E+02
Nitroaromatics										
1,3,5-Trinitrobenzene	5 - 31	0.0786 - 0.902	0.087 - 0.1	U	1.08E-01	1.00E-01		3.76E-01	N(a)	--
2,4,6-Trinitrotoluene	22 - 31	0.0875 - 530	0.0909 - 0.1	L	4.44E+01	3.20E+03		NA	Y(a)	5.30E+02
2,4-Dinitrotoluene	19 - 30	0.0761 - 8912	0.352 - 0.459	U	3.03E+02	3.43E-01		1.28E+00	Y(a)	3.43E-01
2,6-Dinitrotoluene	15 - 31	0.0529 - 10274	0.352 - 0.459	U	4.40E+02	4.34E-01		3.30E-02	Y(a)	4.34E-01
2-Amino-4,6-dinitrotoluene	15 - 31	0.358 - 33.6	0.087 - 0.1	U	3.62E+00	7.57E-01		NA	Y(a)	7.57E-01
2-Nitrotoluene	7 - 31	0.276 - 582	0.174 - 0.2	U	1.98E+01	2.00E-01		NA	Y(a)	2.00E-01
3-Nitrotoluene	7 - 31	0.13 - 59	0.174 - 0.2	U	2.22E+00	2.00E-01		NA	Y(a)	2.00E-01
4-Amino-2,6-dinitrotoluene	19 - 31	0.0915 - 16	0.087 - 0.1	U	2.25E+00	1.29E+00		NA	Y(a)	1.29E+00
4-Nitrotoluene	7 - 31	0.249 - 484	0.174 - 0.2	U	1.59E+01	2.00E-01		NA	Y(a)	2.00E-01
Dinitrotoluene, total[h]	18 - 31	0.114 - 2708	0.087 - 0.1	U	1.22E+02	6.41E-01		6.50E-01	Y(a)	6.41E-01
Nitrobenzene	4 - 31	0.0713 - 0.205	0.087 - 0.1	U	5.76E-02	1.00E-01		4.00E+01	N(a)	--
PCBs										
Aroclor 1260	26 - 31	0.00862 - 69.8	0.076 - 0.0914	U	2.65E+00	1.32E-01		3.71E-01	Y(a)	1.32E-01
Semivolatile Organics										
2-Methylnaphthalene	2 - 31	0.0907 - 0.0999	0.352 - 78.9	U	2.33E+00	4.21E-01		3.24E+00	N(a)	--
Benzo(a)anthracene	4 - 31	0.0386 - 0.295	0.352 - 78.9	U	2.33E+00	4.21E-01		5.21E+00	N(a)	--
Benzo(a)pyrene	4 - 31	0.0424 - 0.218	0.352 - 78.9	U	2.32E+00	4.21E-01		1.52E+00	N(a)	--
Benzo(b)fluoranthene	3 - 31	0.127 - 0.305	0.352 - 78.9	U	2.33E+00	4.21E-01		5.98E+01	N(a)	--
Benzo(ghi)perylene	1 - 31	0.0981 - 0.0981	0.352 - 78.9	U	2.33E+00	4.21E-01		1.19E+02	N(a)	--

Table 2-11

Statistical Summary and COPEC Selection of Total Soil Sample Analyses
TNT Area A, Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution[a]	Arithmetic Mean	95% UCL[b]	Background Screening Criterion[c]	Ecological Screening Criterion[d]	COPEC?[e,f]	Source Term Concentration[g]
Benzo(k)fluoranthene	1 - 31	0.158 - 0.158	0.352 - 78.9	U	2.33E+00	4.21E-01		1.48E+02	N(a)	--
Bis(2-ethylhexyl)phthalate	5 - 31	0.0231 - 0.0595	0.352 - 78.9	U	2.31E+00	4.13E-01		9.26E-01	N(a)	--
Chrysene	4 - 31	0.0733 - 0.202	0.352 - 78.9	U	2.32E+00	4.14E-01		4.73E+00	N(a)	--
Di-n-butyl phthalate	3 - 31	0.0568 - 0.216	0.352 - 78.9	U	2.32E+00	4.21E-01		2.00E+02	N(a)	--
Fluoranthene	2 - 31	0.176 - 0.193	0.352 - 78.9	U	2.33E+00	4.14E-01		1.22E+02	N(a)	--
Indeno(1,2,3-cd)pyrene	1 - 31	0.0996 - 0.0996	0.352 - 78.9	U	2.33E+00	4.21E-01		1.09E+02	N(a)	--
Phenanthrene	4 - 31	0.0516 - 0.0807	0.352 - 78.9	U	2.32E+00	4.14E-01		4.57E+01	N(a)	--
Pyrene	2 - 31	0.153 - 0.175	0.352 - 78.9	U	2.33E+00	4.14E-01		7.85E+01	N(a)	--
Volatile Organics										
2-Butanone	2 - 31	0.00475 - 0.0098	0.0096 - 0.0164	L	5.99E-03	6.31E-03		8.96E+01	N(a)	--
Acetone	29 - 29	0.00713 - 0.194	NA	L	5.81E-02	8.60E-02		2.50E+00	N(a)	--
Benzene	1 - 31	0.00244 - 0.00244	0.0029 - 0.0082	N	2.90E-03	3.05E-03		2.50E-01	N(a)	--
Carbon disulfide	8 - 31	0.00185 - 0.00909	0.0047 - 0.0076	U	3.15E-03	6.10E-03		9.40E-02	N(a)	--
Methylene chloride	31 - 31	0.00201 - 0.107	NA	L	3.09E-02	6.53E-02		1.04E+01	N(a)	--
Toluene	9 - 31	0.00209 - 0.013	0.0047 - 0.0082	U	3.33E-03	6.13E-03		2.00E+02	N(a)	--

COPEC - Chemical of Potential Ecological Concern; UCL - Upper Confidence Limit.
mg/kg - milligram per kilogram.
Total soil is defined by samples taken from 0-6 feet below ground surface.

[a] L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; U - Data are found to be nonparametric distribution.
[b] Calculated based on statistical distribution indicated (Section 2.2.2).
[c] Background data for constituents in soil as presented in Table 2-9.
[d] Ecological screening criteria for constituents in soil as presented in Appendix C.
[e] N = Chemical is not chosen as a COPEC:
(a) = Maximum detection is less than the Ecological Screening Criterion.
(b) = Maximum detection is less than the Background Screening Criterion.
(c) = Frequency of detection is less than 5%.
[f] Y = Chemical is chosen as a COPEC:
(a) = Maximum detection is greater than the Ecological Screening Criterion or no screening criteria is available.
(b) = Maximum detection is greater than the Background Screening Criterion.
[g] Source term concentration represents the minimum of the MDC or the 95% UCL.
[h] Data for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene utilized for assessment since the total of the source term concentrations is greater than the source term concentration of total dinitrotoluene.

Table 2-12

Statistical Summary and COPEC Selection of Surface Water Sample Analyses
TNT Area A, Plum Brook Ordnance Works, Sandusky, Ohio

Chemical Name (mg/L)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution	Arithmetic Mean	95% UCL[a]	Ecological Screening Criterion[b]	COPEC?[c,d]	Source Term Concentration[e]
Inorganics									
Aluminum	8 - 8	0.0726 - 2.88	NA	L	7.33E-01	7.46E+00	8.70E-02	Y	2.88E+00
Arsenic	1 - 8	0.0038 - 0.00375	0.005 - 0.005	U	2.66E-03	3.75E-03	5.30E-02	N	--
Barium	8 - 8	0.0225 - 0.0539	NA	L	3.13E-02	4.15E-02	4.00E-03	Y	4.15E-02
Beryllium	5 - 8	0.0001 - 0.000305	0.001 - 0.001	L	3.15E-03	5.46E-04	6.60E-04	N	--
Cadmium	2 - 8	0.0008 - 0.00078	0.003 - 0.003	U	1.32E-03	7.80E-04	6.60E-04	Y	7.80E-04
Calcium	8 - 8	35.95 - 168	NA	N	1.04E+02	1.43E+02	NA	Y	1.43E+02
Chromium	6 - 8	0.0009 - 0.009845	0.005 - 0.005	L	3.58E-03	7.47E-03	4.20E-02	N	--
Cobalt	3 - 8	0.0013 - 0.00619	0.005 - 0.005	L	2.92E-03	4.23E-03	5.00E-03	Y	4.23E-03
Copper	8 - 8	0.0016 - 0.00628	NA	L	3.62E-03	6.02E-03	5.00E-03	Y	6.02E-03
Iron	8 - 8	0.0396 - 9.85	NA	L	1.86E+00	7.08E+01	1.00E+00	Y	9.85E+00
Lead	6 - 8	0.0015 - 0.00549	0.003 - 0.003	L	2.49E-03	3.90E-03	1.30E-03	Y	3.90E-03
Magnesium	8 - 8	9.1 - 44.4	NA	N	2.60E+01	3.48E+01	NA	Y	3.48E+01
Manganese	8 - 8	0.0249 - 1.03	NA	L	2.26E-01	1.61E+00	1.20E-01	Y	1.03E+00
Nickel	4 - 8	0.0028 - 0.015	0.005 - 0.005	U	4.62E-03	1.50E-02	2.90E-02	N	--
Potassium	8 - 8	1.83 - 5.55	NA	L	2.85E+00	3.83E+00	NA	Y	3.83E+00
Selenium	1 - 8	0.0026 - 0.00263	0.005 - 0.005	U	2.52E-03	2.63E-03	3.90E-04	Y	2.63E-03
Silver	3 - 8	0.0008 - 0.000941	0.003 - 0.003	U	1.25E-03	9.41E-04	3.60E-04	Y	9.41E-04
Sodium	8 - 8	7.71 - 54.3	NA	L	1.72E+01	3.04E+01	NA	Y	3.04E+01
Vanadium	5 - 8	0.0009 - 0.00623	0.005 - 0.005	L	2.51E-03	4.27E-03	1.90E-02	N	--
Zinc	7 - 8	0.005 - 0.0617	0.015 - 0.015	L	1.95E-02	5.92E-02	5.89E-02	Y	5.92E-02
Nitroaromatics									
2-Amino-4,6-Dinitrotoluene	1 - 8	0.002 - 0.00196	3E-04 - 3E-04	U	3.59E-04	1.96E-03	NA	Y	1.96E-03
4-Amino-2,6-Dinitrotoluene	2 - 8	0.0002 - 0.00234	3E-04 - 3E-04	U	4.11E-04	2.34E-03	NA	Y	2.34E-03
Semivolatile Organics									
Di-n-butyl phthalate	2 - 8	0.0012 - 0.001735	0.011 - 0.012	U	4.46E-03	1.74E-03	1.00E-03	Y	1.74E-03
Volatile Organics									
Acetone	1 - 1	0.003 - 0.00295	NA	NA	NA	NA	1.50E+00	N	--
Carbon disulfide	8 - 8	0.001 - 0.0115	NA	L	4.64E-03	1.13E-02	9.20E-04	Y	1.13E-02
Methylene chloride	8 - 8	0.0027 - 0.00375	NA	U	3.49E-03	3.75E-03	4.30E-01	N	--

COPEC - Chemical of Potential Ecological Concern; UCL - Upper Confidence Limit.

L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; U - Data are found to be nonparametric distribution.

mg/kg - milligram per kilogram.

[a] Calculated based on statistical distribution indicated (Section 2.2.2).

[b] Ecological screening criteria for surface water as presented in Appendix C.

[c] N = Chemical is not chosen as a COPEC: Maximum detected concentration does not exceed screening criterion.

[d] Y = Chemical is chosen as a COPEC: Maximum detected concentration exceeds screening criterion or no screening criteria is available.

[e] Source term concentration represents the minimum of the MDC or the 95% UCL.

Table 2-13

Statistical Summary and COPEC Selection of Sediment Sample Analyses
TNT Area A, Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution	Arithmetic Mean	95% UCL[a]	Background Screening Criterion[b]	Ecological Screening Criterion[c]	COPEC?[d,e]	Source Term Concentration[f]
Inorganics										
Aluminum	10 - 10	3020 - 14300	NA	N	1.01E+04	1.21E+04	1.55E+04	NA	N(b)	--
Arsenic	10 - 10	2.735 - 25	NA	L	8.79E+00	1.78E+01	3.65E+01	5.90E+00	N(b)	--
Barium	10 - 10	18.95 - 177	NA	L	5.79E+01	1.02E+02	8.26E+02	NA	N(b)	--
Beryllium	10 - 10	0.172 - 1.56	NA	L	7.30E-01	1.25E+00	1.00E+00	NA	Y(a)(b)	1.25E+00
Cadmium	5 - 10	0.164 - 1.16	0.733 - 0.807	L	4.41E-01	6.36E-01	NA	5.96E-01	Y(a)	6.36E-01
Calcium	10 - 10	2730 - 68700	NA	L	2.99E+04	1.41E+05	5.23E+04	NA	Y(a)(b)	6.87E+04
Chromium	10 - 10	8.08 - 24.2	NA	N	1.73E+01	2.05E+01	2.90E+01	2.60E+01	N(a)(b)	--
Cobalt	10 - 10	2.9 - 84.9	NA	L	2.23E+01	7.03E+01	1.16E+02	5.00E+01	N(b)	--
Copper	10 - 10	5.375 - 26.5	NA	N	1.44E+01	1.81E+01	5.62E+01	1.60E+01	N(b)	--
Iron	10 - 10	13000 - 58300	NA	L	2.46E+04	3.53E+04	2.34E+05	2.00E+04	N(b)	--
Lead	10 - 10	5.645 - 59	NA	L	2.27E+01	4.97E+01	4.86E+01	3.10E+01	Y(a)(b)	4.97E+01
Magnesium	10 - 10	1650 - 9510	NA	N	5.06E+03	6.53E+03	1.04E+04	NA	N(b)	--
Manganese	10 - 10	133.8 - 2770	NA	L	8.01E+02	2.99E+03	3.51E+03	4.60E+02	N(b)	--
Mercury (Inorganic)	5 - 10	0.024 - 0.207	0.041 - 0.047	U	4.58E-02	2.07E-01	8.50E-02	1.74E-01	Y(a)(b)	2.07E-01
Nickel	10 - 10	7.22 - 117	NA	L	4.23E+01	1.01E+02	5.51E+01	1.60E+01	Y(a)(b)	1.01E+02
Potassium	10 - 10	524 - 3030	NA	N	1.79E+03	2.31E+03	3.39E+03	NA	N(b)	--
Selenium	2 - 10	0.851 - 1.13	1.22 - 1.5	U	7.20E-01	1.13E+00	2.00E+00	NA	N(b)	--
Silver	1 - 10	0.557 - 0.557	0.733 - 0.899	U	4.06E-01	5.57E-01	1.11E+01	5.00E-01	N(b)	--
Sodium	8 - 10	71.6 - 252	263 - 300	L	1.39E+02	1.84E+02	NA	NA	Y(a)	1.84E+02
Vanadium	10 - 10	15.3 - 29.4	NA	L	2.11E+01	2.45E+01	4.09E+01	NA	N(b)	--
Zinc	10 - 10	18.4 - 201	NA	L	7.83E+01	1.48E+02	3.22E+02	1.20E+02	N(b)	--
Nitroaromatics										
2,4,6-Trinitrotoluene	7 - 10	0.064 - 4.6	0.095 - 0.1	L	8.47E-01	1.36E+01		NA	Y(a)	4.60E+00
2,4-Dinitrotoluene[g]	2 - 10	0.116 - 0.147	0.421 - 0.504	U	2.05E-01	1.47E-01		7.51E-02	Y(a)	1.47E-01
2,6-Dinitrotoluene[g]	3 - 10	0.049 - 0.0844	0.423 - 0.504	U	1.76E-01	8.44E-02		2.06E-02	Y(a)	8.44E-02
2-Amino-4,6-Dinitrotoluene	5 - 10	0.063 - 2.92	0.091 - 0.1	U	6.70E-01	2.92E+00		NA	Y(a)	2.92E+00
2-Nitrotoluene	1 - 10	0.168 - 0.168	0.174 - 0.2	U	1.01E-01	1.68E-01		NA	Y(a)	1.68E-01
4-Amino-2,6-Dinitrotoluene	6 - 10	0.071 - 1.19	0.091 - 0.1	L	2.75E-01	1.18E+00		NA	Y(a)	1.18E+00
Dinitrotoluene	6 - 10	0.046 - 0.576	0.091 - 0.1	L	2.10E-01	7.63E-01		NA	Y(a)	5.76E-01
PCBs										
Aroclor 1260	4 - 10	0.02 - 0.731	0.085 - 0.101	U	1.23E-01	7.31E-01		3.41E-02	Y(a)	7.31E-01

Table 2-13

Statistical Summary and COPEC Selection of Sediment Sample Analyses
TNT Area A, Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution	Arithmetic Mean	95% UCL[a]	Background Screening Criterion[b]	Ecological Screening Criterion[c]	COPEC?[d,e]	Source Term Concentration[f]
Semivolatile Organics										
Benzo(a)anthracene	1 - 10	0.286 - 0.286	0.421 - 0.504	L	2.32E-01	2.45E-01		3.17E-02	Y(a)	2.45E-01
Benzo(a)pyrene	2 - 10	0.044 - 0.136	0.421 - 0.504	U	1.98E-01	1.36E-01		3.19E-02	Y(a)	1.36E-01
Benzo(b)fluoranthene	1 - 10	0.182 - 0.182	0.421 - 0.504	N	2.22E-01	2.32E-01		1.04E+01	N(a)	--
bis(2-Ethylhexyl) phthalate	1 - 10	0.022 - 0.022	0.421 - 0.504	U	2.06E-01	2.16E-01		1.82E-01	N(a)	--
Chrysene	1 - 10	0.163 - 0.163	0.421 - 0.504	N	2.20E-01	2.33E-01		5.71E-02	Y(a)	1.63E-01
Fluoranthene	1 - 10	0.688 - 0.688	0.421 - 0.504	U	2.72E-01	6.88E-01		1.11E-01	Y(a)	6.88E-01
Phenanthrene	1 - 10	0.107 - 0.107	0.421 - 0.504	U	2.14E-01	1.07E-01		4.19E-02	Y(a)	1.07E-01
Pyrene	1 - 10	0.458 - 0.458	0.421 - 0.504	U	2.49E-01	4.58E-01		5.30E-02	Y(a)	4.58E-01
Volatile Organics										
Acetone	7 - 10	0.011 - 0.021	0.013 - 0.014	N	1.32E-02	1.63E-02		4.53E-01	N(a)	--
Carbon disulfide	1 - 10	0.01 - 0.01	0.006 - 0.008	U	4.05E-03	1.02E-02		1.34E-01	N(a)	--
Methylene chloride	10 - 10	0.004 - 0.063	NA	N	3.20E-02	4.23E-02		1.26E+00	N(a)	--

COPEC - Chemical of Potential Ecological Concern; UCL - Upper Confidence Limit.

L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; U - Data are found to be nonparametric distribution.

mg/kg - milligram per kilogram.

[a] Calculated based on statistical distribution indicated (Section 2.2.2).

[b] Background data for constituents in soil as presented in Table 2-9.

[c] Ecological screening criteria for sediment as presented in Appendix C.

[d] N = Chemical is not chosen as a COPEC: Maximum detected concentration does not exceed screening criterion.

(a) = Maximum detection is less than the Ecological Screening Criterion.

(b) = Maximum detection is less than the Background Screening Criterion.

[e] Y = Chemical is chosen as a COPEC: Maximum detected concentration exceeds screening criterion or no screening criteria is available.

(a) = Maximum detection is greater than the Ecological Screening Criterion or no screening criteria is available.

(b) = Maximum detection is greater than the Background Screening Criterion.

[f] Source term concentration represents the minimum of the MDC or the 95% UCL.

[g] Data for Dinitrotoluene, total utilized for assessment since the total of the source term concentration is greater than the total of the source term concentrations for 2,4- and 2,6-DNT.

Table 2-14

Assessment and Measurement Endpoints and Exposure Delineation
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of terrestrial ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for soil invertebrates.	The presence of site contaminants within surficial soils will have no adverse effect on survival and reproductive capabilities of terrestrial invertebrates.	Terrestrial invertebrates Ingestion of soil and direct exposure to soil	Comparison of soil concentration to soil critical effect values (CEV).
	Protection of long-term survival and reproductive capabilities for herbivorous mammals.	The presence of site contaminants within surface and subsurface soils, surface water, and vegetation will have no adverse effect on survival and reproductive capabilities of herbivorous mammals.	Eastern cottontail (*Sylvilagus floridanus*) white-tailed deer (*Odocoileus virginianus*) ingestion of plants, water, and incidental soil	Comparison of total daily dose to species-specific toxicity endpoint values (TEV).
	Protection of long-term survival and reproductive capabilities for omnivorous mammals.	The presence of site contaminants within surface soils, surface water, terrestrial invertebrates and vegetation will have no adverse effect on survival and reproductive capabilities of omnivorous mammals.	raccoon (*Procyon lotor*) ingestion of terrestrial plants, and invertebrates, small mammals, water and incidental soil	Comparison of total daily dose to species-specific toxicity endpoint values (TEV).

Table 2-14

Assessment and Measurement Endpoints and Exposure Delineation
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 4)

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of terrestrial ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for omnivorous mammals.	The presence of site contaminants within surficial soils, surface water, terrestrial invertebrates, and vegetation will have no adverse effect on survival and reproductive capabilities of omnivorous mammals.	deer mouse (*Peromyscus maniculatus*) ingestion of terrestrial invertebrates, plants, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.
	Protection of long-term survival and reproductive capabilities for carnivorous birds.	The presence of site contaminants within surficial soils, surface water, small mammals, and birds will have no adverse effect on survival and reproductive capabilities of carnivorous birds.	red-tailed hawk (*Buteo jamacencis*) ingestion of small mammals, birds, water, incidental soil	Comparison of total daily dose to species-specific TEVs.
	Protection of long-term survival and reproductive capabilities for small insectivorous mammals.	The presence of site contaminants within surficial soils, surface water, and terrestrial invertebrates will have no adverse effect on survival and reproductive capabilities of insectivorous mammals.	short-tailed shrew (*Blarnia brevicauda*) ingestion of terrestrial invertebrates, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.

Table 2-14

Assessment and Measurement Endpoints and Exposure Delineation
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of terrestrial ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for insectivorous birds.	The presence of site contaminants within surficial soils, surface water, and terrestrial invertebrates will have no adverse effect on survival and reproductive capabilities of insectivorous birds.	march wren (*Cistorthorus palustris*) ingestion of terrestrial invertebrates, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.
Protection of aquatic ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for benthic invertebrates.	The presence of site contaminants within sediments and surface water will have no adverse effect on survival and reproductive capabilities of benthic invertebrates.	benthic invertebrates ingestion of sediment and direct exposure to surface water	Comparison of sediment concentration to sediment CEVs.
	Protection of long-term survival and reproductive capabilities for aquatic invertebrates (crustaceans).	The presence of site contaminants within surface water will have no adverse effect on survival and reproductive capabilities of aquatic invertebrates.	aquatic invertebrates direct exposure to water	Comparison of surface water concentration to aquatic CEVs.

Table 2-14

Assessment and Measurement Endpoints and Exposure Delineation
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
	Protection of long-term survival and reproductive capabilities for semi-aquatic omnivorous mammals (also considered in the terrestrial assessment).	The presence of site contaminants within surface water, sediments, and aquatic invertebrates have no adverse effect on survival and reproductive capabilities of aquatic mammals.	raccoon (*Procyon lotor*) ingestion of aquatic invertebrates, water and incidental sediment	Comparison of total daily dose to species-specific TEVs.
Protection of aquatic ecosystem structure and function. (continued)	Protection of long-term survival and reproductive capabilities for aquatic birds.	The presence of site contaminants within aquatic and benthic invertebrates will have no adverse effect on survival and reproductive capabilities of aquatic birds.	mallard (*Anas platyrhynchos*) ingestion of aquatic and benthic invertebrates, water, and incidental sediment	Comparison of total daily dose to species-specific TEVs.

Table 3-1

Data Used to Model Exposure in the Indicator Wildlife Species
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Indicator Species	Class/ Order	Average Body Weight[a] (kg)	Average Home Range[a] (ha)	Dietary Intake[a] (kg[dw]/day)	Soil/Sed. Intake (kg[dw]/day)	Water Intake (L/day)[b]	Trophic Level	Dietary Composition[a] (percent)
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	0.0148	0.062	0.0028[d]	0.000057 (2.0%)	0.0022	Omnivore	Terr. Inverts. : 39 Plants: 61
Eastern cottontail (*Sylvilagus floridanus*)	Mammalia/ Lagomorpha	1.132	3.1	0.096[d]	0.006 (6.3%)	0.11	Herbivore	Plants: 100
Short-tailed shrew (*Blarina brevicauda*)	Mammalia/ Insectivora	0.015	0.39	0.0022[d]	0.00083 (10.4%)	0.0023	Insectivore	Terr. Inverts.: 100
White-tailed deer (*Odocoileus virginianus*)	Mammalia/ Artiodactyla	61[c]	518[c]	2.0[d]	0.04 (2.0%)	4.0	Herbivore	Plants: 100
Marsh wren (*Cistothorus palustris*)	Aves/ Passeriformes	0.010	0.054	0.0029[d]	0.00019 (2.0%)	0.0027	Insectivore	Terr. Inverts.: 100
Red-tailed hawk (*Buteo jamaicensis*)	Aves/ Falconiformes	0.957	842	0.057[d]	0.002 (2.0%)	0.057	Carnivore	Rabbits: 25.3 Shrews: 25.3 Mice: 25.3 Birds: 24
Mallard duck (*Anas platyrhynchos*)	Aves/ Anseriformes	1.13	580	0.063[d]	0.0013 (2.0%)	0.064	Omnivore	Plants: 62.5 Aq. Inverts. 37.5

Table 3-1

Data Used to Model Exposure in the Indicator Wildlife Species
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Indicator Species	Class/ Order	Average Body Weight[a] (kg)	Average Home Range[a] (ha)	Dietary Intake[a] (kg[dw]/day)	Soil/Sed. Intake (kg[dw]/day)	Water Intake (L/day)[b]	Trophic Level	Dietary Composition[a] (percent)
Raccoon (*Procyon lotor*)	Mammalia/ Carnivora	5.1	156	0.26 [d]	0.024 (9.4%)	0.43	Omnivore	Aq. Inverts.: 21 Terr. Inverts.: 30 Mice: 5.0 Plants: 42 (Fish: 2.0 not included, as no fish on site).

[a] From EPA (1993), except as noted.
[b] Allometric equations for mammals and birds from EPA (1993), as follows:
Mammals: WI (water ingestion; L/day) = 0.099 $Wt^{0.90}$ (kg), where Wt = body weight.
Birds: WI (L/day) = 0.059 $Wt^{0.67}$ (kg).
[c] Information is from *A Guide to the Mammals of Ohio* (Gottschang, 1981).
[d] Allometric equation for mammals: FI (kg/day) = 0.0687 $Wt^{0.822}$ for shrew, deer, and raccoon; FI (g/day) = 0.621 $Wt^{0.564}$ for rodents (deer mouse); and FI (g/day) = 0.577 $Wt^{0.727}$ for small herbivores (cottontail). Allometric equation for birds: FI (kg/day) = 0.0582 $Wt^{0.651}$ (EPA, 1993), where FI = food ingestion (dry weight) and Wt = body weight. Allometric equations from EPA (1993).

Table 3-2

Octanol-Water Partition Coefficients (K_{ow}) for Organic Constituents of Potential Ecological Concern
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	K_{ow} (unitless)[a]
2,4,6-Trinitrotoluene	100[b]
2,4-Dinitrotoluene	95
2,6-Dinitrotoluene	190
2-Amino-4,6-dinitrotoluene	100[d]
2-Nitrotoluene	200[c]
3-Nitrotoluene	282[c]
4-Nitrotoluene	263[c]
4-Amino-2,6-dinitrotoluene	100[d]
Aroclor 1260	14,000,000
Benzo(a)anthracene	410,000
Benzo(a)pyrene	1,150,000
Carbon disulfide	69.2[e]
Chrysene	410,000
Di-n-butyl phthalate	360,000
Dinitrotoluene	190[f]
Fluoranthene	79,000
Phenanthrene	28,000
Pyrene	80,000

[a] Octanol-water partition coefficients (K_{ow}) values are from EPA-440/4-81-014, 1982, Aquatic Fate Process Data for Organic Priority Pollutants, unless otherwise noted.

[b] K_{ow} values are from Rosenblatt, D. H., et. al., 1991, Organic Explosives and Related Compounds.

[c] K_{ow} values are from Leo, A., Hansch, C., and Elkins, D., 1971, Partition Coefficients and Their Uses.

[d] The K_{ow} for 2,4,6-Trinitrotoluene was used as a surrogate.

[e] The K_{ow} values are from Montgomery, 1996.

[f] The K_{ow} for 2,6-Dinitrotoluene was used as a surrogate.

Table 3-3

Fate and Transport Factors for Inorganic Chemicals of Potential Ecological Concern, TNT Area A Plum Brook Ordnance Works, Sandusky, Ohio

COPEC	Soil/Sediment-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor	Water-to-Invertebrate Bio-Concentration Factor	Distribution Coefficient K_d (L/kg)
Aluminum	--	--	1.5×10^{-3} [b]	1.0×10^{2} [a]	1.5×10^{3} [b]
Barium	--	--	2.4×10^{-4} [c]	4.0×10^{0} [c]	6.0×10^{1} [b]
Beryllium	5.8×10^{-3} [b]	1.0×10^{0} [a]	1.0×10^{-3} [b]	1.0×10^{2} [c]	6.5×10^{2} [b]
Cadmium	3.5×10^{-1} [b]	4.2×10^{1} [d]	4.0×10^{-4} [c]	1.0×10^{2} [a]	6.4×10^{0} [b]
Calcium	1.9×10^{0} [b]	1.0×10^{0} [a]	2.0×10^{-3} [c]	1.0×10^{2} [a]	4.0×10^{0} [b]
Chromium	1.0×10^{-3} [c]	7.0×10^{-2} [d]	9.0×10^{-3} [c]	--	--
Cobalt	--	--	1.0×10^{-4} [c]	3.0×10^{2} [c]	5.0×10^{3} [c]
Copper	8.0×10^{-1} [c]	2.5×10^{-1} [e]	9.0×10^{-3} [c]	2.0×10^{2} [c]	3.5×10^{1} [b]
Iron	--	--	2.0×10^{-2} [c]	2.0×10^{2} [c]	5.0×10^{3} [c]
Lead	1.1×10^{-3} [c]	9.3×10^{-1} [d]	4.0×10^{-4} [c]	3.0×10^{2} [c]	4.0×10^{2} [b]
Magnesium	7.8×10^{-1} [b]	1.0×10^{0} [a]	2.0×10^{-2} [c]	1.0×10^{2} [a]	4.6×10^{0} [b]
Manganese	6.8×10^{-1} [c]	3.2×10^{-1} [d]	5.0×10^{-4} [c]	4.0×10^{2} [c]	1.0×10^{3} [c]
Mercury	5.5×10^{-1} [b]	1.0×10^{0} [a]	2.5×10^{-1} [b]	1.0×10^{3} [c]	1.0×10^{1} [b]
Nickel	3.6×10^{-1} [f]	3.8×10^{-1} [d]	5.0×10^{-3} [c]	1.0×10^{2} [c]	1.5×10^{2} [b]
Potassium	--	--	1.0×10^{-2} [c]	1.0×10^{2} [a]	5.6×10^{0} [b]
Selenium	--	--	1.5×10^{-2} [b]	1.0×10^{2} [a]	3.0×10^{2} [b]
Silver	--	--	3.0×10^{-3} [c]	5.0×10^{0} [c]	4.5×10^{1} [b]
Sodium	6.5×10^{-2} [b]	1.0×10^{0} [a]	8.0×10^{-2} [c]	2.0×10^{1} [c]	1.0×10^{2} [b]
Zinc	4.3×10^{-1} [f]	3.0×10^{-1} [e]	1.0×10^{-1} [c]	1.0×10^{3} [c]	4.0×10^{1} [b]

[a] Consevative default values: 1.0×10^{0} for soil-to-insect TF, based on data in Stafford et al. (1991), Ma (1982), and NCRP (1989); 1.0×10^{2} for water-to-invertebrate BCF, based on 95% UCL for nonparametric distribution of 54 BCF values presented in IAEA (1994).
[b] From Baes et. al., (1984); for soil-to-plant transfer factors, average of vegetative and nonvegetative values was used.
[c] From IAEA (1994). For food-to-muscle TFs, transfer coefficients for beef were used. For water-to-invertebrate BCF, values for freshwater fish were utilized.
[d] From Ma (1982).
[e] Stafford et al. (1991).
[f] Based on data in Arthur and Gates (1988).
" -- " symbol indicates factor was not required as the inorganic was not selected as a COPEC for the particular pathway of concern.

Table 3-4

BCF Selection
Sediment to Invertebrate BCF
TNT Area A, PBOW, Sandusky, Ohio

Chemical Name	Literature Value	Site-Specific RME	Selected BCF	Comments
Organics				
Aroclor 1260	14,000,000	NA	14,000,000	Literature
2-Amino-4,6-DNT	100	ND	100	Literature
4-Amino-2,6-DNT	100	ND	100	Literature
Benzo(a)anthracene	410,000	NA	410,000	Literature
Benzo(a)pyrene	1,150,000	NA	1,150,000	Literature
Chrysene	410,000	NA	410,000	Literature
Dinitrotoluene	190	NA	190	Literature
Fluoranthene	79,000	NA	79,000	Literature
2-Nitrotoluene	200	ND	200	Literature
Phenanthrene	28,000	NA	28,000	Literature
Pyrene	80,000	NA	80,000	Literature
2,4,6-TNT	100	ND	100	Literature
Inorganics				
Beryllium	100	NA	100	Literature
Cadmium	100	ND	100	Literature
Calcium	100	0.033	0.033	Site-Specific (Red Water Ponds)
Lead	300	0.025	0.025	Site-Specific (Red Water Ponds)
Mercury	1,000	NA	1,000	Literature
Nickel	100	0.018	0.018	Site-Specific (Red Water Ponds)
Sodium	20	0.77	0.77	Site-Specific (Red Water Ponds)

NA - Not Available
ND - Constituent not detected in RWP site-specific biota or sediment samples.

Notes:
Literature value is porewater to tissue biotransfer factor.
Site-specific BCF is from RWP laboratory bioaccumulation study, with conservative selection of RME over CT value.
Site-specific BCF selected if available.

Table 3-5

BAF Selection
Soil to Invertebrate BAF
TNT Area A, PBOW, Sandusky, Ohio

Chemical Name	Calculated/Literature Value	Site-Specific RME	Selected BAF	Comments
Organics				
Aroclor-1260	27.3	NA	27.3	Calculated
2-Amino-4,6-DNT	15.1	0.1	0.1	2,4-DNT as Surrogate
4-Amino-2,6-DNT	15.1	0.1	0.1	2,4-DNT as Surrogate
2,4-DNT	15	0.1	0.1	Site-Specific (Red Water Ponds)
2,6-DNT	15.6	0.1	0.1	2,4-DNT as Surrogate
Dinitrotoluene	15.6	0.1	0.1	2,4-DNT as Surrogate
2-Nitrotoluene	15.6	0.1	0.1	2,4-DNT as Surrogate
3-Nitrotoluene	15.9	0.1	0.1	2,4-DNT as Surrogate
4-Nitrotoluene	15.8	0.1	0.1	2,4-DNT as Surrogate
2,4,6-TNT	15.1	0.1	0.1	2,4-DNT as Surrogate
Inorganics				
Calcium	1	NA	1	Literature
Chromium	0.07	NA	0.07	Literature
Copper	0.25	NA	0.25	Literature
Lead	0.93	NA	0.93	Literature
Magnesium	1	NA	1	Literature
Mercury	1	NA	1	Literature
Sodium	1	NA	1	Literature
Zinc	0.3	NA	0.3	Literature

NA - Not Available.

Notes:
Site-specific BAF is from RWP laboratory bioaccumulation study, with conservative selection of RME over CT value.
Site-specific BAF selected if available.

Table 4-1

NOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern - TNT Area A Plum Brook Former Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

COPEC	Mammalian Data					Avian Data				
	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)
Organics										
1,3-Dinitrobenzene (1,3-DNB)	--	0.113	rat	Talmage et. al (1999)	0.35	42 (LD_{50})	0.42	red-winged black bird	Talmage et al. (1999)	0.077
2,4-Dinitrotoluene (2,4-DNT)	--	0.2	beagle dog	IRIS on-line (2001)	11	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2,6-Dinitrotoluene	--	0.2	beagle dog	2,4-DNT as surrogate	11	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
4,6-Dinitro-2-methylphenol	10 (LD_{50})	0.1	rat	Montgomery (1996)	0.35	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene (2,4,6-TNT)	--	1.6	rat	Talmage et. al (1999)	0.35	7	0.7	Bobwhite quail	USACHPPM (2000)	0.19
2-Nitrotoluene (2-NT)	--	45	rat	Dunnick et al., 1994 as summarized by Johnson (2000)	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
3-Nitrotoluene	--	45	rat	2-NT as surrogate	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
4-Nitrotoluene	--	45	rat	2-NT as surrogate	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2-Amino-4,6-dinitrotoluene	1394 (LD_{50})	13.9	rat	TOMES database	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
4-Amino-2,6-dinitrotoluene	959 (LD_{50})	9.6	rat	TOMES database	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
Aroclor-1260 (Aroclor-1254)	--	0.068	mouse	Sample, et al. (1996)	0.014	--	0.18	ring neck pheasant	Sample, et al. (1996)	1
Benzo(a)anthracene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Benzo(a)pyrene [B(a)P]	--	1.0	mouse	Sample, et al. (1996)	0.03	NA	NA	NA	NA	NA
Carbon disulfide	3,188 (LD_{50})	31.9	rat	Montgomery (1996)	0.35	NA	NA	NA	NA	NA
Chrysene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Dinitrotoluene	--	0.2	beagle dog	2,4-DNT as surrogate	11	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
Di-n-butyl phthalate	--	550	mouse	Sample, et al. (1996)	0.03	--	0.11	ringed dove	Sample, et al. (1996)	0.155
Fluoranthene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Methylene chloride	--	5.85	rat	Sample, et al. (1996)	0.35	NA	NA	NA	NA	NA
Phenanthrene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Pyrene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
RDX	--	7.0	mouse	Talmage et. al (1999)	0.03	NA	NA	NA	NA	NA
Tetryl	--	1.3	rat	Talmage et. al (1999)	0.35	NA	NA	NA	NA	NA
Inorganics										
Aluminum	--	1.93	mouse	Sample, et al. (1996)	0.03	--	110	ringed dove	Sample, et al. (1996)	0.155
Arsenic	--	0.126	mouse	Sample, et al. (1996)	0.03	--	5.14	mallard duck	Sample, et al. (1996)	1.0

Table 4-1

NOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern - TNT Area A Plum Brook Former Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

COPEC	Mammalian Data					Avian Data				
	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)
Barium	--	5.1	rat	Sample, et al. (1996)	0.435	--	20.8	chicks	Sample, et al. (1996)	0.121
Beryllium	--	0.66	rat	Sample, et al. (1996)	0.35	NA	NA	NA	NA	NA
Cadmium	--	1.0	rat	Sample, et al. (1996)	0.303	--	1.45	mallard duck	Sample, et al. (1996)	1.153
Calcium	--	1053	rabbit	(See Appendix)	3.8	--	2833	Japanese quail	(See Appendix)	0.072
Chromium	--	3.28	rat	Sample, et al. (1996)	0.35	--	1.0	black duck	Sample, et al. (1996)	1.25
Cobalt	--	1.2	rat	US Navy (1998) TRV low	0.35	NA	NA	NA	NA	NA
Copper	--	11.7	mink	Sample, et al. (1996)	1.0	--	47	chicks	Sample, et al. (1996)	0.534
Iron	--	26	rabbit	(See Appendix)	3.8	--	50	poultry	(See Appendix)	1.6
Lead	--	8.0	rat	Sample, et al. (1996)	0.35	--	3.85	Am. Kestrel	Sample, et al. (1996)	0.13
Magnesium	--	158	rabbit	(See Appendix)	3.8	--	150	poultry	(See Appendix)	1.6
Manganese	--	88	rat	Sample, et al. (1996)	0.35	--	977	Japanese quail	Sample, et al. (1996)	0.072
Mercury	--	1.0	mink	Sample, et al. (1996)	1.0	--	0.45	Japanese quail	Sample, et al. (1996)	0.15
Nickel	--	40.0	rat	Sample, et al. (1996)	0.35	--	77.4	mallard duck	Sample, et al. (1996)	0.782
Potassium	--	1579	rabbit	(See Appendix)	3.8	--	1,000	poultry	(See Appendix)	1.6
Selenium	--	0.2	rat	Sample, et al. (1996)	0.35	--	0.5	mallard duck	Sample, et al. (1996)	1.0
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	--	1,597	rabbit	(See Appendix)	3.8	--	1,000	poultry	(See Appendix)	1.6
Zinc	--	160	rat	Sample, et al. (1996)	0.35	--	14.5	hens	Sample, et al. (1996)	1.935

Notes:
NA indicates that the information is not available.
NOAELs for selected nutrients are based on mineral dietary requirements (Appendix H).

The following surrogate values were used:
Benzo(a)pyrene for benzo(a)anthracene, chrysene, indeno(1,2,3-cd)pyrene, fluoranthene, pyrene, and phenanthrene for mammals.
2,4,6-TNT for 2,4-DNT, 2,6-DNT, 2-NT, 3-NT, 4-NT, DNT, 2-Amino-4,6-dinitrotoluene and 4-Amino-2,6-dinitrotoluene for birds.

LD50 values are from RTECS (1998) as summarized in the TOMES CPC™ System Data Base (1/1/99) or from Montgomery (1996).
LD50 values were converted to chronic NOAELs by dividing by a factor of 100 and subchronic LOAELs were converted to chronic NOAELs by dividing by a factor of 20, as recommended by Wentsel, et. al. (1996), Tri-Service Procedural Guidelines for Ecological Risk Assessments.
For Nutrients, NOAELs were set at maximum tolerated dose levels (see Appendix H).

Red-wing blackbird body weight assumed to be equal to American robin.
2,4,6-TNT RTV values from USACHPPM, 2000.

Table 4-2

LOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern - TNT Area A Plum Brook Former Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

COPEC	Mammalian Data					Avian Data				
	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)
Organics										
1,3-Dinitrobenzene (1,3-DNB)	--	1.130	rat	Talmage et. al (1999)	0.35	42 (LD_{50})	2.10	red-winged black bird	Talmage et al. (1999)	0.077
2,4-Dinitrotoluene (2,4-DNT)	--	1.5	beagle dog	IRIS on-line (2001)	11	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2,6-Dinitrotoluene	--	1.5	beagle dog	2,4-DNT as surrogate	11	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2,4,6-Trinitrotoluene (2,4,6-TNT)	1.6 (NOAEL)	8.0	rat	Talmage et. al (1999)	0.35	178	17.8	Bobwhite quail	USACHPPM (2000)	0.19
2-Nitrotoluene (2-NT)	--	87	rat	Dunnick et al., 1994 as summarized by Johnson (2000)	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
3-Nitrotoluene	--	87	rat	2-NT as surrogate	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
4-Nitrotoluene	--	87	rat	2-NT as surrogate	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2-Amino-4,6-dinitrotoluene	1394 (LD_{50})	69.5	rat	TOMES database	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
4-Amino-2,6-dinitrotoluene	959 (LD_{50})	48.0	rat	TOMES database	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
Aroclor-1260 (Aroclor-1254)	--	0.680	mouse	Sample, et al. (1996)	0.014	--	1.80	ring neck pheasant	Sample, et al. (1996)	1
Benzo(a)anthracene	--	10	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Benzo(a)pyrene [B(a)P]	--	10	mouse	Sample, et al. (1996)	0.03	NA	NA	NA	NA	NA
Carbon disulfide	3,188 (LD_{50})	159.4	rat	Montgomery (1996)	0.35	NA	NA	NA	NA	NA
Chrysene	--	10	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Dinitrotoluene	--	1.5	beagle dog	2,4-DNT as surrogate	11	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
Di-n-butyl phthalate	--	1833	mouse	Sample, et al. (1996)	0.03	--	1.10	ringed dove	Sample, et al. (1996)	0.155
Fluoranthene	--	10	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	--	10	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Methylene chloride	--	50	rat	Sample, et al. (1996)	0.35	NA	NA	NA	NA	NA
Phenanthrene	--	10	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Pyrene	--	10	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
RDX	7 (NOAEL)	35	mouse	Talmage et. al (1999)	0.03	NA	NA	NA	NA	NA
Tetryl	1.3 (NOAEL)	6.5	rat	Talmage et. al (1999)	0.35	NA	NA	NA	NA	NA
Inorganics										
Aluminum	--	19.30	mouse	Sample, et al. (1996)	0.03	--	1100	ringed dove	Sample, et al. (1996)	0.155
Arsenic	--	1.260	mouse	Sample, et al. (1996)	0.03	--	12.84	mallard duck	Sample, et al. (1996)	1.0
Barium	--	19.8	rat	Sample, et al. (1996)	0.35	--	41.7	chicks	Sample, et al. (1996)	0.121
Beryllium	0.66 (NOAEL)	3.30	rat	Sample, et al. (1996)	0.35	NA	NA	NA	NA	NA

Table 4-2

LOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern - TNT Area A Plum Brook Former Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

COPEC	Mammalian Data					Avian Data				
	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)
Cadmium	--	10	rat	Sample, et al. (1996)	0.303	--	20	mallard duck	Sample, et al. (1996)	1.153
Calcium	--	5265	rabbit	(See Appendix)	3.8	--	14165	Japanese quail	(See Appendix)	0.072
Chromium	2737 (NOAEL)	13690.00	rat	Sample, et al. (1996)	0.35	--	5.0	black duck	Sample, et al. (1996)	1.25
Cobalt	--	12	rat	US Navy (1998) TRV low	0.35	NA	NA	NA	NA	NA
Copper	--	15.1	mink	Sample, et al. (1996)	1.0	--	62	chicks	Sample, et al. (1996)	0.534
Iron	--	130	rabbit	(See Appendix)	3.8	--	250	poultry	(See Appendix)	1.6
Lead	--	80	rat	Sample, et al. (1996)	0.35	--	38.50	Am. Kestrel	Sample, et al. (1996)	0.13
Magnesium	--	790	rabbit	(See Appendix)	3.8	--	750	poultry	(See Appendix)	1.6
Manganese	--	284	rat	Sample, et al. (1996)	0.35	--	9770	Japanese quail	Sample, et al. (1996)	0.072
Mercury	1.0 (NOAEL)	5.0	mink	Sample, et al. (1996)	1.0	--	0.90	Japanese quail	Sample, et al. (1996)	0.15
Nickel		80.0	rat	Sample, et al. (1996)	0.35	--	107	mallard duck	Sample, et al. (1996)	0.782
Potassium	--	7895	rabbit	(See Appendix)	3.8	--	5,000	poultry	(See Appendix)	1.6
Selenium	--	0.33	rat	Sample, et al. (1996)	0.35	--	1.0	mallard duck	Sample, et al. (1996)	1.0
Silver	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sodium	--	7,895	rabbit	(See Appendix)	3.8	--	5,000	poultry	(See Appendix)	1.6
Zinc	--	320	rat	Sample, et al. (1996)	0.35	--	131	hens	Sample, et al. (1996)	1.935

Notes:

NA indicates that the information is not available.
NOAELs for selected nutrients are based on mineral dietary requirements (Appendix H).

The following surrogate values were used:
Benzo(a)pyrene for benzo(a)anthracene, chrysene, indeno(1,2,3-cd)pyrene, fluoranthene, pyrene, and phenanthrene for mammals.
2,4,6-TNT for 2,4-DNT, 2,6-DNT, 2-NT, 3-NT, 4-NT, DNT, 2-Amino-4,6-dinitrotoluene and 4-Amino-2,6-dinitrotoluene for birds.

LD50 values are from RTECS (1998) as summarized in the TOMES CPC™ System Data Base (1/1/99).
LD50 values were converted to chronic NOAELs by dividing by a factor of 100 and subchronic LOAELs were converted to chronic NOAELs by dividing by a factor of 20 and chronic NOAELs were converted to chronic LOAELs by multiplying by a factor of 5.0, as recommended by Wentsel, et. al. (1996), Tri-Service Procedural Guidelines for Ecological Risk Assessments.
For Nutrients, NOAELs were set at maximum tolerated dose levels (see Appendix H) and multiplied by an uncertainty factor of 5 to estimate LOAELs.

Red-wing blackbird body weight assumed to be equal to American robin.
2,4,6-TNT Avian RTV values from USACHPPM, 2000.

Table 4-3

Uncertainty Factors [a] for Ecological RTV [b] Extrapolations [c]
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Laboratory Animals (toxicity data base)		Selected Site Receptor Species	
Rat	G: Rattus F: Muridae O: Rodentia	Deer mouse	G: Peromyscus F: Cricetidae O: Rodentia
Mouse	G: Mus F: Muridae O: Rodentia	Eastern cottontail	G: Sylvilagus F: Leporidae O: Lagomorpha
Mink	G: Mustela F: Mustelidae O: Carnivora	Raccoon	G: Procyon F: Procyonidae O: Carnivora
Rabbit: (N. Zealand White)	G: Oryctolagus F: Leporidae O:Lagomorpha	Short-tailed shrew	G: Blarina F: Soricidae O: Insectivora
Ringed dove	G: Streptopelia F: Columbidae O: Columbiformes	White-tailed deer	G: Odocoileus F: Cervidae O: Artiodactyla
Ring-necked pheasant	G: Phasianus F: Phasianidae O: Galliformes	Mallard duck	G: Anas F: Anatidae O: Anseriformes
Beagle dog	G: Canis F: Canidae O: Carnivora	Marsh wren	G: Cistothorus F: Troglodytidae O: Passeriformes
Black duck	G: Anas F: Anatidae O: Anseriformes	Red-tailed hawk	G: Buteo F: Accipitridae O: Falconiformes
Red-wing blackbird	G: Agelaius F: Fringillidae O: Passeriformes		
Bobwhite quail	G: Colinus F: Phasianidae O: Galliformes		
Chick, Poultry	G: Gallus F: Phasianidae O: Galliformes		

Table 4-3

Uncertainty Factors [a] for Ecological RTV [b] Extrapolations [c]
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Laboratory Animals (toxicity data base)		Selected Site Receptor Species
Mallard duck	G: Anas F: Anatidae O: Anseriformes	
Japanese quail	G: Coturnix F: Phasianidae O: Galliformes	
American kestrel	G: Falco F: Falconidae O: Falconiformes	

[a] From ***Tri-Service Procedural Guidelines for Ecological Risk Assessment*** (Wentsel et al. 1996)
[b] RTV = Reference Toxicity Value
[c] Interclass extrapolations not performed; only within bird class or within mammal class.

Extrapolation between two different species = uncertainty factor of 2
Extrapolation between two different genera (G) = uncertainty factor of 4
Extrapolation between two different families (F) or orders (O) = uncertainty factor of 8
Thus, for all extrapolations used in the current Eco RA (except for the New Zealand White extrapolated to the cottontail, for the mallard duck to the mallard duck, and for the black duck to the mallard duck), an uncertainty factor of 8 was used. For the latter three, an uncertainty factor of 4 was used for extrapolating the New Zealand White to the cottontail, an uncertainty factor of 1 was used for the mallard duck, and an uncertainty factor of 2 was used for extrapolating the black duck to the mallard duck. It should be noted that the laboratory animals listed in this table are based on all COPECs selected for all exposure media, and it is possible some extrapolations are not needed due to some COPECs not being selected for a particular medium.

Table 5-1

Terrestrial Plant Impact Assessment
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

Constituent	Source-Term Surface Soil Concentration[a] (mg/kg)	Benchmark Concentration for Plants (mg/kg)	Benchmark Exceeded?
Organics			
2-Amino-4,6-dinitrotoluene	9.23	80[b]	No
4-Amino-2,6-dinitrotoluene	5.98	80[b]	No
Aroclor-1260	2.48	40[c]	No
Dinitrotoluene, total	6.97	NA[d]	cnba[e]
2-Nitrotoluene	0.374	NA	cnba
2,4,6-Trinitrotoluene	152	30[b]	Yes
Inorganics			
Calcium	125,000	NA	cnba
Copper	70.8	100[c]	No
Lead	564	50[c]	Yes
Mercury	0.0696	0.3[c]	No
Sodium	261	NA	cnba
Zinc	642	50[c]	Yes

[a] 95 percent upper confidence limit concentrations presented for COPECs in Table 2-10.
[b] Talmage, et. al (1999).
[c] Efroymson, et. al. (1997c).
[d] NA = not available.
[e] cbna = could not be assessed.

Table 5-2

Aquatic Biota Surface Water Impact Assessment
TNT Area A PBOW, Sandusky, Ohio

(Page 1 of 2)

Constituent	Source -Term Concentration [a] (µg/L)	NAWQ [b] (µg/L)	Tier II [c] (µg/L)	State of Ohio [d] (µg/L)	Other [e] (µg/L)	Benchmark Exceeded?
Organics						
2-Amino-4,6-Dinitrotoluene	1.96	NA	NA	NA	20 **	No
4-Amino-2,6-Dinitrotoluene	2.34	NA	NA	NA	20 **	No
Carbon disulfide	11.33	NA	8.89	NA	244 *	Yes (1/2)
Di-n-butyl phthalate	1.74	NA	32.7	NA	697 *	No
Inorganics						
Aluminum	2,880	87	NA	NA	1,900 *	Yes
Barium	41.5	NA	3.8	NA	5,800 *	Yes (1/2)
Cadmium (hardness dependent)	0.78	3.4	NA	7.3	0.15 *	Yes (1/3)
Calcium	143,000	NA	NA	NA	116,000 *	Yes
Cobalt	4.23	NA	3.06	NA	5.1 *	Yes (1/3)
Copper (hardness dependent)	6.02	38	NA	30	0.23 *	Yes
Iron	9,850	1,000	NA	NA	158 *	Yes
Lead (hardness dependent)	3.9	19	NA	37	12.3 *	No
Magnesium	34,800	NA	NA	NA	82,000 *	No
Manganese	1,030	1,500 #	80.3	NA	< 1,100 *	Yes (1/3)
Potassium	3,830	NA	NA	NA	53,000 *	No

Table 5-2

Aquatic Biota Surface Water Impact Assessment
TNT Area A PBOW, Sandusky, Ohio

(Page 2 of 2)

Constituent	Source -Term Concentration [a] (µg/L)	NAWQ [b] (µg/L)	Tier II [c] (µg/L)	State of Ohio [d] (µg/L)	Other [e] (µg/L)	Benchmark Exceeded?
Selenium	2.63	35	NA	5.0	91.7 *	No
Silver	0.94	NA	0.36	NA	0.12	Yes
Sodium	30,400	15,000,000 #	NA	NA	680,000 *	No
Zinc (hardness dependent)	59.2	340	NA	390	46.7	Yes (2/3)

[a] COPECs and UCL concentrations from Table 2-12.

[b] National Ambient Water Quality (NAWQ) criteria for chronic exposure (federal) from 40 CFR 131.36, Quality Criteria for Water (Red Book) (EPA, 1976), and EPA Health and Ecological Criteria Division recommendations (1997). Hardness of 400 mg/L assumed. Lowest effect concentration (LEC) values (that are not criteria) are indicated with "#."

[c] Values calculated using Great Lakes Water Quality Initiative Tier II methodology, as summarized in Eco Update (EPA, 1996b) and Suter and Mabrey (1994).

[d] Ohio Water Quality Criteria for the protection of aquatic life (Lake Erie Basin; Title 3745-1-33, assuming a hardness of 400 mg/L $CaCO_3$).

[e] Other references include the following:

- * indicates that the value is chronic LEC, or estimated lowest chronic value for daphnids and fish from Suter and Mabrey (1994).
- ** indicates that the value is a LOEC from Talmage, et. al. (1999).

Notes:
1) Water hardness measurements ranged from 372 to 592 mg/L at West Area Red Water Ponds and from 284 to 488 mg/L at Pentolite Road Red Water Ponds (IT, 2000). These values were assumed to be representative of TNT Area A.
2) NA = Not Available.
3) Hardness dependent criteria calculated for total water body concentration, not dissolved fraction, using average hardness of approximately 400 mg/L $CaCO_3$.

Table 5-3

Summary of Surface Water Field Parameters [a]
TNT Area A, PBOW, Sandusky, Ohio

Location Code	Eh (mV)	pH (su)	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)
SW-02	42.7	7.52	0.95	55	0.12	16.8
SW-03	116	7.44	0.656	42	0.71	21.8
SW-04	N/A	7.85	1.22	0	3.99	18.3
SW-05	162	8.11	0.952	157	0.36	20.5
SW-06	-56.9	8.05	0.3095	0	3.47	22.75
SW-07	22.6	7.77	0.337	9	4.35	21.1
SW-09	169	8.08	0.422	20	0.04	17.5
SW-10	N/A	8.35	0.696	38	0.02	16.6

(a) If sample location was dry, no field parameters were recorded and the location is not presented; data collected September 2000.

Notes:
- If more than one field reading was recorded, the average value of those readings is presented.
- Data are from the Field Collection Logs.
- N/A – Not Available.

Table 5-4

Aquatic Biota Sediment Impact Assessment
TNT Area A, PBOW, Sandusky, Ohio

(Page 1 of 2)

COPEC	Source-Term Concentration[a] (mg/kg)	NOAA ER-L[b] (mg/kg)	NOAA ER-M[c] (mg/kg)	FDEP TEL[d] (mg/kg)	FDEP PEL[e] (mg/kg)	OMOE Low[f] (mg/kg)	OMOE Severe[g] (mg/kg)	Talmage et. al., SQC[h] (mg/kg)	Benchmark Exceeded?
Organics									
2,4,6-Trinitrotoluene	4.6	NA[i]	NA	NA	NA	NA	NA	9.2	No
2-Amino-4,6-dinitrotoluene	2.92	NA	NA	NA	NA	NA	NA	NA	cnba[j]
2-Nitrotoluene	0.168	NA	NA	NA	NA	NA	NA	NA	cnba
4-Amino-2,6-dinitrotoluene	1.18	NA	NA	NA	NA	NA	NA	NA	cnba
Dinitrotoluene	0.576	NA	NA	NA	NA	NA	NA	NA	cnba
Aroclor 1260	0.731	NA	NA	NA	NA	0.005	0.24	NA	Yes
Benzo(a)anthracene	0.245	0.261	1.6	0.075	0.693	0.32	1,480	NA	Yes (1/6)
Benzo(a)pyrene	0.136	0.43	1.6	0.089	0.763	0.37	1,440	NA	Yes (1/6)
Chrysene	0.163	0.384	2.8	0.108	0.846	0.34	460	NA	Yes (1/6)
Fluoranthene	0.688	0.6	5.1	0.113	1.49	0.75	1,020	NA	Yes (2/6)
Phenanthrene	0.107	0.24	1.5	0.0867	0.544	0.56	950	NA	Yes (1/6)
Pyrene	0.458	0.665	2.6	0.153	1.398	0.49	850	NA	Yes (1/6)
Inorganics									
Beryllium	1.25	NA	NA	NA	NA	NA	NA	NA	cnba

Table 5-4

Aquatic Biota Sediment Impact Assessment
TNT Area A, PBOW, Sandusky, Ohio

(Page 2 of 2)

COPEC	Source-Term Concentration[a] (mg/kg)	NOAA ER-L[b] (mg/kg)	NOAA ER-M[c] (mg/kg)	FDEP TEL[d] (mg/kg)	FDEP PEL[e] (mg/kg)	OMOE Low[f] (mg/kg)	OMOE Severe[g] (mg/kg)	Talmage et. al., SQC[h] (mg/kg)	Benchmark Exceeded?
Cadmium	0.636	1.2	9.6	0.68	4.21	0.6	10	NA	Yes (1/6)
Calcium	68,700	NA	NA	NA	NA	NA	NA	NA	cnba
Lead	49.7	46.7	218	30.2	112	31	250	NA	Yes (3/6)
Mercury	0.207	0.15	0.71	0.13	0.7	0.2	2	NA	Yes (3/6)
Nickel	101	20.9	51.6	15.9	42.8	16	75	NA	Yes
Sodium	184	NA	NA	NA	NA	NA	NA	NA	cnba

[a]COPECs and 95% UCL concentrations are from Table 2-13.
[b]Effects Range - Low, developed by NOAA published by Long and Morgan (1990), updated by Long (1995, and summarized in Jones, et al. (1996). Should be used only if no freshwater benchmarks available (e.g., OMOE, 1993).
[c]Effects Range - Medium, developed by NOAA published by Long and Morgan (1990), updated by Long (1995), and summarized in Jones, et al. (1996). Should be used only if no freshwater benchmarks available (e.g., OMOE, 1993).
[d]Florida Department of Environmental Protection, threshold effects level, summarized in Jones, et al. (1996).
[e]Florida Department of Environmental Protection, probable effects level, summarized in Jones, et al. (1996).
[f]Ontario Ministry of the Environment (OMOE, 1993), Low = lowest effect level and is the 5th percentile of the screening level concentration.
[g]Ontario Ministry of the Environment (OMOE, 1993), Severe = severe effect level and is the 95th percentile of the screening level concentration.
[h]Talmage, et al. (1999), Sediment Quality Criteria/Screening Benchmarks.
[i]NA = Not available.
[j]cbna = could not be assessed.

Table 5-5

Terrestrial Receptors NOAEL-based Hazard Index (HI) Summary for TNT Area A[a]
Plum Brook Ordnance Works, Sandusky, Ohio

Media	Terrestrial Receptor						
	Deer Mouse	Cottontail	Shrew	Marsh Wren	Raccoon	Deer	Hawk
Soil [b] HI	812	189	848	1,420	751	42	6
Risk Drivers:	73% Aroclor-1260 (invert. intake) 14% 2,4,6-TNT (plant intake) 9% Calcium (plant intake)	71% 2,4,6-TNT (plant intake) 17% Calcium (plant intake)	88% Aroclor-1260 (invert. intake) 4% Lead (invert. intake) 3% Calcium (invert. intake)	61% Aroclor-1260 (invert. intake) 24% Lead (invert. intake) 8% Calcium (invert. intake) 6% 2,4,6-TNT (invert. intake)	76% Aroclor-1260 (invert. intake) 12% 2,4,6-TNT (plant intake) 8% Calcium (plant intake)	94% 2,4,6-TNT (plant intake)	94% Aroclor-1260 (shrew intake) (bird intake)
Surface Water HI	1.7	1.8	1.1	1.2	2.1	17	0.01
Risk Drivers:	86% Aluminum (water intake)	92% Aluminum (water intake)	86% Aluminum (water intake)	40% Magnesium (water intake)	86% Aluminum (water intake)	86% Aluminum (water intake)	41% Magnesium (water intake)
Total Receptor HI	814	191	849	1,421	753	59	6

[a] Details presented in ecological risk assessment spreadsheets in Appendix G.
[b] All receptors exposed to surface soil, except burrowing shrew exposed to surface and subsurface soil via ingestion of soil, and deer exposed to surface and subsurface soil via ingestion of plants (e.g., tree leaves) that have translocated COPECs via deep feeder roots.

Table 5-6

Terrestrial Receptors LOAEL-based Hazard Index (HI) Summary for TNT Area A[a]
Plum Brook Ordnance Works, Sandusky, Ohio

Media	Terrestrial Receptor						
	Deer Mouse	Cottontail	Shrew	Marsh Wren	Raccoon	Deer	Hawk
Soil [b] HI	101	38	92	148	92	8.3	0.6
Risk Drivers:	59% Aroclor-1260 (invert. intake) 22% 2,4,6-TNT (plant intake)	71% 2,4,6-TNT (plant intake) 17% Calcium (plant intake)	80% Aroclor-1260 (invert. intake) 5% Calcium (invert. intake)	59% Aroclor-1260 (invert. intake) 23% Lead (invert. intake) 15% Calcium (invert. intake) 2% 2,4,6-TNT (invert. intake)	62% Aroclor-1260 (invert. intake) 20% 2,4,6-TNT (plant intake) 13% Calcium (plant intake)	93% 2,4,6-TNT (plant intake)	95% Aroclor-1260 (shrew intake) (bird intake)
Surface Water HI	0.2	0.2	0.1	0.2	0.2	2.0	0.003
Risk Drivers:	74% Aluminum (water intake)	82% Aluminum (water intake)	74% Aluminum (water intake)	42% Magnesium (water intake)	74% Aluminum (water intake)	74% Aluminum (water intake)	42% Magnesium (water intake)
Total Receptor HI	101	38	92	148	92	10	0.6

[a] Details presented in ecological risk assessment spreadsheets in Appendix G.
[b] All receptors exposed to surface soil, except burrowing shrew exposed to surface and subsurface soil via ingestion of soil, and deer exposed to surface and subsurface soil via ingestion of plants (e.g., tree leaves) that have translocated COPECs via deep feeder roots.

Table 5-7

Aquatic NOAEL-based Hazard Index (HI) Summary for TNT Area A [a]
Plum Brook Ordnance Works, Sandusky, Ohio

Media	Aquatic Receptor	
	Mallard Duck	Raccoon
Sediment HI	51	86
Risk Drivers:	30% 2,4,6-TNT (invertebrate intake)	75% Aroclor-1260 (invertebrate intake)
	21% Aroclor-1260 (invertebrate intake)	7% 2,4,6-TNT (invertebrate intake)
	19% 2-Amino-4,6-DNT (invertebrate intake)	4% Fluoranthene (invertebrate intake)
	12% Mercury (invertebrate intake)	
Surface Water HI	0.05	0.4
Risk Drivers:	41% Magnesium (water intake)	85% Aluminum (water intake)
Total Receptor HI	51	86

[a]Details presented in ecological risk assessment spreadsheets (Appendix G).

Table 5-8

Aquatic LOAEL-based Hazard Index (HI) Summary for TNT Area A[a]
Plum Brook Ordnance Works, Sandusky, Ohio

Media	Aquatic Receptor	
	Mallard Duck	Raccoon
Sediment HI	6	10
Risk Drivers:	52% Mercury (invertebrate intake)	66% Aroclor-1260 (invertebrate intake)
	18% Aroclor-1260 (invertebrate intake)	13% 2,4,6-TNT (invertebrate intake)
Surface Water HI	0.01	0.05
Risk Drivers:	42% Magnesium (water intake)	74% Aluminum (water intake)
Total Receptor HI	6	10

[a]Details presented in ecological risk assessment spreadsheets (Appendix G).

Table 5-9

Uncertainty Analysis
TNT A Area
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Component	Bias	Magnitude	Ways to Minimize Uncertainty
Use of 95% UCL as source-term concentration	Overestimates Risk	Medium	Use central tendency
Assumption that soil depth interval of 0-2 ft is representative of surface soil	Overestimates Risk	Low to Medium	Resample to obtain additional samples 0-1 ft. for surface soil characterization
Assumption that MDC for some COPECs in surface water or sediment is representative	Overestimates Risk	Medium	Collect additional surface water or sediment samples
Use of representative receptor species for site ecological community	Underestimates Risk	Low	Select additional receptor species
Use of average intake values and average body weights	Underestimates Risk	Low	Measure site-specific intake values and species' body weights
Use of conservative foraging factors (i.e., 100%) for some species	Overestimates Risk	Medium	Use more site-specific foraging factors, i.e., less than 100%
Assumption that all COPECs are 100% bioavailable	Overestimates Risk	Medium to High	Obtain medium- and COPEC-specific bioavailability factors
Discounting of dermal and inhalation exposure routes	Underestimates Risk	Low	Include dermal and inhalation routes of exposure
Use of partitioning and transfer factors to estimate some COPEC concentrations in plants, invertebrates, other prey items, and sediment pore water	Overestimates Risk	Medium to High	Measure COPEC concentrations in site plants, invertebrates, other prey species, and/or sediment pore water
Inclusion of sample outliers in estimation of exposure point concentration for risk drivers	Overestimates Risk	Medium to High	Isolate sample data for "hot spot" analysis and estimate hazards separately for "hot spot" vs. "non-hot spot"
Assumption that soil F_{oc} = 1%; assumption that sediment F_{oc} = 6.7% (i.e., similar to West Area Red Water Pond)	Overestimates or Underestimates Risk	Unknown	Measure site-specific soil and sediment F_{oc}

Table 5-9

Uncertainty Analysis
TNT A Area
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Component	Bias	Magnitude	Ways to Minimize Uncertainty
Use of K_{ow} to estimate aquatic BCFs for some organic COPECs	Overestimates Risk	Medium to High	Use alternative BCF estimation method (e.g., Bintein and Devillers, 1993)
Assumption that sediment-pore-water-to-benthic-macro-invertebrate BCFs, are linear	Overestimates Risk	Medium to High	Measure concentrations in site benthic macroinvertebrates, or perform literature search for alternative BCF values
Use of Eq. 2.2 to estimate lognormal UCL exposure point concentration for risk drivers	Overestimates Risk	Medium to High	Use alternative UCL statistic such as Boot Strap (Singh et al., 1997)
Use of safety factors to convert LOAEL and LD_{50} toxicity data to NOAELs	Overestimates Risk	Medium	Obtain COPEC-specific NOAEL data
Use of safety factors to convert subchronic LOAEL and LD_{50} toxicity data to LOAELs	Overestimates Risk	Medium	Obtain COPEC-specific LOAEL data
Use of uncertainty factor of 8 to extrapolate RTVs between most species within the same class	Overestimates Risk	Medium	1) Assume RTVs similar for all species in the same genus, family, or order; or 2) obtain species-specific toxicity data
Assumption that body weight scaling factor = 0 for all bird species' toxicity data	Overestimates or Underestimates Risk	Low	Obtain species-specific NOAEL toxicity data
Use of surrogate constituents to estimate toxicity for those COPECs without available toxicity data	Overestimates or Underestimates Risk	Low to Medium	Obtain COPEC-specific toxicity data
Use of hazard quotient method to estimate risks to populations or communities may be biased	Overestimates Risk	High	Perform population or community studies

FIGURES

Figure 2-1

Photo No. 1 - Field vegetative community habitat typical at TNT Area A (9/13/00).

Photo No. 2 - Open forest vegetative community habitat typical at TNT Area A (5/21/01).

Figure 2-2

Photo No. 3 - Forest with understory vegetative community habitat typical at TNT Area A (9/13/00).

Photo No. 4 - Cattails along Maintenance Road, TNT Area A (5/21/001).

Figure 2-3

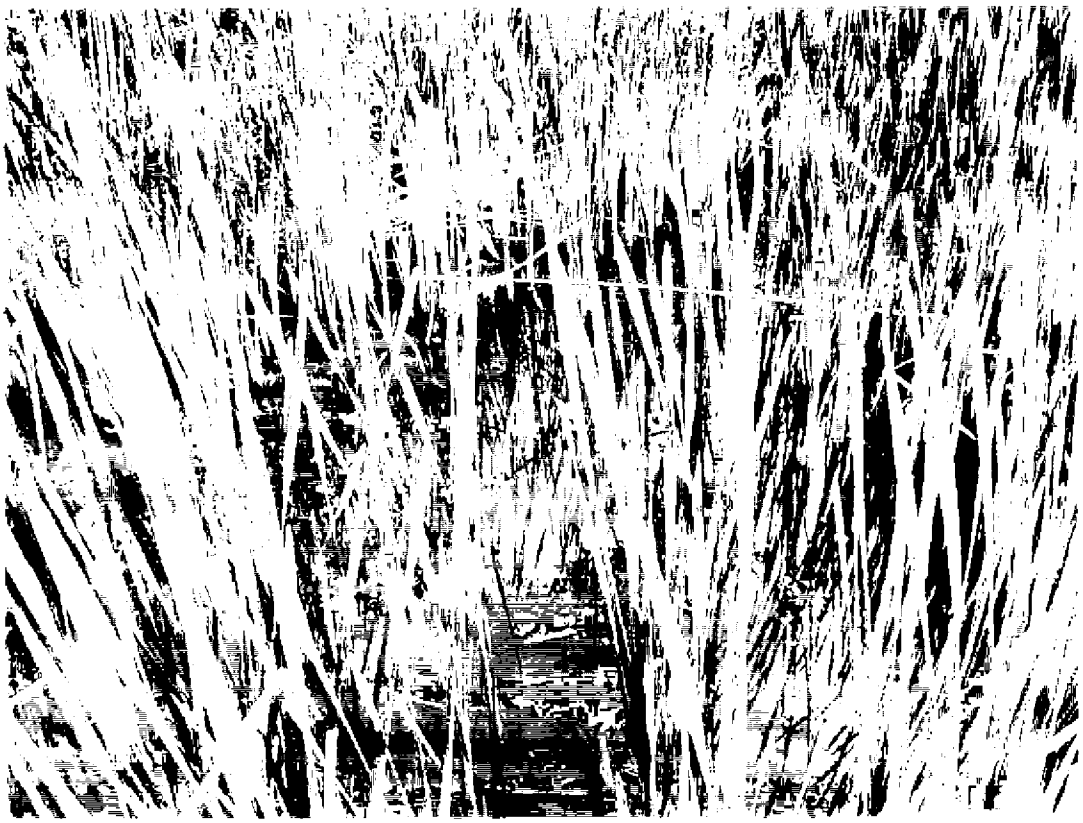

Photo No. 5 - Cattails in unnamed stream near Bldg. 128, TNT Area A (5/21/01).

Photo No. 6 - TNT hot spot near Bldg. 112, TNT Area A; bare soil from trenching/backfilling (5/21/01).

Photo No. 7 - TNT hot spot at Bldg. 146, TNT Area A; bare soil from trenching/backfill (5/21/01).

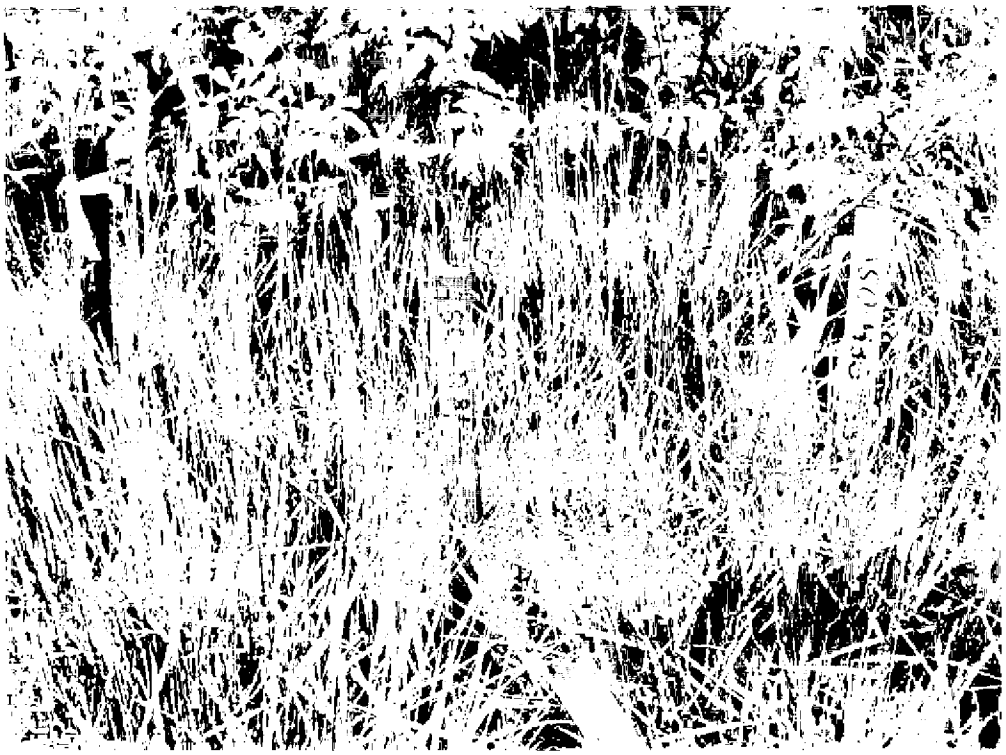

Photo No. 8 - Close up of TNT hot spot at Bldg. 146, TNT Area A (5/21/01).

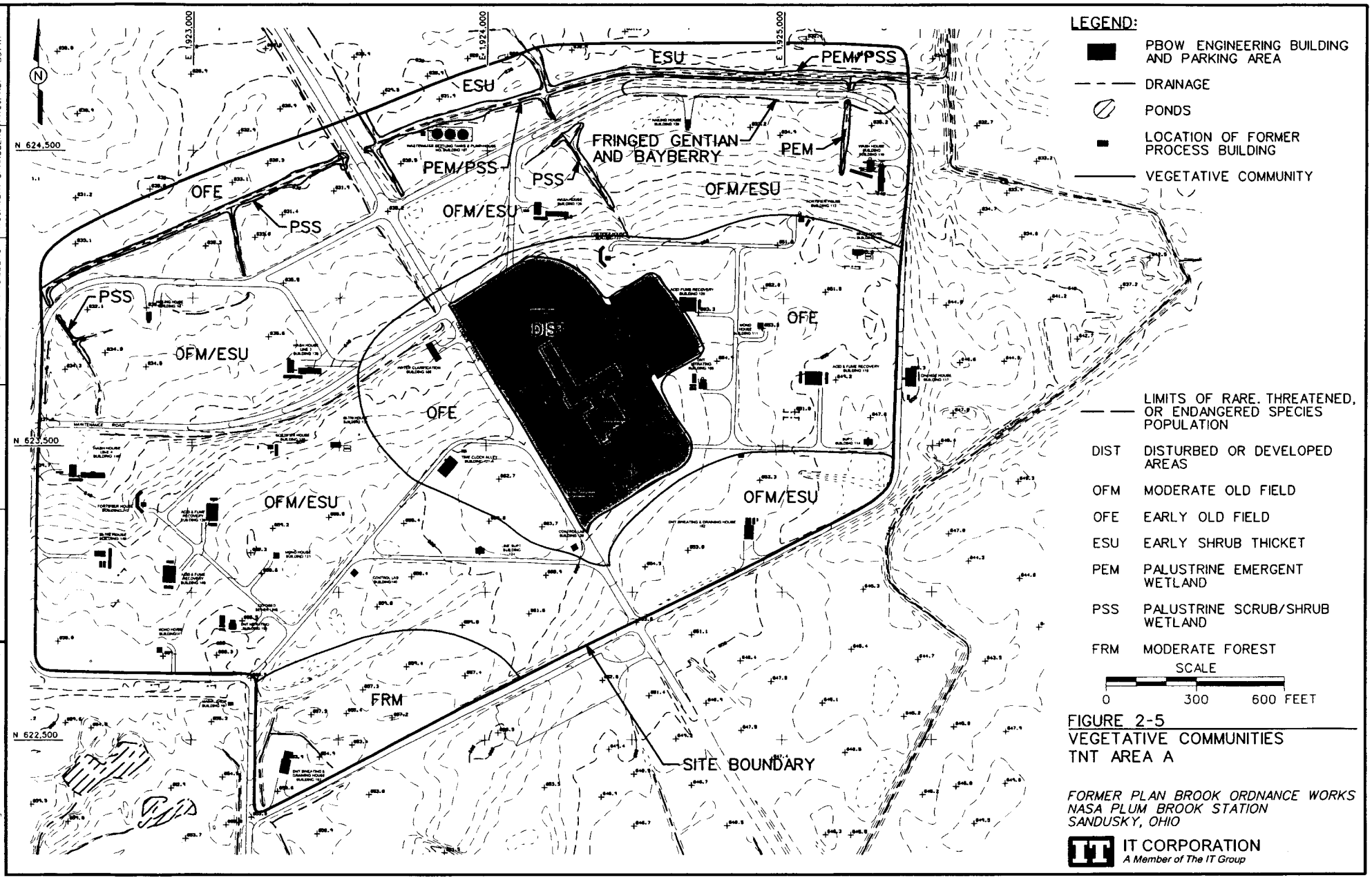

FIGURE 2-5
VEGETATIVE COMMUNITIES
TNT AREA A

FORMER PLAN BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE: 06/01/01 | DATE LAST REV.: | DRAFT CHCK BY: C. TUMLIN | INITIATOR: M. WEISBERG | DWG. NO.: ...\807111es.045
DRAWN BY: B. VANDERGRIFF | DRAWN BY: | ENGR CHCK BY: M. WEISBERG | PROJ. MGR.: SPANGBERG | PROJ. NO.: 807111
06/04/01 11:23:03
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Figure 2-6

Simplified Terrestrial Food Web Conceptual Site Model (CSM)
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

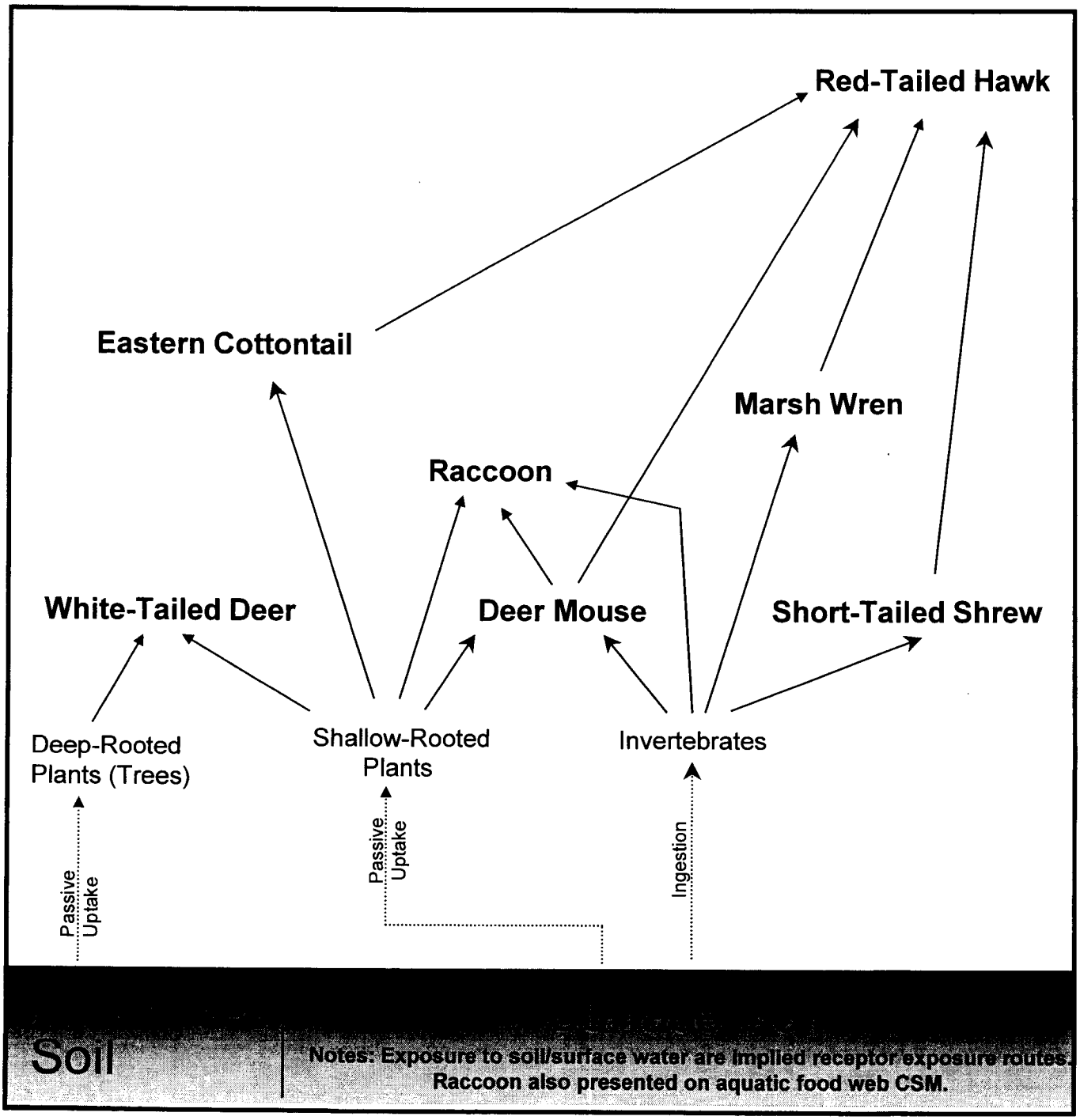
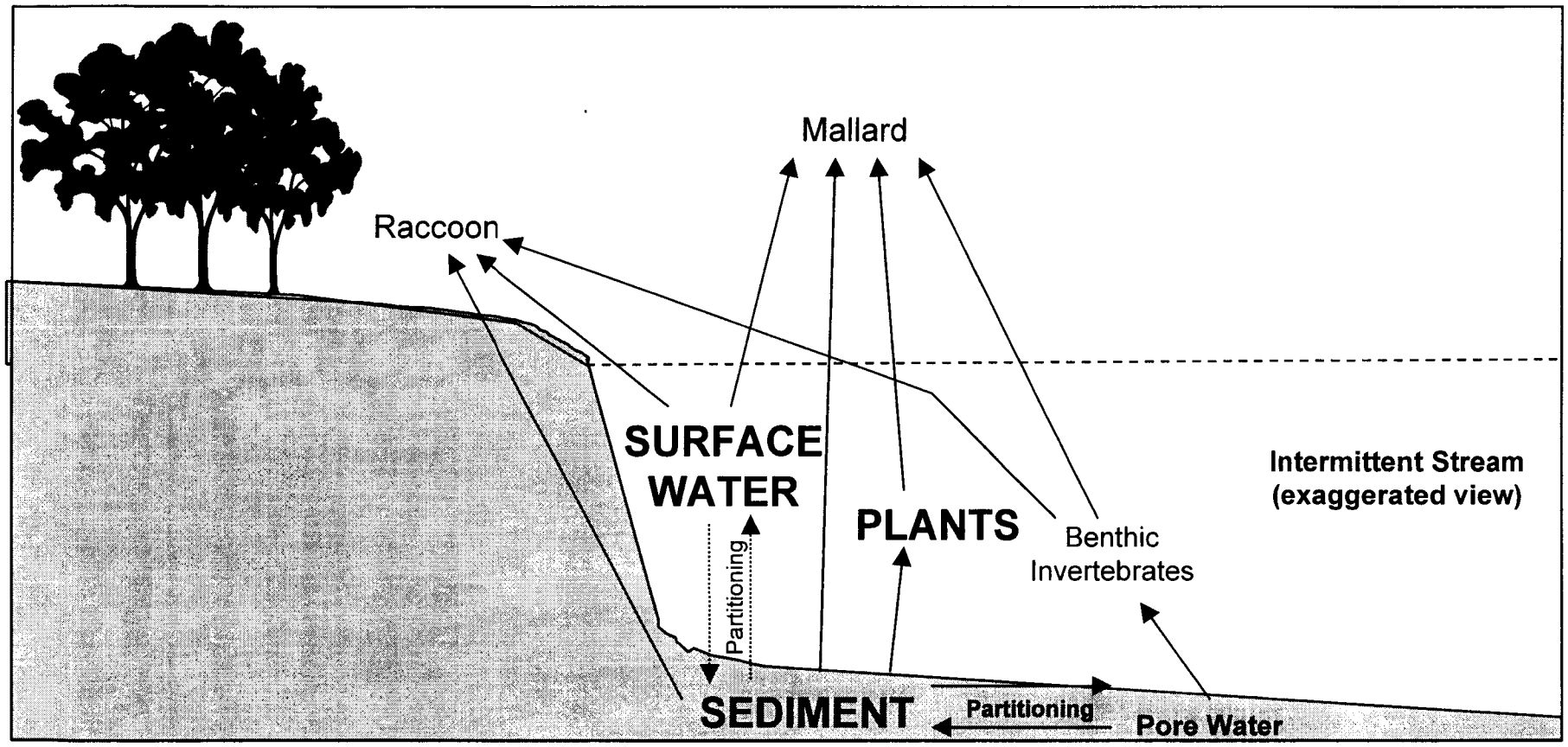


Figure 2-7

Simplified Aquatic Food Web Conceptual Site Model (CSM)
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

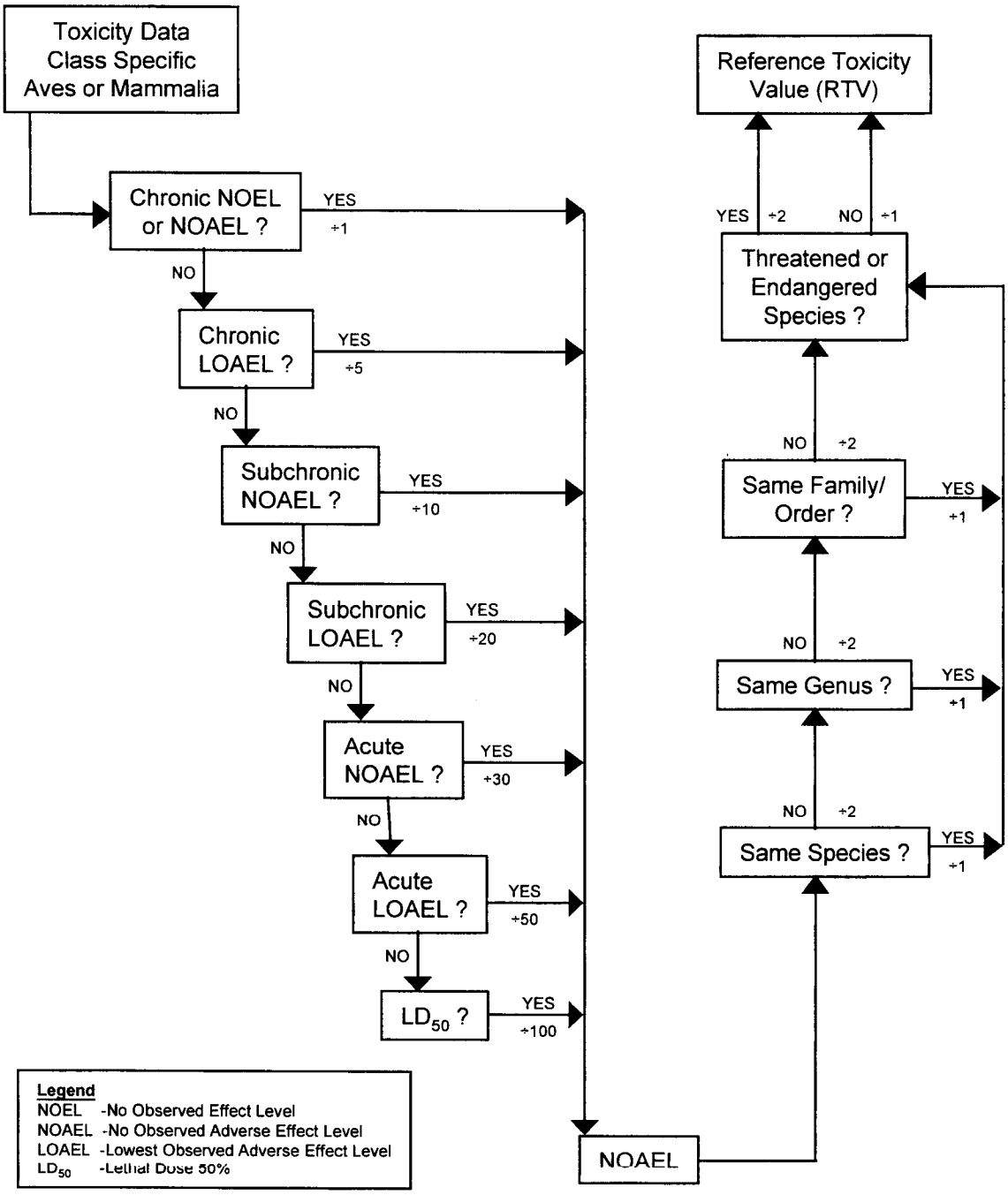


Note: Raccoon also presented on terrestrial food web CSM.

KN/PBOW/TNTArea/AreaA/A_Fig. 2-7.ppt/11/1/01 9:50 AM

Figure 4-1

Procedural Flow Chart for Deriving Reference Toxicity Values (RTV) from Class-Specific Toxicity Data Plum Brook Ordnance Works, Sandusky, Ohio



Credit: Adapted from Ford et al. (1992) in *Tri-Service Procedural Guidelines for Ecological Risk Assessments*, 1996

APPENDIX A

VASCULAR PLANT SPECIES OBSERVED ON SITE

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Acer negundo	box-elder maple	Frequent		Stream banks, ditches, and moist woods	1, 2
*Acer platanoides	Norway maple	Occasional		Disturbed woods	1
Acer rubrum	red maple	Common		Dry to moist woods	1
Acer saccharinum	Silver maple	Rare		Dry to moist woods	2
Acer saccharum	Sugar maple	Occasional		Dry to moist woods	2
*Achillea millefolium	Yarrow	Frequent		Dry fields, roadsides, and about buildings	1, 2
Acorus calamus	Sweet flag	Rare		Wet ditches	2
Agalinis purpurea	purple false-foxglove	Frequent		Moist openings and ditches	1
Agrimonia parviflora	southern agrimony	Frequent		Moist fields and ditches	1, 2
*Agropyron repens	Quack grass	Frequent		Old fields and roadsides	2
Agrostis hyemalis	Ticklegrass	Occasional		Dry, grassy fields and shaley openings	1
*Agrostis gigantea	Redtop	Common		Moist fields, ditches, and roadsides	1, 2
Agrostis perennans	autumn bent-grass	Frequent		Dry woods and borders on shale	1
Alisma subcordatum	water-plantain	Occasional		Ponds and ditches	1, 2
*Alliaria petiolata	garlic mustard	Frequent		Dry to moist wood lots	1, 2
Allium canadense	Wild garlic	Occasional		Successional woods	2
Ambrosia artemisiifolia	common ragweed	Frequent, occasional 2		Dry fields and roadsides	1, 2
Ambrosia trifida	giant ragweed	Occasional		Dry fields and roadsides	1
Andropogon gerardii	big bluestem	Frequent, 0ccasional 2		Dry to moist fields and roadsides	1, 2
*Andropogon virginicus	broom-sedge	Occasional, frequent 2		Dry fields and roadsides	1, 2
Antennaria parlinii	pussy-toes	Occasional		Dry fields and openings, especially on shale	1
*Anthoxanthum odoratum	vernal-grass	Occasional		Dry fields and openings, especially on shale	1
Apocynum cannabinum	Dogbane	Frequent		Dry to moist fields and roadsides	1, 2

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Arabidopsis thaliana	mouse-ear cress	Occasional		Road berms and about buildings	1
*Arctium minus	Burdock	Occasional		Disturbed fields and about buildings	1
Arenaria lateriflora	grove sandwort	Rare	T	Woods along Ransom Brook north of reactor	1
Arisaema triphyllum	Jack-in-the-pulpit	Rare		Moist to dry woods	2
Aristida dichotoma	Churchmouse grass	Occasional		Dry fields and openings	1
Aristida longespica	slimspike triple-awned grass	Common		Dry fields and openings	1
Aristida oligantha	prairie triple-awned grass	Occasional		Dry openings and roadsides	1
*Artemisia ludoviciana var. gnaphaloides	white sage	Occasional		Grassy roadsides	1
Asclepias hirtella	prairie milkweed	Common		Dry to moist openings	1
Asclepias incarnata	Swamp milkweed	Occasional		Wet ditches	2
Asclepias sullivantii	Sullivant's milkweed	Rare		Moist field along Patrol Road south of Scheid Road	1
Asclepias syriaca	common milkweed	Frequent		Dry to moist fields and roadsides	1, 2
Asclepias tuberosa	butterfly-weed	Occasional		Dry openings and roadsides	1
Aster ericoides	white heath aster	Rare, frequent 2		Grassy strip along Patrol Road southeast of Taft Road	1, 2
Aster laevis	smooth aster	Rare		White oak grove on Taft Road	1
Aster lateriflorus	calico aster	Common, frequent 2		Moist woods and thickets	1, 2
Aster novae-angliae	New England aster	Occasional		Dry fields and roadsides	1, 2
Aster pilosus	common white aster	Common		Dry fields, roadsides, and about buildings	1
Aster sagittifolius	Arrow-leaved aster	Frequent		Woods and fields	2
Aster umbellatus	flat-top aster	Frequent, rare 2		Dry to moist fields and roadsides	1, 2
Baptisia lactea	prairie false indigo	Occasional	P	Dry openings in bunker area	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Baptisia tinctoria	yellow false indigo	Occasional		Dry openings in bunker area	1
*Berberis thunbergii	Japanese barberry	Occasional, rare 2		Woodland borders	1, 2
Bidens coronata	northern tickseed-sunflower	Common		Moist fields and ditches	1
Bidens frondosa	Beggar ticks	Rare		Ditches	2
Boehmeria cylindrica	false nettle	Occasional		Ponds and ditches	1, 2
Botrychium virginianum	Rattlesnake fern	Occasional		Successional woods	2
*Brassica nigra	black mustard	Occasional		Roadsides	1, 2
*Bromus inermis	smooth brome	Frequent		Dry to moist fields and roadsides	1
Bromus pubescens	Brome	Occasional		Dry fields	2
*Bromus tectorum	downy chess	Occasional		Dry openings and roadsides on shale	1
Cacalia atriplicifolia	pale Indian-plantain	Occasional		Dry fields and roadsides; woods	1, 2
Calamagrostis canadensis	blue-joint	Occasional		Moist fields and ditches	1
Callitriche heterophylla	water-starwort	Occasional		Pond margins and seasonally-moist depressions	1
Calystegia sepium	Hedge bindweed	Occasional		Fields	2
*Campsis radicans	trumpet-vine	Occasional		Disturbed openings and roadsides	1
*Capsella bursa-pastoris	shepherd's-purse	Occasional		Roadsides and about buildings	1
*Cardamine hirsuta	bitter-cress	Occasional		Roadsides and about buildings	1
*Carduus nutans	musk-thistle	Occasional, frequent 2		Dry fields and roadsides	1, 2
Carex aggregata	sedge	Occasional		Moist woods	
Carex alata	broad-winged sedge	Rare	P	Grassy field along Patrol Road south of Scheid Road, also in grassy strip between Patrol Road and artificial pond southeast of Taft Road	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Carex amphibola	NA	Occasional		Thickets and woods borders	1, 2
Carex annectens var. annectens	NA	Occasional		Moist, grassy fields	1
Carex annectens var. xanthocarpa	yellow-fruited sedge	Occasional		Moist, grassy fields	1
Carex blanda	NA	Frequent		Moist woods	1, 2
Carex cephaloidea	thin-leaf sedge	Rare	E	Woods border along Pentolite Road west of reactor	1
Carex complanata var. hirsutella	NA	Frequent		Dry fields and woods borders	1
Carex conoidea	field sedge	Rare	T	Grassy depression along Taft Road south of North Magazine Road	1
Carex cristatella	NA	Occasional		Moist fields and ditches	1
Carex festucacea	fescue sedge	Occasional		Moist, grassy fields	1
Carex gracillima	NA	Occasional		Moist woods	1
Carex granularis	meadow sedge	Common		Moist, grassy fields and ditches	1
Carex hirtifolia	NA	Rare		Disturbed oak woods along angling road	1
Carex hystericina	Bottlebrush sedge	Rare		Moist depression along Taft Road	1
Carex pensylvanica	Pennsylvania sedge	Common		Dry woods	1
Carex rosea	NA	Frequent		Dry to moist woods	1, 2
Carex scoparia	NA	Frequent		Moist, grassy fields	1
Carex stipata	NA	Frequent		Moist fields and ditches	1
Carex stricta	tussock sedge	Occasional		Moist fields and ditches	1
Carex swanii	Swan's sedge	Occasional		Dry, grassy fields	1
Carex tribuloides	NA	Occasional		Moist, grassy fields and ditches	1
Carex umbellata	NA	Occasional		Well-drained, grassy fields on sandy soil	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Carex vulpinoidea	fox sedge	Common		Moist fields, ditches, and about ponds	1
Carya ovata	shagbark hickory	Rare		Sandy soil along fence at far southeast boundary	1
Celastrus orbiculatus	Bittersweet	Occasional		Thickets and woods borders	2
Celtis occidentalis	Hackberry	Occasional		dry to moist woods and borders	1
Cephalanthus occidentalis	Buttonbush	Occasional		Moist depressions and ditches	1
Cerastium arvense	field chickweed	Rare		White oak grove along Taft Road	1
*Cerastium fontanum	mouse-ear chickweed	Frequent		Road berms and about buildings	1
*Cerastium semidecandrum	NA	Occasional		Road berms and about buildings	1
*Chaenorrhinum minus	dwarf snapdragon	Occasional		Road berms and about buildings	1
Chamaecrista fasciculata	partridge-pea	Occasional		Dry openings on shale	1
*Chrysanthemum leucanthemum	ox-eye daisy	Frequent		Dry to moist fields and roadsides	1
*Cichorium intybus	Chicory	Occasional		Roadsides	1, 2
Circaea lutetiana	Southern broad-leaved enchanter's nightshade	Frequent		Woods	2
Cinna arundinacea	Wood reed grass	Occasional		Woods	2
*Cirsium arvense	Canada thistle	Common		Disturbed fields and roadsides	1, 2
Cirsium discolor	prairie thistle	Frequent, occasional 2		Grassy fields and roadsides	1, 2
*Cirsium vulgare	bull thistle	Frequent		Disturbed fields and roadsides	1, 2
Clinopodium vulgaris	wild basil	Occasional		Dry roadsides and openings	1
*Confolvulus arvensis	field bindweed	Occasional		Disturbed fields and roadsides	1
*Convallaria majalis	lily-of-the-valley	Rare		Grassy field along Columbus Avenue	1
Conyza canadensis	Horseweed	Frequent		Dry fields and roadsides	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Cornus amomum	swamp dogwood	Frequent, occasional 2		Moist fields and thickets	1, 2
Cornus drummondii	rough-leaved dogwood	Frequent		Moist borders, thickets, and roadsides	1, 2
Cornus florida	flowering dogwood	Occasional		Woodland borders and roadsides	1
Cornus racemosa	gray dogwood	Frequent		Dry fields and roadsides	1, 2
*Coronilla varia	crown-vetch	Occasional, common 2		Grassy fields and roadsides	1, 2
Crataegus mollis	downy hawthorn	Frequent		Thickets and woodland borders	1
Crataegus punctata	dotted hawthorn	Frequent		Thickets and woodland borders	1
Cryptotaenia canadensis	honewort	Occasional, rare 2		Dry to moist woods	1, 2
Cuscuta gronovii	dodder	Frequent		Moist fields and ditches	1
*Cyperus esculentus	yellow nutgrass	Occasional, frequent 2		Moist, disturbed openings	1, 2
Cyperus flavescens	Umbrella sedge	occasional		Old fields and waste places	2
Cyperus strigosus	umbrella-sedge	Frequent		Moist openings, ponds, and ditches	1, 2
*Dactylis glomerata	orchard-grass	Occasional		Dry to moist fields and roadsides	1, 2
Danthonia spicata	poverty-grass	Occasional		Dry openings over shale	1
Datura stramonium	jimson-weed	Occasional		Disturbed openings and roadsides	1
*Daucus carota	wild carrot	Frequent		Dry fields and roadsides	1, 2
Desmodium canescens	Tick trefoil	Occasional		Fields	2
*Dianthus armeria	Deptford pink	Occasional, rare 2		Dry openings and roadsides on shale	1, 2
Digitaria cognatum (Leptoloma cognatum)	N/A	Occasional		Old fields	2
Diodia teres	buttonweed	Occasional		Dry openings over shale	1
*Dipsacus fullonum	common teasel	Frequent		Dry, disturbed openings and roadsides	1
*Draba verna	early whitlow-wort	Occasional		Dry roadsides and about buildings	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Dryopteris carthusiana	spinulose woodfern	Frequent		Moist woods and shaded borders	1
*Eleagnus umbellata	autumn-olive	Occasional		Roadsides and woodland borders	1, 2
Eleocharis acicularis	needle spikerush	Frequent		Margins of artificial pond	1
Eleocharis erythropoda	red-footed spikerush	Occasional		Moist openings and ditches	1
Eleocharis obtusa	NA	Common		Moist openings and ditches	1
Eleocharis smallii	Small's spikerush	Frequent		Margins of artificial pond	1
Eleocharis tenuis	NA	Frequent		Moist openings and ditches	1
Elymus virginica	Wild rye	Occasional		Moist to dry woods	2
*Elytrigia repens	quack-grass	Frequent		Dry fields and roadsides	1
Equisetum arvense	horsetail	Frequent		Moist openings, roadsides, and ditches	1, 2
Equisetum hyemale	scouring-rush	Occasional		Moist roadsides and ditches	1, 2
Eragrostis frankii	NA	Occasional		Moist openings and ditches	1
Eragrostis spectabilis	showy lovegrass	Occasional		Dry to moist fields	1
Erechtites hieracifolia	Pilewort	Common		Disturbed woods, borders, and roadsides	1
Erigeron philadelphicus	Philadelphia fleabane	Frequent, occasional 2		Roadsides and borders	1, 2
Erigeron strigosus	smooth fleabane	Occasional		Dry openings and roadsides	1
Eupatorium perfoliatum	Boneset	Occasional, frequent 2		Moist fields, ponds, and ditches	1, 2
Eupatorium purpureum	purple joe-pye-weed	Occasional		Borders of moist woods, fields	1, 2
Eupatorium rugosum	White snake root	Common		Woods and fields	2
Euphorbia corollata	Flowering spurge	Occasional		Dry fields	1
Euphorbia maculata	Prostrate spurge	Occasional		Dry openings, road berms, and about buildings	1, 2
Euthamia graminifolia	grass-leaved goldenrod	Common		Dry to moist fields and roadsides	1, 2
*Festuca elatior	tall fescue	Occasional		Roadsides and grassy fields	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Festuca obtusa	Fescue	Common		Old fields	2
Fragaria virginiana	wild strawberry	Frequent		Dry to moist fields and roadsides	1, 2
Fraxinus americana	white ash	Frequent		Dry to moist woods and borders	1
Fraxinus pensylvanica	green ash	Frequent, common 2		Moist woods and stream banks	1, 2
Galine aparine	Cleavers	Occasional		Moist woods and borders	1
Galium circaezans	wild licorice	Rare		Dry woods	1, 2
Galium tinctorium	Southern bedstraw	Rare		Moist depression along Taft Road	1
Gentianopsis crinita	Fringed gentian	Occasional	P	Old fields along ditch banks, small groups and scattered individuals in northeast portion of TNT area A	2
Gerardia tenuifolia	Slender gerardia	Frequent		Disturbed fields	2
Geranium maculatum	Wild geranium	Occasional		Successional woods	2
Geum vernum	spring avens	Occasional		Moist woods and borders	1
Geum virginianum	white avens	Occasional		Woods borders and roadsides	1, 2
*Glechoma hederacea	ground-ivy	Frequent		Moist openings, roadsides, and about buildings	1
Gleditsia triacanthos	honey-locust	Occasional, rare 2		Dry to moist woods and borders	1, 2
Glyceria striata	manna-grass	Occasional		Moist woods and about ponds	1
Gnaphalium obtusifolium	Cudweed	Frequent, occasional 2		Dry openings on shale, fields	1, 2
Gratiola virginiana	round-fruited hedge-hyssop	Rare	P	ca 20 plants; moist, shaded ground by pond west of Snake Road	1
Hackelia virginiana	Virginia stickseed	Rare		Woods	2
Hedyotis caerula	Bluets	Occasional		Dry openings and roadsides on shale	1
Helenium autumnale	Sneezeweed	Occasional		Disturbed fields	2
Helenium flexuosum	Southern sneezeweed	Occasional		Moist, open ground and ditches	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Helianthus mollis	ashy sunflower	Rare	T	ca 200 plants in grassy field south and southwest of junction of Fox and Patrol Roads; the exact number of individuals in this population is uncertain since excessive browsing by deer has reduced the plants to leafy tufts.	1
Helianthus tuberosus	Jerusalem artichoke	Occasional		Old fields	2
Hibiscus moscheutos	rose-mallow	Rare		Moist swale along Ransom Road	1
*Hieracium piloselloides	king-devil	Frequent		Dry openings on shale, fields	1, 2
Hypericum gentianoides	orange-grass	Frequent		Dry openings	1
Hypericum gymnanthum	least St. John's-wort	Rare	E	ca 50 plants; moist, open ground along Patrol Road south of Fox Road	1
Hypericum majus	tall St. John's-wort	Rare	P	Moist, shaded ground by pond west of Snake Road	1
Hypericum mutilum	little St. John's-wort	Frequent		Moist openings, ponds, and ditches	1
*Hypericum perforatum	dotted St. John's-wort	Frequent		Disturbed fields and roadsides	1
Hypericum punctatum	St. Johns wort	Rare		Fields	2
Hypoxis hirsuta	yellow-eyed-grass	Occasional		Grassy fields	1
Hystrix patula	Bottlebrush grass	Occasional		Woods	2
*Inula helenium	Elecampane	Rare		Moist roadside along Taft Road	1
Ipomoea pandurata	wild sweet-potato	Occasional		Dry openings over shale	1
Iris versicolor	Northern blue flag	Occasional		Moist woods and ditches	1
Isanthus brachiatus	false pennyroyal	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Juglans nigra	black walnut	Rare		A few young trees at edge of grassy field southwest of junction of Fox and Patrol Roads, woods (2b)	1, 2
Juncus acuminatus	NA	Common		Moist openings and ditches	1
Juncus biflorus	NA	Occasional		Moist openings and ditches	1
Juncus brachycarpus	NA	Occasional		Moist openings	1
Juncus canadensis	Canada rush	Frequent		Moist openings	1
Juncus dudleyi	Dudley's rush	Frequent		Moist openings	1
Juncus effusus	Common rush	Frequent		Moist openings, ponds, and ditches	1
Juncus marginatus	NA	Occasional		Moist openings	1
Juncus nodosus	rush	Occasional		Old fields and ditches	2
Juncus tenuis	path rush	Frequent, occasional 2		Dry openings, road berms, and about buildings	1, 2
Juncus torreyi	Torrey's rush	Occasional		Moist fields	2
*Lamium purpureum	dead-nettle	Frequent		Disturbed fields, roadsides, and about buildings	1
Lathyrus latifolius*	Everlasting pea	Occasional		Old fields	2
Leersia oryzoides	rice cutgrass	Occasional		Moist fields and ditches	1, 2
Lemna minor	little duckweed	Occasional		Ponds and standing water	1
*Lepidium campestre	field-cress	Occasional		Roadsides and about buildings	1
Lepidium virginicum	poor man's pepper	Frequent		Roadsides, disturbed openings, and about buildings	1
Lespedeza capitata	bush-clover	Occasional		Dry fields	1
Leucospora multifida	NA	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Liatris scariosa var. novae-angliae	northern blazing-star	Rare		Dry ground along Patrol Road at Olemacher Ditch	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Liatris spicata	spiked blazing-star	Occasional		Moist openings	1
*Linaria vulgaris	butter-and-eggs	Occasional		Roadsides and about buildings	1
Lindernia dubia	false pimpernel	Occasional		Moist openings, ditches, and pond margins	1
Linum medium	wild flax	Frequent		Dry to moist openings	1
Linum virginianum	Virginia flax	Rare		About pond in northern bunker area	1
Lobelia siphilitica	Great lobelia	Frequent		Moist fields	2
Lonicera japonica	Japanese honeysuckle	Occasional		Fields and disturbed areas	2
*Lonicera maackii	Amur honeysuckle	Rare		Roadsides and thickets along Columbus Avenue near Scheid Ditch	1
*Lonicera morrowii	Asiatic honeysuckle	Frequent		Thickets, borders, and roadsides	1
*Lonicera tatarica	Tatarian honeysuckle	Frequent, common 2		Thickets, borders, and roadsides	1, 2
*Lotus corniculatus	bird's-foot trefoil	Occasional		Grassy fields and road berms	1, 2
Ludwigia alternifolia	rattlebox	Occasional		Ponds and ditches	1
Ludwigia palustris	water-purslane	Frequent, occasional 2		Ponds and ditches	1, 2
Ludwigia polycarpa	NA	Rare		Moist, shaded ground by pond on Snake Road	1
Lycopus americanus	American water-horehound	Frequent		Ponds and ditches	1, 2
Lycopus uniflorus	northern water-horehound	Frequent		Moist woods and shaded borders	1
Lysimachia terrestris	swamp loosestrife	Occasional		Moist openings	1
Lythrum alatum	prairie loosestrife	Occasional		Moist openings	1
Maclura pomifera	osage-orange	Occasional		Disturbed woods and borders	1
*Matricaria matricarioides	pineapple-weed	Occasional		Roadsides and about buildings	1
*Medicago lupulina	Black medic	Occasional		Old fields and disturbed areas	2

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Melilotus alba	white sweet-clover	Occasional, frequent 2		Disturbed fields and roadsides	1, 2
*Melilotus officinalis	yellow sweet-clover	Occasional		Disturbed fields and roadsides	1, 2
Mentha spicata	Spearmint	Occasional		Moist fields	2
Mimulus ringens	monkey-flower	Occasional, rare 2		Moist openings and ditches	1, 2
Monarda fistulosa	bergamont	Occasional		Grassy fields	1
Morus alba	Mulberry	Occasional		Fields and thickets	2
Muhlenbergia frondosa	muhly grass	Frequent		Moist fields and ditches	1
Myrica pensylvanica	Bayberry	Rare	E	One individual in old field in northern portion of area	2
Najas flexilis	northern naiad	Occasional		Artificial ponds	1
*Najas minor	Eurasian naiad	Frequent		Artificial ponds	1
*Nepeta cataria	catnip	Occasional, frequent 2		Roadsides and weedy openings	1, 2
Nyssa sylvatica	blackgum	Occasional		Thickets and woods borders	1
Oenothera biennis	evening-primrose	Frequent		Dry fields, roadsides, and about buildings	1
Oenothera tetragona	northern sundrops	Frequent		Moist, grassy fields	1
Onoclea sensibilis	Sensitive fern	frequent		Wet areas	2
Osmunda cinnamomea	cinnamon fern	Rare		Depressions in moist woods along angling road	1
Osmunda regalis	royal fern	Occasional		Depressions in moist woods	1
*Oxalis europea	Sorrel	Common		Old fields and disturbed areas	2
Oxalis violacea	purple wood-sorrel	Occasional		Drier oak woods and borders on shale	1
Panicum dichotomiflorum	Panic grass	Frequent		Fields	2
Panicum flexile	wiry witch-grass	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Panicum lanuginosum	hairy panic-grass	common		Dry, grassy fields and roadsides	1, 2
Panicum oligosanthes	sand panic-grass	Occasional		Dry, grassy fields	1
Panicum rigidulum	stiff panic-grass	Frequent		Moist openings and ditches	1
Panicum virgatum	switch-grass	Occasional		Dry fields	1, 2
Parietaria pensylvanica	pellitory	Occasional		Dry, disturbed wood lots and borders	1
Paronychia fastigata	forked chickweed	Occasional		Dry woods and borders on shale	1
Parthenocissus quinquefolia	Virginia-creeper	Occasional		Dry to moist woods borders and thickets	1, 2
Parthenocissus vitacea	grape-woodbine	Rare		Dry opening north of Center Magazine Road	1
*Pastinaca sativa	wild parsnip	Occasional		Roadsides	1
Penstemon digitalis	tall white beard-tongue	Frequent		Grassy fields and roadsides	1, 2
Phalaris arundinacea	reed canary-grass	Common		Moist fields and ditches	1
*Phleum pratense	timothy	Frequent		Disturbed fields and roadsides	1, 2
Phragmites australis	reed-grass	Occasional, rare 2		Moist openings and ditches	1, 2
Phryma leptostachya	lopseed	Rare		Edge of woods along Scheid Ditch near Columbus Avenue; successional woods	1, 2
Phytolacca americana	pokeberry	Occasional, rare 2		Moist woods and borders	1, 2
*Plantago lanceolata	English plantain	Frequent		Disturbed openings and about buildings	1, 2
*Plantago major	broad-leaved plantain	Frequent		Road berms and about buildings (1) disturbed areas and old fields (2a)	1
Platanthera lacera	ragged fringe-orchid	Rare		Ditch along south Patrol Road	1
Platanus occidentalis	sycamore	Occasional, frequent 2		Moist woods and stream banks, fields and waste areas	1, 2
*Poa annua	early bluegrass	Common		Road berms and about buildings	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Poa compressa	Canada bluegrass	Frequent		Dry openings, especially on shale, and roadsides	1, 2
Podophyllum peltatum	may-apple	Occasional		Dry to moist woods	1
Polygala sanguinea	blood milkwort	Frequent		Moist openings	1
Polygala verticillata	whorled milkwort	Occasional		Moist openings	1
*Polygonum caespitosum	NA	Rare		Moist, shaded ground in bunker area	1
*Polygonum hydropiper	water-pepper	Occasional		Margins of ponds	1
Polygonum hydropiperoides	false water-pepper	Occasional		Wet ditches and pond margins	1
Polygonum sagittatum	arrow-leaved tearthumb	Occasional		Moist thickets and ditches	1
Polygonum scandens	climbing false buckwheat	Occasional		Thickets and roadsides	1
Polygonum virginianum	Virginia knotweed	Common		Moist to dry woods	2
Populus deltoides	cottonwood	Frequent, common 2		Moist woods, borders, and stream banks	1, 2
Potamogeton diversifolius	snailseed pondweed	Frequent		Artificial ponds	1
Potamogeton foliosus	leafy pondweed	Occasional		Artificial ponds	1
Potamogeton nodosus	longleaf pondweed	Occasional		Artificial ponds	1
Potentilla simplex	cinquefoil	Frequent		Dry openings and roadsides on shale	1
Prunella vulgaris	self-heal	Occasional, frequent 2		Roadsides and about buildings	1, 2
Prunus americana	wild plum	Occasional		Thickets and roadsides	1
Prunus serotina	wild black cherry	Frequent, common 2		Dry to moist woods and borders	1, 2
Pycnanthemum tenuifolium	narrow-leaved mountain-mint	Frequent, common 2		Moist openings, especially on shale, old fields	1, 2
Pycnanthemum virginianum	Virginia mountain-mint	Occasional		Moist openings and ditches	1
Pyrus coronaria	crab-apple	Frequent		Thickets and borders	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Quercus alba	white oak	Occasional		Dry woods and sandy ridges; a small grove on Taft Road has an unusually pure stand of this species	1
Quercus bicolor	swamp white oak	Frequent		Moist woodlands	1
Quercus imbricaria	shingle oak	Frequent, occasional 2		Moist to dry woodlands	1, 2
Quercus macrocarpa	bur oak	Rare		ca 5 trees on sandy ridge in bunker area south of North Magazine Road; a few trees in area 2a	1
Quercus palustris	pin oak	Common, frequent 2		Moist woods	1, 2
Ratibida pinnata	green-headed coneflower	Occasional, frequent 2		Roadsides and dry fields	1, 2
Rhexia virginica	Virginia meadow-beauty	Occasional	P	Moist openings and pond margins, south of North Magazine Road and along the angling road	1
Ribes cynosbati	Gooseberry	Rare		Woods	2
Robinia pseudoacacia	Black locust	Rare		Old fields and thickets	2
Rosa carolina	pasture rose	Occasional		Dry fields	1, 2
*Rosa multiflora	multiflora rose	Occasional		Disturbed openings, borders, and thickets	1, 2
Rosa setigera	prairie rose	Rare		Grassy roadside and thickets along Patrol Road at Olemacher Ditch	1
Rotala ramosior	toothcup	Occasional		Moist openings and about ponds	1
Rubus allegheniensis	blackberry	Common		Woods, fields, and borders	2
Rubus flagellaris	dewberry	Frequent, common 2		Dry openings and roadsides on shale, old fields	1, 2
Rubus occidentalis	Black raspberry	common		Dry woods, and borders	2
Rudbeckia hirta	black-eyed susan	Frequent		Dry fields and roadsides	1, 2
*Rumex acetosella	red sorrel	Occasional		Dry openings over shale	1
*Rumex crispus	curly dock	Occasional		Roadsides and about buildings	1, 2

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Rumex verticillatus	Swamp dock	Rare		Ditches	2
Sagittaria latifolia	broad-leaved arrowhead	Occasional		Ponds and ditches	1, 2
Salix amygdaloides	peachleaf willow	Occasional		Ditches and about ponds	1
Salix discolor	pussy willow	Occasional		Moist openings, ponds, and ditches	1
Salix exigua	sandbar willow	Frequent		Moist openings, stream banks, and ditches	1
Salix nigra	black willow	Common		Moist woods, stream banks, and ditches	1, 2
Sambucus canadensis	elder-berry	Frequent, occasional 2		Moist openings, stream banks, and ditches	1, 2
*Saponaria officinalis	soapwort	Frequent, occasional 2		Dry fields, roadsides, and about buildings	1, 2
Sassafras albidum	sassafras	Occasional		Dry woods and borders	1
Schizachyrium scoparium	little bluestem	Frequent		Dry fields and roadsides	1
Scirpus acutus	hardstem bulrush	Rare		Moist depression west of Taft Road	1
Scirpus americanus	Three square	rare		Ditches	2
Scirpus atrovirens	dark green bulrush	Common, occasional 2		Moist openings, roadsides, and ditches	1, 2
Scirpus cyperinus	woolgrass	Occasional		About artificial ponds	1
Scirpus fluviatilis	river bulrush	Rare		Moist depression west of Taft Road	1
Scirpus pendulus	NA	Occasional		Moist openings	1
Scirpus validus	softstem bulrush	Occasional		Moist openings, ponds, and ditches	1
Scleria triglomerata	tall nut-rush	Rare	P	Moist swale in northern bunker area	1
Scutellaria lateriflora	mad-dog skullcap	Occasional		Moist depressions and ditches	1, 2
Senecio aureus	golden ragwort	Occasional		Moist woods borders	1
*Setaria faberi	nodding foxtail-grass	Occasional, common 2		Grassy roadsides in the bunker area	1, 2
*Setaria viridis	green foxtail-grass	Frequent, common 2		Dry roadsides and about buildings	1, 2

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Silphium terebinthinaceum	prairie-dock	Rare		Dry openings at crossing of Patrol Road and Olemacher Ditch	1
Sisyrinchium albidum	prairie blue-eyed-grass	Frequent		Grassy fields	1
Sisyrinchium angustifolium	common blue-eyed-grass	Frequent		Grassy fields	1
*Solanum caroliniense	horse-nettle	Occasional, common 2		Dry openings and roadsides	1, 2
*Solanum dulcamara	bittersweet-nightshade	Occasional		Roadsides, ditches, thickets, and about buildings	1
Solanum nigrum	Black nightshade	Occasional		Fields and waste areas	2
Solidago canadensis	Canada goldenrod	Common		Grassy fields	1, 2
Solidago juncea	early goldenrod	Frequent		Dry to moist fields and roadsides	1
Solidago nemoralis	gray goldenrod	Common		Dry fields and roadsides	1, 2
Solidago riddellii	Riddell's goldenrod	Rare		Moist opening over limestone, west of Snake Road and south of North Magazine Road	1
Sparganium eurycarpum	giant bur-reed	Rare		Wet ditch along Ransom Road	1
Spartina pectinata	prairie cord-grass	Frequent, occasional 2		Moist depressions, fields, and ditches	1, 2
Spiranthes ochroleuca	creamy ladies'-tresses	Occasional, rare 2		Ditches and moist openings	1, 2
Sporobolus asper	tall dropseed	Rare		A single stand in dry opening along angling road	1
Sporobolus neglectus	NA	Frequent		Dry openings and road berms	1
Stachys tenuifolia	Hedge nettle	Occasional		Fields	2
Stellaria longifolia	long-leaved stitchwort	Occasional		Moist, grassy fields	1
*Stellaria media	chickweed	Common		Road berms and about buildings	1
Symphoricarpos orbiculatus	coralberry	Occasional		Thickets, woods borders, and roadsides	1

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Taraxacum officinalis	dandelion	Frequent, occasional 2		Roadsides and about buildings	1, 2
Teucrium canadense	American germander	Occasional		Moist openings	1
Thelypteris palustris	marsh fern	Occasional, frequent 2		Moist depressions and roadsides	1, 2
Toxicodendron radicans	Poison ivy	Frequent		Upland and facultative woods, old fields	2
Tradescantia ohioensis	Ohio spiderwort	Occasional		Old fields	2
*Tragopogon pratensis	Yellow goatsbeard	Rare		Old fields	2
Triadenum virgnianum	pink St. John's-wort	Rare		Moist swale in northern bunker area	1
Tridens flavus	purpletop	Occasional		Moist fields and roadsides	1
Trifolium hybridum	Alsike clover	Occasional		Fields	2
*Trifolium pratense	red clover	Occasional		Grassy fields and roadsides	1, 2
*Trifolium repens	common white clover	Common		Grassy roadsides and about buildings	1
Triosteum perfoliatum	Wild coffee	Rare		Fields	2
Typha angustifolia	Narrow-leaved cattail	frequent		Ditches	2
Typha latifolia	broad-leaved cattail	Frequent		Moist openings, ponds, and ditches	1, 2
Ulmus americana	American elm	Occasional		Moist woods and stream banks	1, 2
Ulmus rubra	slippery elm	Occasional		Moist woods and stream banks	1
Urtica dioica var. procera	American stinging nettle	Occasional, common 2		Moist fields and openings	1, 2
*Verbascum blattaria	moth-mullein	Occasional, rare 2		Disturbed fields and roadsides	1, 2
*Verbascum thapsus	common mullein	Frequent, occasional 2		Disturbed fields	1, 2
Verbena hastata	purple vervain	Frequent		Moist fields, stream banks, and ditches	1, 2
Verbena simplex	prairie vervain	Rare		A single stand in dry opening along angling road	1
Verbena stricta	Vervain	Occasional		Fields	2

Appendix A Table
Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area A

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Verbena urticifolia	white vervain	Occasional, frequent 2		Moist woods borders and roadsides	1, 2
Verbesina alternifolia	wingstem	Frequent, occasional 2		Moist woods borders, stream banks, and ditches	1, 2
Vernonia gigantea	tall ironweed	Occasional, frequent 2		Dry to moist fields	1, 2
*Veronica officinalis	common speedwell	Occasional		Dry openings on shale	1
*Veronica serpyllifolia	thyme-leaved speedwell	Occasional		Roadsides and about buildings	1
Viburnum lentago	nannyberry	Frequent		Moist thickets and borders	1
Vicia americana	American vetch	Rare		Old field	2
Viola lanceolata	lance-leaved violet	Frequent	P	Ditches and moist openings	1
Viola sagittata	arrow-leaved violet	Frequent		Grassy fields and dry banks	1
Viola sororia	common blue violet	Common, occasional 2		Grassy fields, roadsides, and about buildings	1, 2
Vitis riparia	riverbank grape	Frequent		Woods borders, thickets, and stream banks	1, 2
Vitis vulpina	fox grape	Occasional		Woods borders and thickets	1
Zanichellia palustris	horned pondweed	Rare		Artificial pond west of Snake Road	1
Zizia aurea	Golden alexanders	Rare		Old fields	2

[a] Common = Species which occur in large numbers throughout.
[b] T = Ohio Threatened Species.
[c] 1 = Biological Inventory of Plum Brook Station (Ohio Department of Natural Resources, 1994).

Frequent = Species regularly encountered, but occurring in lesser numbers than common ones.
Occasional = Species found in several places, but never present in large numbers.
Rare = Species found in few places and in low numbers.
P = Ohio Potentially Threatened Species.
E = Ohio Endangered Species.
2 = IT site reconnaissance September 11 and 12, 2000 and May 21, 2001.

* Non-native species.

APPENDIX B

LETTER FROM BOTANICAL EXPERT

From: Crandall Todd [tcrandall@davey.com]
Sent: Monday, October 01, 2001 6:26 AM
To: 'mweisberg@TheITGroup.com'
Subject: Plum Brook

I finally have a definite identification on that sedge from the Michigan expert. It is Carex pellita, which is found throughout the state. It is not rare, and is not on any state or federal list.

APPENDIX C

COMPILATION OF RISK-BASED SCREENING ECOTOXICITY VALUES

Table C-1

Soil Screening Concentrations
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Chemical	Ecological PRGs[a] (mg/kg)	Tox. Benchmark for COPECs for Effects on Soil, Litter Inv., and Microbes[b] (earthworm/microbial) (mg/kg)	Tox. Benchmarks for COPECs Terrestrial Plants[c] (mg/kg)	USEPA Region V EDQL[d] (mg/kg)	Screening Value[e] (mg/kg)
Inorganics					
Aluminum	NA	NA/600	50	NA	600
Antimony	5	NA/NA	5	0.14	5
Arsenic	9.9	60/100	10	5.7	9.9
Barium	283	NA/3,000	500	1.04	283
Beryllium	10	NA/NA	10	1.06	10
Cadmium	4	20/20	4	0.002	4
Calcium	NA	NA/NA	NA	NA	NA
Chromium	0.4	0.4/10	1	0.4	0.4
Cobalt	20	NA/1,000	20	0.14	20
Copper	60	50/100	100	0.313	60
Iron	NA	NA/200	NA	NA	200
Lead	40.5	500/900	50	0.054	40.5
Magnesium	NA	NA/NA	NA	NA	NA
Manganese	NA	NA/100	500	NA	100
Mercury	0.00051	0.1/30	0.3	0.1	0.00051
Nickel	30	200/90	30	13.6	30
Potassium	NA	NA/NA	NA	NA	NA
Selenium	0.21	70/100	1	0.028	0.21
Silver	2	NA/50	2	4.04	2
Sodium	NA	NA/NA	NA	NA	NA
Thallium	1	NA/NA	1	0.057	1
Vanadium	2	NA/20	2	1.59	2
Zinc	8.5	200/100	50	6.62	8.5
Volatile Organics					
2-Butanone	NA	NA/NA	NA	89.6	89.6
Acetone	NA	NA/NA	NA	2.5	2.5
Benzene	NA	NA/NA	NA	0.25	0.25
Carbon disulfide	NA	NA/NA	NA	0.094	0.094
Methylene chloride	NA	NA/NA	NA	10.4	10.4
Toluene	200	NA/NA	200	5.45	200
Semivolatile Organics					
2-Methylnaphthalene	NA	NA/NA	NA	3.24	3.24
Benzo(a)anthracene	NA	NA/NA	NA	5.21	5.21
Benzo(a)pyrene	NA	NA/NA	NA	1.52	1.52
Benzo(b)fluoranthene	NA	NA/NA	NA	59.8	59.8
Benzo(ghi)perylene	NA	NA/NA	NA	119	119
Benzo(k)fluoranthene	NA	NA/NA	NA	148	148
bis(2-Ethylhexyl) phthalate	NA	NA/NA	NA	0.926	0.926
Chrysene	NA	NA/NA	NA	4.73	4.73
Di-n-butyl phthalate	200	NA/NA	200	0.15	200

Table C-1

Soil Screening Concentrations
TNT Area A
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Chemical	Ecological PRGs[a] (mg/kg)	Tox. Benchmark for COPECs for Effects on Soil, Litter Inv., and Microbes[b] (earthworm/microbial) (mg/kg)	Tox. Benchmarks for COPECs Terrestrial Plants[c] (mg/kg)	USEPA Region V EDQL[d] (mg/kg)	Screening Value[e] (mg/kg)
Fluoranthene	NA	NA/NA	NA	122	122
Indeno(1,2,3-cd)pyrene	NA	NA/NA	NA	109	109
Phenanthrene	NA	NA/NA	NA	45.7	45.7
Pyrene	NA	NA/NA	NA	78.5	78.5
PCBs					
Aroclor-1260	0.371	NA/NA	40	0.0003	0.371
Nitroaromatics					
1,3,5-Trinitrobenzene	NA	NA/NA	NA	0.376	0.376
2,4,6-Trinitrotoluene	NA	NA/NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA/NA	NA	1.28	1.28
2,6-Dinitrotoluene	NA	NA/NA	NA	0.033	0.033
2-Amino-4,6-dinitrotoluene	NA	NA/NA	NA	NA	NA
2-Nitrotoluene	NA	NA/NA	NA	NA	NA
3-Nitrotoluene	NA	NA/NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	NA	NA/NA	NA	NA	NA
4-Nitrotoluene	NA	NA/NA	NA	NA	NA
Dinitrotoluene	NA	NA/NA	NA	0.65	0.65
Nitrobenzene	NA	40/1000	NA	1.31	40

[a] Preliminary Remediation Goals (PRG) for Ecological Endpoints (Efroymson et. al., 1997a).
[b] Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotropic Process: 1997 Revisions, Efroymson, R.A., et al. November 1997b.
[c] Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants, Efroymson, R.A., et al. November 1997c.
[d] Ecological Data Quality Levels (EDQL) (USEPA Region V, 1999).
[e] Hierarchy employed for selection of screening criteria, as recommended by OEPA, is as follows:
First source : Ecological PRGs (Efroymson, et al., 1997a).
Second source : Efroymson et. al., 1997b.
Third source : Efroymson et. al., 1997c.
Fourth source : EDQL (USEPA, 1999).

Table C-2

Surface Water Screening Concentrations
TNT Area A
Plum Brook Ordnance Site
Sandusky, Ohio

Chemical	Ohio EPA Water Quality Criteria[a] (total) (mg/L)	Ecological PRGs[b] (mg/L)	USEPA Region V EDQLs[c] (mg/L)	Lowest Screening Value[d] (mg/L)
Inorganics				
Aluminum	NA	0.087	NA	0.087
Arsenic	0.34	0.19	0.053	0.053
Barium	NA	0.004	5	0.004
Beryllium	NA	0.00066	0.0076	0.00066
Cadmium	0.022	0.0011	0.00066	0.00066
Calcium	NA	NA	NA	NA
Chromium	5.6	0.21	0.042	0.042
Cobalt	NA	0.023	0.005	0.005
Copper	0.052	0.012	0.005	0.005
Iron	NA	1	NA	1
Lead	0.71	0.0032	0.0013	0.0013
Magnesium	NA	NA	NA	NA
Manganese	NA	0.12	NA	0.12
Nickel	1.5	0.16	0.029	0.029
Potassium	NA	NA	NA	NA
Selenium	0.005	0.00039	0.005	0.00039
Silver	NA	0.00036	0.001	0.00036
Sodium	NA	NA	NA	NA
Vanadium	NA	0.02	0.019	0.019
Zinc	0.39	0.11	0.0589	0.0589
Nitroaromatics				
2-Amino-4,6-Dinitrotoluene	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	NA	NA	NA	NA
Semivolatile Organics				
Di-n-butyl phthalate	NA	0.001	0.003	0.001
Volatile Organics				
Acetone	NA	1.5	78	1.5
Carbon disulfide	NA	0.00092	0.0841	0.00092
Methylene chloride	NA	2.2	0.43	0.43

[a] Water Quality Criteria for the Lake Erie Drainage Basin (Ohio Administrative Code, 3745-1-33).
[b] Preliminary Remediation Goals (PRG) for Ecological Endpoints (Efroymson et. al., 1997).
[c] Ecological Data Quality Levels (EDQL) (USEPA Region V, 1999).
[d] Screening value is based on the lowest available value presented for each constituent.

Table C-3

Sediment Screening Concentrations
TNT Area A
Plum Brook Ordnance Site, Sandusky, Ohio

(Page 1 of 2)

Chemical	USEPA Region V EDQLs[a] (mg/kg)	Ecological PRGs[b] (mg/kg)	Ontario MOE PSQG[c] (mg/kg)	Screening Value[d] (mg/kg)
Inorganics				
Aluminum	NA	NA	NA	NA
Arsenic	5.9	42	6	5.9
Barium	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA
Cadmium	0.596	4.2	0.6	0.596
Calcium	NA	NA	NA	NA
Chromium	26	159	26	26
Cobalt	50	NA	50	50
Copper	16	77.7	16	16
Iron	NA	NA	20,000	20,000
Lead	31	110	31	31
Magnesium	NA	NA	NA	NA
Manganese	NA	NA	460	460
Mercury (Inorganic)	0.174	0.7	0.2	0.174
Nickel	16	38.5	16	16
Potassium	NA	NA	NA	NA
Selenium	NA	NA	NA	NA
Silver	0.5	1.8	0.5	0.5
Sodium	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA
Zinc	120	270	120	120
Volatile Organics				
Acetone	0.453	0.0091	NA	0.453
Carbon disulfide	0.134	0.00086	NA	0.134
Methylene chloride	1.26	18	NA	1.26
Semivolatile Organics				
Benzo(a)anthracene	0.0317	0.69	0.32	0.0317
Benzo(a)pyrene	0.0319	0.394	0.37	0.0319
Benzo(b)fluoranthene	10.4	4	0.24	10.4
bis(2-Ethylhexyl) phthalate	0.182	2.7	NA	0.182
Chrysene	0.0571	0.85	0.34	0.0571
Fluoranthene	0.111	0.834	0.75	0.111
Phenanthrene	0.0419	0.54	0.56	0.0419
Pyrene	0.053	1.4	0.49	0.053
Total PAH	NA	13.66	4	13.6

Table C-3

Sediment Screening Concentrations
TNT Area A
Plum Brook Ordnance Site, Sandusky, Ohio

(Page 2 of 2)

Chemical	USEPA Region V EDQLs[a] (mg/kg)	Ecological PRGs[b] (mg/kg)	Ontario MOE PSQG[c] (mg/kg)	Screening Value[d] (mg/kg)
PCBs				
Aroclor 1260	0.0341	63	0.005	0.0341
Nitroaromatics				
2,4,6-Trinitrotoluene	NA	NA	NA	NA
2,4-Dinitrotoluene	0.07513	NA	NA	0.07513
2,6-Dinitrotoluene	0.02062	NA	NA	0.02062
2-Amino-4,6-dinitrotoluene	NA	NA	NA	NA
2-Nitrotoluene	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	NA	NA	NA	NA
Dinitrotoluene	NA	NA	NA	NA

[a] Ecological Data Quality Levels (EDQL) (USEPA Region V, 1999).
[b] Preliminary Remediation Goals (PRG) for Ecological Endpoints (Efroymson et. al., 1997).
[c] Provincial Sediment Quality Guideline (PSQG). Ontario Ministry of the Environment (MOE), 1993 (low effect values).
[d] Hierarchy employed for selection of screening criteria, as recommended by OEPA, is as follows:
First source : EDQL (USEPA Region V, 1999).
Second source : PRGs for Ecological Endpoints, Efroymson, et al., 1997a.
Third source : OMOE, 1993.

APPENDIX D

ECOLOGICAL TOXICITY PROFILES FOR THE CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN PLUM BROOK ORDNANCE WORKS

Table of Contents

Page

D.1.0 Introduction D-1
D.2.0 Inorganic Compounds D-1
D.2.1 Calcium D-1
D.2.2 Lead D-2
D.2.3 Mercury D-6
D.3.0 Organic Compounds D-11
D.3.1 Aroclor-1260 (PCB) D-11
D.3.2 2-Amino-4,6-Dinitrotoluene D-17
D.3.3 Fluoranthene (Polycyclic Aromatic Hydrocarbons) D-20
D.3.4 2,4,6-Trinitrotoluene D-24

APPENDIX D

ECOLOGICAL TOXICITY PROFILES FOR THE CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN PLUM BROOK ORDNANCE WORKS

TNT AREA A

D.1.0 Introduction

A large variety of both inorganic and organic chemicals have been measured in environmental media at Plum Brook Ordnance Works at concentrations in excess of background measurements. This appendix contains toxicity information related to each of the chemicals of potential ecological concern that were identified as being risk drivers (i.e., contributing a large percentage of the total hazard index for a particular receptor). General toxicity information is presented for plants, wildlife, and freshwater aquatic biota, as available. Much of the information was obtained from biological and toxicological databases, such as the hazardous substance database (National Library of Medicine [NLM], 1996), registry of toxic effects of chemical substances [RTECS], 1999), Integrated Risk Information System (U.S. Environmental Protection Agency [EPA], 2001) and from wildlife hazard reports published by the U.S. Fish and Wildlife Service (i.e., Eisler, 1986).

D.2.0 Inorganic Compounds

D.2.1 Calcium

Calcium is a soft, silvery white metallic element found most widely in rocks, such as chalk, limestone, and marble. Calcium is an alkaline earth metal and is the fifth most abundant element in the earth's crust. Calcium is the most abundant mineral element in the animal body, with ninety-nine percent of it occurring in bone and teeth (McDowell, 1992).

Plants

Calcium is present in the tissues of plants at varying concentrations, dependent on the species. However, data on the toxicity of calcium to plants was not readily available from literature reviewed.

Animals

Calcium is an essential nutrient for the proper development of animals. It is one of the most abundant mineral elements in the animal body. Deficiency of calcium in animal diets results in development of rickets (McDowell, 1992).

Data do not exist on the effects of calcium on wild animals. Laboratory studies have linked the deficiency of calcium in the diets of pigs, cattle, and poultry to the development of rickets. Studies suggest that dietary calcium is not toxic when single large doses are consumed by animals. Under normal conditions, it is absorbed according to need, and the excess is excreted; nonetheless, an excess of calcium in the diet can pose adverse health effects in tested species. A no observable adverse effect level (NOAEL) of 1,053 mg/kg per day has been derived from data reported by McDowell (1992) for laboratory rabbits exposed to calcium (Appendix H). For birds, a NOAEL of 2,833 mg/kg per day has been derived from data reported by McDowell (1992) for Japanese quail (Appendix H). These NOAELs have been multiplied by an uncertainty factor of 5 (from Wentsel et al. [1996]) to estimate LOAELs of 5,265 mg/kg-day and 14,165 mg/kg-day, respectively, for rabbits and quail.

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D.2.2 Lead

Global production of lead from both smelter and mining operations has been high throughout this century. Lead is commonly used in storage batteries as well as ammunition, solder, and casting materials. In addition, tetraethyl lead was a principal additive to gasolines as an anti-knock agent, and was commonly used as an additive in paints. In short, lead is one of the most ubiquitous pollutants in the civilized world.

Lead is strongly sorbed in sediments and the rate is strongly correlated with grain size and organic content. In the absence of soluble complexing species, lead is almost totally adsorbed to clay particles at pHs greater than 6 (Moore and Ramamoorthy, 1984).

Mammals

In laboratory studies, breeding mice exposed to low doses of lead in drinking water (25 ppm) resulted in loss of the strain in two generations with many abnormalities (Schroeder and Mitchner, 1971). Exposure of rats in this same experiment resulted in many early deaths and runts. Blood δ-aminolevulinic acid dehydratase (ALAD) activity associated with exposure to lead was reduced in white-footed mice living near a metal smelter (Beyer et al., 1985). Amounts of whole-body lead content and feeding habits of roadside rodents have been correlated with highest body burdens in insectivores such as shrews; intermediate in herbivores, and lowest in granivores (Boggess, 1977; Getz et al., 1977). For the current RA, rat NOAEL and LOAEL values of 8.0 and 80 mg/kg-day have been used from Sample et al. (1996).

Birds

Most of the information on the effects of lead to terrestrial vertebrates is concerned with the poisoning of waterfowl by lead shot. Apparent symptoms include loss of appetite and mobility, avoidance of other birds, lethargy, weakness, emaciation, tremors, dropped wings, green feces, impaired locomotion, loss of balance and depth perception, nervous system damage, inhibition of heme synthesis, damage to kidneys and liver, and death (Eisler, 1988; Mudge, 1983). Anemia, kidney disease, testicular and liver lesions, and neurological disorders have been associated with high brain lead concentrations in mourning doves (*Zeneida macroura*) (Kendall, 1992). Hatchlings of chickens, Japanese quail, mallards and pheasants are relatively more tolerant to moderate lead exposure, including no effect on growth at dietary levels of 500 ppm and no effect on survival at 2,000 ppm (Hoffman, et al., 1985). For the current RA, American kestrel NOAEL and LOAEL values of 3.85 and 38.5 mg/kg-day have been used from Sample et al. (1996).

Fish

All life stages are sensitive to the toxic effects of lead; however, embryos are more sensitive to lead than are later juvenile stages (Davies et al. 1976). Lead uptake depends on exposure time, aqueous concentration, pH, temperature, salinity, diet, and other factors. For example, gill, liver, kidney, and erythrocytes accumulate lead from aqueous sources in proportion to exposure time and concentration (Holcombe et al., 1976). Direct erythrocyte injury is considered the first and most important sign of lead poisoning in catfish (Dawson, 1935). Respiratory distress occurs in fish living in rivers receiving lead mining wastes in England (Carpenter, 1924; 1925; 1926). Fish are thought to be asphyxiated as a result of a mucous coating over the gills (National Academy of Sciences, 1972).

Invertebrates

The majority of benthic invertebrates do not bioconcentrate lead from water or abiotic sediment particles. There is some evidence of bioaccumulation through the food web of organic forms of lead, such as tetraethyl lead. Anderson et al. (1980) reported lead LC_{50}s of 258 ppm for the chironomid and that growth of this amphipod was not reduced above this level in freshwater sediments. In addition, Suter and Mabrey (1994) reported effect levels in the water flea (*Daphnia magna*) to be in the 12.26 ppb range, while Khangrot and Ray (1989) reported a *D. magna* LC_{50} of 4.89 ppm.

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D.2.3 Mercury

Mercury is a natural element which may be found in coal, crude oils, and petroleum crudes. It may be released from the working and smelting of ores of copper, gold, lead, silver, and zinc which normally contain mercury (Jonasson et al., 1972, as cited in NLM, 1996) as well as through the combustion of coal (NRCC, 1979, as cited in NLM, 1996). Methyl mercury is

formed naturally in aquatic and terrestrial environments through microbial actions (Schroeder, 1982, as cited in NLM, 1996), and is more toxic than elemental mercury.

Plants

Mercury is not required for plant growth. Background concentrations of mercury in plants usually range from 0.0026 to 0.086 mg/kg (dry weight) (Kabata-Pendias and Pendias, 1992). Some plants, such as lichens, mushrooms, carrots, and lettuce, often contain higher concentrations of mercury than other plants from the same site (Kabata-Pendias and Pendias, 1992). Pine needles have also been reported to be good biomonitors of mercury-contaminated environments (Barghigiani et al., 1987, as cited in Kabata-Pendias and Pendias, 1992). In general, the concentration of mercury in plants will be elevated when mercury concentrations in soils are high. Mercury concentrations in plants, however, generally do not exceed those in associated soils (Lisk, 1972). Above-background concentrations of mercury usually occur in plants growing in the vicinity of chloralkali plants, smelters and mines, pulp and paper mills, sludge disposal areas, and mercury-treated agricultural areas (Eisler, 1987). According to Kitagishi and Yamane (1981, as cited in Kabata-Pendias and Pendias, 1992), methyl-mercury is more available to plants than either phenyl- or sulfide-mercury. In addition to mercury uptake from the soil, plants can also absorb mercury vapor (Browne and Fang, 1978). The methylation of mercury by methylating bacteria and fungi can occur under aerobic and anaerobic soil conditions.

Concentrations of mercury in leaf tissue that are excessive or toxic to various plant species, with the exclusion of very sensitive and highly tolerant species, range from 1 to 3 mg/kg (dry weight) (Kabata-Pendias and Pendias, 1992). Concentrations of mercury in plant tissues that are expected to result in a 10 percent loss in crop yield range from 1 to 8 mg/kg (dry weight) (Macnicol and Beckett, 1985). A soil concentration of 0.3 mg/kg (dry weight) has been proposed by Will and Suter (1994) as a benchmark screening value for mercury phytotoxicity. General symptoms of mercury toxicity in plants include severe stunting of seedlings and roots and leaf chlorosis and browning of leaf points (Kabata-Pendias and Pendias, 1992).

Wildlife

Mercury is not an essential element for animal life. Background mercury concentrations in wildlife tend to be less than 1 mg/kg (wet weight) (Eisler, 1987). Biomonitoring studies have shown that mercury concentrations in mammals are highest in hair, followed by kidney and liver tissues (Bull et al., 1977; Goyer, 1991; Wren, 1986). Feathers of birds have been used to

monitor mercury concentrations in the environment (Eisler, 1987). Mercury is bioaccumulated and biomagnified in terrestrial food chains (Eisler, 1987; Talmage and Walton, 1993). Talmage (1989) has shown the insectivorous short-tail shrew (*Blarina brevicauda*) to be a better monitor of environmental mercury contamination than the granivorous white-footed mouse (*Peromyscus leucopus*). Transfer factors for diet to kidney for these species were 4.40 and 0.75, respectively (Talmage and Walton, 1993). Mink (*Mustela vison*) and river otter (*Procyon lotor*) have been shown to be good monitors of mercury contamination within river environments due to their consumption of contaminated fish (Kucera, 1983).

Organic mercury compounds, especially methyl mercury, are more toxic to mammals than inorganic forms of mercury. Selenium has been shown to have a protective effect against mercury poisoning (Ganther et al., 1972). Interspecies variations in susceptibility to methyl mercury poisoning exist, with mink being more sensitive than otters (*Lutra canadensis*), ferrets (*Mustela furo/Mustela putorius* cross), dogs, and cats (Wren, 1986). Based on methyl mercury toxicity data for the rat and the mink, extrapolated NOAELs for chronic exposure of various mammalian wildlife species to methyl mercury are 0.064 for the white-footed mouse, 0.054 mg/kg/d for the meadow vole, and 0.01 mg/kg/d for the red fox (Opresko et al., 1996). Mercury has been shown to be teratogenic, mutagenic, and carcinogenic in animal studies (Eisler, 1987). Signs of mercury poisoning that have been observed in mink include anorexia, weight loss, ataxia and splaying of hind legs, irregular vocalization, salivation, and convulsions (Wren, 1986). For this RA, a mink NOAEL value of 1.0 mg/kg-day from Sample et al. (1996) has been used. Application of an uncertainty factor of 5 (from Wentsel et al. [1996]) to this NOAEL results in an estimated LOAEL of 5.0 mg/kg-day.

Concentrations of mercury that are acutely toxic to birds following oral exposure range from 2.2 to 31.0 mg/kg body weight (Eisler, 1987). Mercury concentrations in the livers of methyl-mercury-poisoned birds ranged from 17 to 70 mg/kg (dry weight) (Solonen and Lodenius, 1984, as cited in Eisler, 1987). Methyl mercury is more toxic to avian species than inorganic mercury (Hill, 1981, as cited in Eisler, 1987). In addition to the form of mercury to which the bird is exposed, the species, gender, age, and health of the bird may also influence the toxic response (Fimreite, 1979, as cited in Eisler, 1987). Based on avian test data for mallards exposed to methyl mercury, NOAELs for chronic exposure of avian species to methyl mercury are 0.006 mg/kg/d for the American robin, red-tailed hawk, and belted kingfisher (Sample et al., 1996). Physical signs of mercury poisoning in birds include muscular incoordination, falling, slowness, fluffed feathers, calmness, withdrawal, hyperactivity, and eyelid drooping (Eisler,

1987). For this RA, Japanese quail NOAEL and LOAEL values of 0.45 mg/kg-day and 0.90 mg/kg-day from Sample et al. (1996) have been used.

Aquatic Life

Concentrations of mercury in freshwater fish collected from 112 monitoring stations in the United States from 1978 to 1981 ranged from 0.1 to 1.10 mg/kg (wet weight), with an average of 0.11 mg/kg (wet weight) (Lowe et al., 1985). Elevated concentrations of mercury in fish have often been associated with low pH, low calcium concentrations in the water, and low water hardness (Eisler, 1987). Methylating bacteria in sediments actively convert inorganic mercury into methyl mercury. This results in an increase in the bioavailability of mercury. Fish absorb methyl mercury more easily than inorganic mercury from the water column (Huckabee et al., 1979, as cited in Eisler, 1987). Because exposure of fish to methyl mercury can occur via ingestion of contaminated prey, methyl mercury concentrations are usually highest in organisms near the top of the food chain, such as carnivorous fish (Huckabee et al., 1979, as cited in Eisler, 1987).

Exposure of aquatic organisms to elevated mercury concentrations can result in reduced growth and reproduction (Eisler, 1987). The Federal Water Quality Criteria for the Protection of Aquatic Life for acute and chronic exposure to methyl mercury in freshwater systems are 2.4 and 0.012 µg/L, respectively (EPA, 1996). The lowest chronic values of methyl mercury reported in the literature for fish and *Daphnia* are 0.52 µg/L and less than 0.04 µg/L, respectively (Suter and Mabrey, 1994). The lowest chronic value for inorganic mercury reported in the literature for fish is less than 0.23 and 0.96 µg/L for daphnids (Suter and Mabrey, 1994). The test EC_{20} for fish can be used as a benchmark indicative of production within a population. It is the highest tested concentration causing less than 20 percent reduction in either the weight of young fish per initial female fish in a life cycle or partial life-cycle test or the weight of young per egg in an early life-stage test (Suter and Mabrey, 1994). The values for methyl mercury and inorganic mercury are less than 0.03 and 0.87 µg/L, respectively (Suter and Mabrey, 1994). Daphnid test EC_{20} values for methyl and inorganic mercury are both 0.87 µg/L (Suter and Mabrey, 1994). Physical signs of acute mercury poisoning in fish include the flaring of gills, an increase in the frequency of respiratory movements, loss of equilibrium, and sluggishness (Armstrong, 1979, as cited in Eisler, 1987).

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D.3.0 Organic Compounds

D.3.1 Aroclor-1260 (PCB)

Polychlorinated biphenyls (PCB) are a group of synthetic chlorinated aromatic hydrocarbon molecules that have a worldwide distribution due to their wide use and persistence in the environment (Eisler, 1986). PCBs are often referred to by the trade name Aroclor followed by a four-digit number. The first two digits represent the 12 carbons of the biphenyl structure, and the second two digits represent the approximate weight percentage of chlorine in the product (Hooper, et al., 1990). Aroclors are comprised of several different PCB species and isomers.

Plants

PCBs are among the most abundant chlorinated hydrocarbons in the environment (Risebrough, et al., 1968). Total PCB concentrations in terrestrial plants are usually less than 0.3 mg/kg (dry weight) (Buckley, 1983, as cited in Eisler, 1986). Soil-to-plant transfer factors for PCBs are generally low, ranging from 0 to 0.5 (Pal et al., 1980). Uptake by plants is dependent on the degree of chlorination of the PCB compound, with uptake greater for the lipophilic, highly chlorinated forms (Pal et al., 1980). Plant uptake of PCBs is also dependent on the solubility of

the PCB. PCBs within plants can be metabolized; however, the degree and rate of metabolism is related to the degree of chlorination (Pal et al., 1980). Greater metabolism occurs for the less chlorinated PCBs (Pal et al., 1980).

Very few studies have been conducted to investigate the effects of PCBs on the growth of terrestrial plants. From the available data, a soil concentration of 40 mg/kg (dry weight) has been proposed by Will and Suter (1994) as a benchmark screening value for PCB toxicity to terrestrial plants.

The more highly chlorinated PCBs are more persistent in the environment. Studies have shown mono-, di-, and trichlorinated biphenyls to be more biologically degradable by microorganisms than tetra-, penta-, and hexachlorobiphenyl compounds (Pal, et al., 1980). Several species of soil bacteria are known to metabolize and decompose PCBs. These include *Achromobacter*, which degrade mono- and dichlorinated biphenyls to benzoic acid (Hooper, et al., 1990).

Wildlife

According to Pal et al. (1980), PCBs are detected more frequently in mammals, birds, fish, and eggs than in plants. In, 1979, 83 percent of European starlings (*Sturnus vulgaris*) collected nationwide contained measurable amounts of PCBs (Cain and Bunck, 1983, as cited in Eisler, 1986). Maximum PCB concentrations in eggs of American bald eagles (*Haliaetus leucocephalus*) collected nationwide during 1979 ranged from 5.6 to 81 mg/kg (wet weight) (Wiemeyer, et al., 1984, as cited in Eisler, 1986). PCB concentrations in small mammals collected from relatively uncontaminated sites usually range from 0 to 1.3 mg/kg (wet weight) (Talmage and Walton, 1991). PCBs are readily absorbed through the gastrointestinal tract, respiratory system, and skin (Eisler, 1986). They can cross the placenta of mammals (Rogan et al., 1988). Simple PCBs are metabolized in the body and excreted in urine and bile (Eisler, 1986). Exposure of vertebrates to PCB congeners can induce the production of mixed-function oxidase enzymes that metabolize foreign compounds (Parkinson and Safe, 1981, as cited in Dillon and Burton, 1991). In some instances, as with Aroclor-1254, metabolites may be more toxic than the parent compounds (Aulerich and Ringer, 1986). Nonortho-substituted coplanar PCBs are among the most toxic PCB isomers to mammals and birds (Kannan, et al., 1989; Brunström, 1989).

Among mammals, mink (*Mustela vison*) are especially sensitive to PCBs (Eisler, 1986). A concentration of 0.64 mg/kg in the diet can induce reproductive failure in mink (Fleming et al.,

1983, as cited in Eisler, 1986). Mink diets containing 6.7 to 8.6 mg/kg (wet weight) Aroclor-1242 and -1254, respectively, resulted in the death of 50 percent of the animals within a nine-month period (Ringer, 1983, as cited in Eisler, 1986). Acute oral toxicity studies with mink have the revealed toxicity of Aroclor-1221 to be greater than that for either Aroclor-1242 or -1254 (Aulerich and Ringer, 1977). Based on white-footed mouse and mink toxicity data, extrapolated NOAELs for chronic exposure of various mammalian wildlife species to specific Aroclor-1254 have been determined (Opresko, et al., 1994). Estimated NOAEL values for the white-footed mouse, cottontail rabbit, and red fox are 0.13, 0.035, and 0.083 mg/kg per day, respectively (Opresko, et al., 1994). Calculated chronic benchmark values for mammalian wildlife range from 0.15 to 1.38 mg/L for exposure to Aroclor-1254 in drinking water only (Opresko, et al., 1994). Mammalian wildlife NOAELs have also been estimated for Aroclors-1016, -1242, and -1248. The values for Aroclor-1248, which are the lowest among the PCBs listed, are 0.060 mg/kg per day for the mouse, 0.016 mg/kg per day for the cottontail rabbit, and 0.010 mg/kg per day for the fox. Drinking water NOAELs for these species are 0.2, 0.17, and 0.069 mg/L, respectively. Certain PCB congeners have been shown to induce mutagenic, carcinogenic, and teratogenic effects in mammals (Eisler, 1986). Symptoms of PCB toxicity in mink fed diets supplemented with PCBs included anorexia; bloody stools; reproductive failure; increased infant mortality; and the presence of fatty livers, hemorrhagic gastric ulcers, and kidney degeneration (Aulerich and Ringer, 1977). For this RA, the NOAEL and LOAEL values utilized for Aroclor-1260 are 0.068 mg/kg/d and 0.68 mg/kg/d, based on rats exposed to Aroclor-1260 (Sample et al., 1996).

The toxicity of PCB compounds to birds is influenced by the species of bird and its associated food habits, health and body fat content, gender, and age (Eisler, 1986). Concentrations of PCBs in brain tissue greater than 310 mg/kg (wet weight) are lethal (Stickel, et al., 1984). Dietary LD_{50} values for various species of birds exposed to PCB Aroclor mixtures were highest for Aroclor-1221 and generally decreased with increasing percent chlorination (Heath, et al., 1972, as cited in Eisler, 1986). Toxicological benchmark values for wild birds have been estimated based on experiments with ring-necked pheasants (Opresko, et al., 1994). A benchmark value of approximately 3 mg/L was estimated for chronic exposure of these birds to Aroclor-1254 in drinking water only (Opresko, et al., 1994). NOAELs have also been estimated for birds exposed to Aroclor-1242 (Opresko et al., 1994). Based on a screech owl oral NOAEL of 0.41 mg/kg per day, values for the heron and hawk were calculated as 0.175 and 0.22 mg/kg per day, respectively. The drinking water NOAEL for these birds was 3.9 mg/L. Exposure to PCBs can result in adverse effects on reproduction, growth, metabolism, and behavior (Eisler, 1986). Eggshell

thinning may also occur as a result of exposure of the female birds to PCBs (Hayes, 1975, as cited in NLM, 1996). Exposure to PCBs can also render a bird more susceptible to certain types of viral infections (Friend and Trainer, 1970). For this RA, the NOAEL and LOAEL values utilized for avian species are 0.18 mg/kg-day and 1.8 mg/kg-day, based on the ring-neck pheasant exposed to Aroclor-1260 (Sample, et al., 1996).

Aquatic Life

PCBs are bioconcentrated, bioaccumulated, and biomagnified in freshwater environments. Bioconcentration factors for freshwater invertebrates exposed to Aroclor-1254 have been reported to range from 60 to 27,000 (Eisler, 1986). National surveys of PCB concentrations in freshwater fish collected from 1978 to 1979 revealed total PCB concentrations in whole fish to average 1.4 mg/kg (wet weight) (Schmitt, et al., 1983, as cited in Eisler, 1986). Concentrations of specific Aroclors were measured in later surveys conducted from 1980 to 1981 where mean concentrations of Aroclor-1248, Aroclor-1254, and Aroclor-1260 in whole fish were reported to be 0.1, 0.2, and 0.3 mg/kg (wet weight), respectively (Schmitt, et al., 1983, as cited in Eisler, 1986). Diet appears to be the major route of PCB uptake in freshwater fish (Eisler, 1986). Aquatic invertebrates have been shown to contribute to the cycling of PCBs in freshwater environments by their uptake of sediment-associated PCBs and their subsequent migration to the water column or surface, where they can be ingested by other organisms (Eisler, 1986). PCB concentrations that exceed 1,000 mg/kg (wet weight) have been measured in the fat of snapping turtles (*Chelydra serpentina*) collected from contaminated environments (Meyers-Schöne and Walton, 1994).

Because of the strong hydrophobicity of PCBs, these compounds localize in sediments and accumulate in the lipids of freshwater biota (Hooper, et al., 1990). The high affinity of PCBs for lipids and the relative resistance of highly chlorinated congeners to metabolism are responsible for the biomagnification of these compounds in aquatic environments (Sanders and Chandler, 1972, as cited in Hooper, et al., 1990). Dechlorination of PCBs by bacteria in anaerobic sediments has been reported to reduce the toxicity of these compounds (Brown, et al., 1987).

The toxicity of PCBs to aquatic biota increases with percent chlorination of the PCB mixture (Birge, et al., 1978, as cited in Pal, et al., 1980). Laboratory toxicity tests have shown PCB toxicity to increase with exposure time (Eisler, 1986). Also, younger developmental stages are more sensitive to PCBs than older stages (Eisler, 1986). Federal Water Quality Criteria exist for the protection of freshwater aquatic life from exposure to PCBs. The values for acute and

chronic exposure to PCBs in freshwater systems are 2.0 μg/L and 1.4 x 10E-2 μg/L, respectively (EPA, 1986). Suter and Mabrey (1994) derived acute and chronic advisory values for freshwater biota exposed to specific PCBs. The test EC20 for fish can be used as a benchmark indicative of production within a population. It is the highest tested concentration of a specific PCB causing less than 20 percent reduction in either the weight of young fish per initial female fish in a life cycle or partial life-cycle test or the weight of young per egg in an early life-stage test (Suter and Mabrey, 1994). A similar value can be determined for daphnids, which reflects the highest tested concentration of a PCB causing less than 20 percent reduction in the product of growth, fecundity, and survivorship in a chronic test with a daphnid species (Suter and Mabrey, 1994).

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D.3.2 2-Amino-4,6-Dinitrotoluene

Little information is available for 2-amino-4, 6-dinitrotoluene (DNT) and 4-amino-2,6-DNT. Information is thus also provided for DNT.

DNT compounds are used in organic synthesis, dyes, explosives, and in isocyanate production (NLM, 1996). 2,6 DNT is expected to be slightly mobile in soils (NLM, 1996). Biodegradation of 2,6-DNT is expected to occur in soils (NLM, 1996). In aquatic environments, 2,6-DNT will have a slight tendency to adsorb to sediments, suspended solids, and biota (NLM, 1996). Volatilization of 2,6-DNT and 2,4-DNT from water is relatively low; however, photolysis is a significant removal mechanism for the compound (NLM, 1996).

Plants

Based on information presented in Talmage, et al. (1999), soil amended with 80 mg/kg of 2-amino-4,6-DNT was not toxic to yellow nutsedge over a 42-day period. This concentration was deemed a NOAEL value.

Wildlife

As with plants, data on concentrations of dinitrotoluenes in mammalian and avian wildlife species could not be found in the open literature. The liver and small intestine are the major sites of 2,6-DNT and 2,4-DNT metabolism (Schut, et al., 1983, and Rickert, et al., 1983, as cited in NLM, 1996).

Large differences exist in the toxicity of the various dinitrotoluene isomers in laboratory mammals (ACGIH, 1980, as cited in NLM, 1996). The 2,4-, 2,6- and 3,4- dinitrotoluene isomers have been found to be the most toxic DNT isomers to rats (ACGIH, 1980, as cited in NLM, 1996). Adverse reproductive effects have been documented in rats exposed to 2,4-DNT (NLM, 1996). Inhalation of fumes or dust containing 2,4-DNT may produce changes in blood chemistry (EPA, 1980, as cited in NLM, 1996). Experimentally determined LD_{50} values for rats and mice orally exposed to 2,6-DNT are 117 and 621 mg/kg, respectively (NLM, 1996). LD_{50} values for rats, mice, and guinea pigs orally exposed to 2,4-DNT are 268; 790; and 1,300 mg/kg, respectively (NLM, 1996). No observable effects were observed in rats exposed to 2,4-DNT at 0.57 and 0.71 mg/kg/d (Ellis, et al., 1978, as cited in NLM, 1996). 2,6-DNT and 2,4-DNT have been shown to be mutagenic (NLM, 1996). Laboratory studies have found 2,4-DNT to be carcinogenic (NLM, 1996). 2,6-DNT has been shown to be a potent hepatocarcinogen in laboratory rats (Dixit, et al., 1986, as cited in NLM, 1996). Signs of 2,6-DNT poisoning that have been

noted in laboratory mammals include decreased appetite, weight loss, and inhibition of muscular coordination (EPA, 1980, as cited in NLM, 1996). Signs of 2,4-DNT toxicity in rats include changes in body weight and behavior, humpback, and jerky coordination (Kozuka, et al., 1979, as cited in NLM, 1996).

For this risk assessment, for mammalian species, LD_{50} values for rats exposed to 2-amino-4,6-DNT and 4-amino-2,6-DNT are 1,394 mg/kg per day and 959 mg/kg per day, respectively (TOMES, 1999). These LD_{50} values were utilized to derive NOAELs of 13.9 mg/kg per day and 9.59 mg/kg per day, respectively ($LD_{50}/100$). These LD_{50} values were also utilized to derive LOAELs of 69.5 mg/kg per day and 48.0 mg/kg per day, respectively ($LD_{50}/20$). For avian species 2,4,6-TNT toxicity results were used as a surrogate.

Aquatic Life

Limited data exists on concentrations of DNTs in freshwater biota. A bioconcentration factor of 5,225 has been measured for algae exposed to 2,6-DNT in a model waste stabilization pond (Davis, et al., 1981, as cited in NLM, 1996). The EPA has estimated a bioconcentration factor of 3.8 for aquatic organisms that contain about 7.6 percent lipid (EPA, 1980, as cited in NLM, 1996).

Aquatic toxicity data for DNTs are limited. Federal water quality criteria do not exist for the protection of freshwater aquatic life from acute and chronic exposure to 2,6-DNT or 2,4-DNT (EPA, 1986; EPA, 1992). Concentrations of 2,4-DNT as low as 330 and 230 g/L are toxic to freshwater aquatic life following acute and chronic exposure, respectively (EPA, 1986).

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D.3.3 Fluoranthene (Polycyclic Aromatic Hydrocarbons)

Polycyclic aromatic hydrocarbons (PAH) comprise a group of compounds containing two or more fused benzene rings. Although thousands of different PAHs are known to exist, 13 are of great environmental concern. These include acenaphthalene, anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. PAHs are ubiquitous in nature, occurring from both natural and anthropogenic sources. PAHs present in surface waters are expected to undergo hydrolysis. In general, these compounds have low water solubilities and therefore partition into sediments (Sims and Overcash, 1983).

Plants

Some PAHs are synthesized by plants at very low concentrations (Sims and Overcash, 1983). Background concentrations of specific PAH compounds usually range from 22 to 88 μg/kg (dry weight) in tree leaves, 48 to 66 μg/kg (dry weight) in cereal crop plants, 0.05 to 50 μg/kg (dry weight) in leafy vegetables, 0.01 to 6 μg/kg (dry weight) in underground vegetables, and 0.02 to 0.04 μg/kg (dry weight) in fruits (Sims and Overcash, 1983). In general, PAH concentrations are usually greater in aboveground plant parts than in belowground parts and are greater on plant surfaces than within internal tissues (Edwards, 1983, as cited in Eisler, 1987). Lower-molecular-weight PAHs are taken up from soil by plants more readily than higher-molecular-weight PAHs (Eisler, 1987). Plant-to-soil concentration ratios for total PAHs have been reported to range from 0.001 to 0.183 (Wang and Meresz, 1981, as cited in Edwards, 1989). According to Edwards (1983, as cited in Talmage and Walton, 1990), plant-to-soil concentration ratios for benzo(a)pyrene are usually low, ranging from 0.0001 to 0.33. Atmospheric deposition is believed to be the usual source of PAHs in plants, not uptake from soil (Sims and Overcash, 1983). The waxy surface of some plant leaves and fruits can concentrate PAHs through surface adsorption (EPA, 1980, as cited in NLM, 1996). Mosses have been recommended as good indicators of regional PAH air pollution (Herrmann and Hubner, 1984, as cited in Eisler, 1987). Some species of bacteria and fungi can degrade specific PAH compounds (Eisler, 1987; Sims and Overcash, 1983).

Limited data exist on the phytotoxicity of PAHs to plants. Benzo(b)fluoranthene concentrations of 6,254 μg/kg in soil were reported to reduce stem growth in wheat but did not affect rye plants (Sims and Overcash, 1983). Dry-leaf mass was slightly reduced, and total dry yield was reduced by 11 percent in the wheat plants exposed to the elevated benzo(b)fluoranthene concentration. Benzo(a)pyrene and benzo(b)fluoranthene soil concentrations of up to 18,000 μg/kg do not appear to be severely toxic to higher plants (Sims and Overcash, 1983). There is some evidence that low concentrations of some PAHs may actually stimulate plant growth (Edwards, 1989).

Wildlife

Concentrations of PAH compounds in wild mammals and birds could not be found in the open literature. Exposure to PAHs can occur via inhalation, ingestion, or dermal exposure. Most of the PAHs taken in the body are not accumulated but are oxidized, and the metabolites are excreted (Sittig, 1985, as cited in NLM, 1996). In fact, most PAH compounds are detoxified and excreted from the body (Doull, et al., 1986, as cited in NLM, 1996). PAHs are metabolized in vertebrates by a group of enzymes known as mixed-function oxidase in the liver. Some of the

intermediate metabolites have been identified as mutagenic, carcinogenic, and teratogenic (Sims and Overcash, 1983).

In most cases, tissue damage from exposure to PAH compounds usually occurs at dose levels that would be expected to induce carcinomas (Eisler, 1987). The toxic response to a PAH compound is a function of the specific compound, the dose, and the route of exposure. Unsubstituted aromatic PAHs with less than four condensed rings have not been shown to be tumorigenic (Eisler, 1987). Many PAHs with four to six rings are carcinogenic (Eisler, 1987). Compounds such as 7,12-dimethylbenz(a)anthracene and benzo(a)pyrene can induce skin tumors following dermal exposure (Weisburger and Williams, 1980). One isomer of the benzo(a)pyrene metabolite 7,8-dihydrodiol 9,10-epoxide is a very potent carcinogen to newborn mice (Slaga, et al., 1978, as cited in Eisler, 1987). Some PAH compounds may act in a synergistic or cocarcinogenic manner when combined (Eisler, 1987).

Studies have not been conducted on the toxicity of PAH compounds to wildlife. A few laboratory studies on rodents have revealed acute oral toxicities of PAHs are greatest for benzo(a)-pyrene, followed in decreasing order of toxicity by phenanthrene, naphthalene, and fluoranthene (Sims and Overcash, 1983). LD_{50} values range from 50 mg/kg body weight to 2,000 mg/kg body weight (Sims and Overcash, 1983). Chronic oral doses that result in the production of cancer are lowest for 7,12-dimethylbenz(a)anthracene at a dose of 4.0×10^{-5} to 2.5×10^{-4} mg/kg body weight (Eisler, 1987). Benzo(a)pyrene concentrations of 0.002 mg/kg body weight and anthracene concentrations of 3,300 mg/kg body weight will also result in cancer following chronic oral exposure to the specific compound (Eisler, 1987).

For this RA, estimated laboratory mouse oral NOAEL and LOAEL values of 1.0 mg/kg-day and 10 mg/kg-day, for benzo(a)pyrene (Sample, et al., 1996), were utilized as surrogate NOAEL and LOAEL values for fluoranthrene. NOAEL and LOAEL values for avian species could not be located from the reviewed references.

Aquatic Life

Bioconcentration factors have been reported for aquatic biota exposed to PAHs under laboratory conditions (Eisler, 1987). Bioconcentration factors for *Daphnia* exposed to specific PAH compounds for a period of at least 24 hours range from 131 for naphthalene to 134,248 for benzo(a)pyrene (Eisler, 1987). Water to liver bioconcentration factors for freshwater fish exposed to benzo(a)pyrene for a minimum of 8 days range from 182 for rainbow trout (*Salmo*

gairdneri) to 1,375 for Northern pike (*Esox lucius*) (Eisler, 1987). There is little evidence for bioaccumulation and biomagnification of PAHs in the aquatic environment (Eisler, 1987).

The toxicity of PAH compounds to fish is also related to the solubility of the compound in water. Toxicity to aquatic biota also increases as the molecular weight of the PAH compound and the degree of alkyl substitutions on the aromatic ring increase (Eisler, 1987). The toxicity of PAHs to aquatic organisms is very species-specific and related to the organisms' ability to metabolize and excrete the compound (Eisler, 1987). Because many species of fish are able to metabolize benzo(a)pyrene to reactive intermediates that have mutagenic and carcinogenic properties, the presence of tumors in fish from PAH-contaminated environments is often related to exposure to PAHs (Eisler, 1987). Other toxic responses that have been noted in aquatic biota exposed to PAHs include inhibited reproduction in daphnids, delayed emergence of larval midges, decreased respiration and heart rate in mussels, inhibition of photosynthesis in algae and aquatic macrophytes, and liver enlargement in fish (Eisler, 1987).

A few Federal Water Quality Criteria exist for the protection of freshwater aquatic life. These are an acute value of 3,980 ug/L for fluoroanthene, an acute value of 30 ug/L and chronic value of 6.3 ug/L for phenanthrene, and an acute value of 2,300 ug/L and a chronic value of 620 ug/L for naphthalene (EPA, 1996). Suter and Mabrey (1994), however, have derived acute and chronic advisory values for freshwater biota exposed to PAHs. The test EC_{20} for fish can be used as a benchmark indicative of production within a population. It is the highest tested concentration of a specific PAH causing less than 20 percent reduction in either the weight of young fish per initial female fish in a life cycle or partial life-cycle test or the weight of young per egg in an early life-stage test (Suter and Mabrey, 1994). A similar value can be determined for daphnids, which reflects the highest tested concentration of a PAH causing less than 20 percent reduction in the product of growth, fecundity, and survivorship in a chronic test with a daphnid species (Suter and Mabrey, 1994).

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D.3.4 2,4,6-Trinitrotoluene

Plants

Information on the concentration of 2,4,6-Trinitrotoluene (2,4,6-TNT) in wild flora or phytotoxicity data on 2,4,6-TNT could not be found in the reviewed literature, except for a screening benchmark of 30 mg/kg for 2,4,6-TNT in soil that is protective of plants (Talmage et al., 1999).

Wildlife

The literature regarding nitroaromatic explosives shows that 2,4,6-TNT is less toxic than 2,4- or 2,6-DNT. A 14-day LD_{50} for mice is reported as 660 mg/kg per day for TNT (Dilley, et al., 1982). Levine, et al. (1990) report reproductive effects in rats as low as 125 mg/kg per day 2,4,6-TNT. For the current risk assessment, mammal data from Talmage et al. (1999) are used. Talmage et al. (1999) presents a chronic NOAEL of 1.6 mg/kg-day for rats, and this value is multiplied by a factor of 5 (per Wentsel et al., 1996) obtain an estimated LOAEL of 8.0 mg/kg-day. For birds, USACHPPM (2000) presents a subchronic NOAEL of 7 mg/kg-day for bobwhite quail. This value is divided by a factor of 10 to obtain an estimated chronic NOAEL of 0.7 mg/kg-day that is used in the current risk assessment. USACHPPM (2000) also presents a subchronic LOAEL of 178 mg/kg-day for bobwhite quail, and this value is divided by a factor of 10 to obtain an estimated chronic LOAEL of 17.8 mg/kg-day that is used in the current risk assessment.

Aquatic Life

No criteria have been established for 2,4,6-TNT for the protection of aquatic life. However, the available data indicate that 2,4,6-TNT is acutely toxic to freshwater fish at levels of approximately 1 mg/L and to invertebrates as low as 0.19 mg/L. Chronic toxicity data indicate effects as low as 0.12 mg/L (Dacre, 1980). Burrows, et al. (1989), indicate that concentrations of

560 and 40 μg/L are protective of aquatic life due to acute and chronic exposure to 2,4,6-DNT, respectively.

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APPENDIX E

ASSESSMENT RECEPTOR PROFILES

Appendix E

Assessment Receptor Profiles

Eastern Cottontail (Sylvilagus floridanus). These medium-size grazing herbivores are found over most of the eastern half of the United States and southern Canada, and have been widely introduced into the western U.S. Environmental Protection Agency ([EPA], 1993). The eastern cottontail is unique to the genus because of the large variety of habitats that it occupies, including glades and woodlands, deserts, swamps, prairies, hardwood forests, rain forests, and boreal forests (EPA, 1993). Open grassy areas are generally are used for grazing at night, whereas dense, heavy cover typically is used for shelter during the day (EPA, 1993). During the summer seasons these rabbits consume herbaceous plants (e.g. grasses, clover, timothy, and alfalfa), whereas winter diet typically consists of woody vines, shrubs and trees (e.g.. birch, maple, and apple) (EPA, 1993). Home range is 3 to 20 acres, with larger ranges in the summer and smaller ranges in the winter (Burt and Grossenheider, 1980). Populations fluctuate from 1 to 4 cottontail per four acres to several per acre in winter conditions (Burt and Grossenheider, 1980). The eastern cottontail breeds from February through September and usually produces 3 to 4 litters per year of 1 to 9 young (usually 4 to 5); however, this rabbit's' death rate vies with its birth rate, and few rabbits live for more than one year (Whitaker, 1995). The average longevity is 1.25 years (EPA, 1993).

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Deer Mouse (Peromyscus maniculatus). This medium-sized mouse is found in the eastern United States from the Hudson Bay to Pennsylvania, the southern Appalachians, central Arkansas, and central Texas. In the west it is found from Mexico to the south Yukon and north-

west territories (Whitaker, 1995). Deer mice habitat includes nearly every dry land habitat within its range, including forest, grasslands, or a mixture of the two (Burt and Grossenheider, 1980). Nocturnal and active year-round, these mice construct nests in the ground, trees, stumps, and buildings (Burt and Grossenheider, 1980). Omnivorous, the deer mouse feeds on nuts and seeds (e.g., jewel weed and black cherry pits), fruits, beetles, caterpillars, and other insects. Deer mice may cache their food during the fall and winter in the more northern parts of their range (EPA, 1993). Home range is 0.15 to 3 acres (Burt and Grossenheider, 1980; EPA, 1993). Density of populations is 4 to 12 mice per acre, and average life span is 2 years in the wild (Burt and Grossenheider, 1980). The breeding season is from February to November, depending on latitude. Three to five young are born in each of two to four litters per year (Burt and Grossenheider, 1980). They are greyish to reddish-brown with a white belly, with a distinctly short-haired, bicolor tail (Whitaker, 1995). Weight range is 14.8 (EPA, 1993) to 33 grams (Whitaker, 1995).

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Mallard Duck (Anas platyrhynchos). The mallard duck is widespread throughout most of the United States and is the most abundant of the United States ducks. It is large, migratory duck with an average body size of 58 centimeters from bill to tail tip. Wintering mallards prefer the natural bottom-land wetlands and rivers where water depths are 20 to 40 centimeters. The primary habitat requirement for nesting is thought to be dense grassy vegetation. Nests are generally located within a few kilometers of water (EPA, 1993).

In winter, mallards feed primarily on seeds, invertebrates, agricultural grains and, to a limited extent, leaves, stems, buds, rootlets, and tubers. In spring, females shift mostly to a diet of invertebrates to support molting and egg laying activities. Ducklings also feed mainly on

invertebrates to help support their rapid growth rates. Mallards are serially monogamous and remate annually. Each pair of mallards establishes a territory and the drake defends it against other mallards. Average home range size varies, depending upon the type of habitat available. High rates of nest failure require the females to renest persistently, with average clutch size decreasing as the breeding season progresses. Annual adult mortality rates vary with year, depending on location, hunting pressure, age, and sex. Females suffer greater natural mortality rates than do males (EPA, 1993).

The typical home range of the mallard is from 540 to 620 hectares (ha) for adult female and male birds, respectively, for wetlands and river habitat in Minnesota (USEPA, 1993). For the current ERA, an average home range of 580 ha was used. The typical migration schedule is from mid-March through mid-May for the spring migration. The fall migration typically starts in mid-October, and peaks in November (USEPA, 1993).

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Red-Tailed Hawk (Buteo jamacensis). This carnivorous hawk is one of the most common and widespread members of the genus *Buteo* in the continental United States and Canada (Brown and Amadon, 1968). Red-tailed hawks live in a variety of habitats, such as farmlands, woodlands, mountains, and deserts, as long as there is open country interdispersed with woods, bluffs, or streamside trees. They are primarily carnivorous, feeding on (greater than 85 percent) small rodents, as well as fish. Other prey items include amphibians, reptiles, crayfish, and other birds (Adamcik, et al., 1979; Ehrlich, et al., 1988). Home range has been reported as approximately 66.8 acres, with a population density of 0.16 pairs per acre (Janes, 1984), although EPA (1993) reports an average territory size of 842 hectares (2,080 acres). Breeding population density is one nest per 0.009 acre or one individual per 0.004 acre. Body weight for male red-tails is 1,028.6 to 1,142.9 grams, and for females 1,371.4 to 1,600 grams (Brown and Amadon, 1968), although EPA (1993) reports an average body weight of 957 grams. They typically mate for life or until one of the pair dies, with pairs clinging to territories year after year (Austing, 1964).

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Raccoon (Procyon lotor). Raccoons are native only in the Americas. Their range extends from the southern edge of the southern provinces of Canada and most of the United States, except for portions of the Rocky Mountain states, central Nevada, and Utah (Whitaker, 1995). The raccoon weighs from 3 to 15 kilograms (Merritt, 1987; EPA, 1993) and has a head and body length of 46 to 71 centimeters and a tail length of 20 to 30 centimeters (Burt and Grossenheider, 1980). The raccoon is nocturnal and solitary, except when breeding or caring for its young. During particularly cold spells, the raccoon may sleep for several days at a time but does not hibernate (Whitaker, 1995). The raccoon is found along lakes near wooded areas or rock cliffs (Burt and Grossenheider, 1980), but prefers wooded streams (Whitaker, 1995). The raccoon is highly omnivorous and is an opportunistic feeder, consuming virtually any animal or plant matter that is available (Merritt, 1987; EPA, 1993). Animal matter predominates the diet during the spring and early summer; plant matter predominates during late summer, autumn, and winter (Merritt, 1987; EPA, 1993). The home range of the raccoon extends up to 3.2 kilometers across, but usually it is less than 1.6 kilometers. Population densities range from one per acre (highest) to one per 15 acres (considered high) (Burt and Grossenheider, 1980). Captive raccoons live for approximately 14 years (Burt and Grossenheider, 1980). Average body weight is 5.1 kilograms (EPA, 1993).

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U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook, Volume I of II***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc., New York.

Short-tailed Shrew (Blarina brevicauda). This shrew is the largest found in North America. It is solid grey above and below, with a short tail, and weighs between 15 and 29 grams (Whitaker, 1995). Total length of this shrew is 76 to 102 millimeters (Burt and Grossenheider, 1980). The range of this shrew extends from southeastern Canada and the northeastern U.S. to Nebraska, Missouri, Kentucky, and in the mountains to Alabama (Whitaker, 1995). Preferable habitat for the shrew includes forests, grasslands, marshes, and brushy areas. It will make a nest of dry leaves, grass, and hair beneath logs, stumps, rocks, or debris (Burt and Grossenheider, 1980). This underground tunneler may burrow as deep as 6 feet, and has a voracious appetite, eating one half of its own body weight per day of earthworms, other terrestrial vertebrates, and sometimes young mice (Whitaker, 1995). Mean population densities range from 5.7 in the winter, to 28 per acre in the summer (EPA, 1993). Their home range varies from 0.5 to 1 acre (Burt and Grossenheider, 1980). Longevity is typically around 20 months (EPA, 1993), with five to eight young born to each of two to three litters (Burt and Grossenheider, 1980).

References:

Burt, W. H. and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc., New York.

White-tailed Deer (Odocoileus virginianus). The white-tailed deer is a member of the Family Cervidae. They are large, even-toed, hoofed mammals with long legs. Their coat is predominantly light brown or chestnut colored, with the underparts being white. Deer are primarily herbivorous grazers and browsers, constantly moving from one food source to the next. The deer's diet changes seasonally. When available, farm crops such as winter wheat, corn, alfalfa, soy beans, and hay are important components of the species diet. Other top food items include wild crab apples, sumac, grasses, green briar, clover, jewelweed, acorns, and dogwood. In regions where the climate varies from season to season, deer may make annual migrations of 10 to 20 miles in the search for food. However, in Ohio, deer typically have rather small home ranges (2 to 3 square miles) and are reluctant to leave this range. The average weight for the species is 88 kilograms for males and 61 kilograms for females. Breeding season ranges from November through February, with the young offspring born in May and early June. Virtually all yearling and adult does conceive each year, and in Ohio usually carry twins. Triplets and quadruplets have also been recorded Gottschang (1981).

References:

Gottschang, J. L., 1981, ***A Guide to the Mammals of Ohio***, The Ohio State University Press, pp. 143-149.

Marsh Wren (Cistothorus palustris). The marsh wren is a small bird (4 to 4.5 inches in length) which inhabits freshwater cattail marshes and salt marshes. Nesting pairs are not likely to occupy other habitats and the species avoids the wet meadow and sedge meadow habitats preferred by sedge wrens. Marsh wrens breed throughout most of the northern half of the United States and in coastal areas as far south as Florida. The species eats mostly insects, and occasionally snails and other invertebrates. The average body weight is 0.01 kilograms, and the average home range for the species is 0.054 hectares. Because the species is polygamous, there may be more females than males inhabiting a breeding marsh. Densities as high as 120 birds per hectare have been recorded (EPA, 1993). Marsh wrens' nests are globular structures placed at heights of 2 to 5 feet in dense vegetation. The males commonly build dummy nests in addition to the one where the eggs will be laid (Peterjohn and Rice, 1991).

References:

U.S. Environmental Protection Agency (EPA), Office of Research and Development, 1993, ***Wildlife Exposure Factors Handbook***, EPA/600/R-93/187a.

Peterjohn, B. G., and Rice, D. L., 1991, ***The Ohio Breeding Bird Atlas***, The Ohio Department of Natural Resources.

APPENDIX F

GLOSSARY OF TERMS (ECOLOGICAL)

Appendix F

Glossary of Terms

Bioconcentration. For aquatic organisms, bioconcentration is the uptake and retention of a substance by an aquatic organism from the surrounding water through gill membranes or other external body surfaces. Terrestrial bioconcentration focuses on uptake and retention of contaminants from the surrounding medium on the organism level (as by the earthworm, for example).

Bioaccumulation. This refers to the uptake and retention of a substance by an aquatic organism from its surrounding medium and food. Terrestrial bioaccumulation, as with aquatic bioaccumulation, is defined as an organism's uptake and retention of a substance from its surrounding medium and food.

Biomagnification. This refers to the process by which tissue concentrations of bioaccumulated toxic substances increase as the substances pass up through two or more trophic levels. The definition of this term is similar for both terrestrial and aquatic organisms.

APPENDIX G

ECOLOGICAL RISK CHARACTERIZATION SPREADSHEETS

Table G-1

Plum Brook Ordnance Works
TNT Area A

Chemical Data

(Page 1 of 9)

Chemical Name	Surface Soil Conc. (mg/kg)	Total Soil Conc. (mg/kg)	Water Conc. (mg/L)	log Kow (organics)	Soil-to-Plant TF	Shallow-rooted Plant Conc. (mg/kgdw)	Deep-rooted Plant Conc. (mg/kgdw)	Soil-to-Invert. BAF	Invert. Conc. (mg/kgdw)	Food-to-Muscle TF
Organics										
Aroclor-1260	2.48E+00	1.32E-01		7.15E+00	2.87E-03	7.11E-03	3.79E-04	2.73E+01	6.76E+01	4.44E-01
Carbon disulfide			1.13E-02	1.84E+00	3.35E+00	0.00E+00	0.00E+00	NA	0.00E+00	1.46E-06
Di-n-butyl phthalate			1.74E-03	5.56E+00	2.37E-02	0.00E+00	0.00E+00	NA	0.00E+00	1.02E-02
2-Amino-4,6-DNT	9.23E+00	7.57E-01	1.96E-03	2.00E+00	2.70E+00	2.50E+01	2.05E+00	1.00E-01	9.23E-01	2.14E-06
4-Amino-2,6-DNT	5.98E+00	1.29E+00	2.34E-03	2.00E+00	2.70E+00	1.62E+01	3.49E+00	1.00E-01	5.98E-01	2.14E-06
2,4-DNT		3.43E-01		1.98E+00	2.79E+00	0.00E+00	9.55E-01	1.00E-01	0.00E+00	2.03E-06
2,6-DNT		4.34E-01		2.28E+00	1.87E+00	0.00E+00	8.10E-01	1.00E-01	0.00E+00	4.16E-06
Dinitrotoluene	6.97E+00			2.28E+00	1.87E+00	1.30E+01	0.00E+00	1.00E-01	6.97E-01	4.16E-06
2-Nitrotoluene	3.74E-01	2.00E-01		2.30E+00	1.81E+00	6.77E-01	3.62E-01	1.00E-01	3.74E-02	4.38E-06
3-Nitrotoluene		2.00E-01		2.45E+00	1.49E+00	0.00E+00	2.97E-01	1.00E-01	0.00E+00	6.25E-06
4-Nitrotoluene		2.00E-01		2.42E+00	1.55E+00	0.00E+00	3.09E-01	1.00E-01	0.00E+00	5.82E-06
2,4,6-TNT	1.52E+02	5.30E+02		2.00E+00	2.70E+00	4.11E+02	1.43E+03	1.00E-01	1.52E+01	2.14E-06
Inorganics										
Aluminum			2.88E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.50E-03
Barium			4.15E-02	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	2.00E-04
Cadmium			7.80E-04	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	4.00E-04
Calcium	1.25E+05	4.00E+04	1.43E+02	---	1.90E+00	2.38E+05	7.60E+04	1.00E+00	1.25E+05	2.00E-03
Chromium		1.35E+01		---	1.00E-03	0.00E+00	1.35E-02	7.00E-02	0.00E+00	9.00E-03
Cobalt			4.23E-03	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.00E-04
Copper	7.08E+01	2.39E+01	6.02E-03	---	8.00E-01	5.66E+01	1.91E+01	2.50E-01	1.77E+01	9.00E-03
Iron			9.85E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	2.00E-02
Lead	5.64E+02	6.24E+02	3.90E-03	---	1.10E-03	6.20E-01	6.86E-01	9.30E-01	5.25E+02	4.00E-04
Magnesium		4.96E+03	3.48E+01	---	7.80E-01	0.00E+00	3.87E+03	1.00E+00	0.00E+00	2.00E-02
Manganese			1.03E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	5.00E-04
Mercury	6.96E-02	3.36E-02		---	5.50E-01	3.83E-02	1.85E-02	1.00E+00	6.96E-02	2.50E-01
Potassium			3.83E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.00E-02
Selenium			2.63E-03	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.50E-02
Silver			9.41E-04	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	3.00E-03
Sodium	2.61E+02	2.32E+02	3.04E+01	---	6.50E-02	1.70E+01	1.51E+01	1.00E+00	2.61E+02	8.00E-02
Zinc	6.42E+02	1.71E+02	5.92E-02	---	4.30E-01	2.76E+02	7.35E+01	3.00E-01	1.93E+02	1.00E-01

Table G-1

Plum Brook Ordnance Works
TNT Area A

Toxicity Data

Chemical Name	Mammals			Birds		
	NOAEL (mg/kg/d)	Test Species	Body Wt. (kg)	NOAEL (mg/kg/d)	Test Species	Body Wt. (kg)
Organics						
Aroclor-1260	6.80E-02	mouse	0.014	1.80E-01	ring-neck pheasant	1
Carbon disulfide	3.19E+01	rat	0.35	--	--	--
Di-n-butyl phthalate	5.50E+02	mouse	0.03	1.10E-01	ringed dove	0.155
2-Amino-4,6-DNT	1.39E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
4-Amino-2,6-DNT	9.59E+00	rat	0.35	7.00E-01	Bobwhite quail	0.19
2,4-DNT	2.00E-01	beagle dog	11	7.00E-01	Bobwhite quail	0.19
2,6-DNT	2.00E-01	beagle dog	11	7.00E-01	Bobwhite quail	0.19
Dinitrotoluene	2.00E-01	beagle dog	11	7.00E-01	Bobwhite quail	0.19
2-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
3-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
4-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
2,4,6-TNT	1.60E+00	rat	0.35	7.00E-01	Bobwhite quail	0.19
Inorganics						
Aluminum	1.93E+00	mouse	0.03	1.10E+02	ringed dove	0.155
Barium	5.10E+00	rat	0.435	2.08E+01	chicks	0.121
Cadmium	1.00E+00	rat	0.303	1.45E+00	mallard duck	1.153
Calcium	1.05E+03	rabbit	3.8	2.83E+03	Jap. quail	0.072
Chromium	3.28E+00	rat	0.35	1.00E+00	black duck	1.25
Cobalt	1.20E+00	rat	0.35	--	--	--
Copper	1.17E+01	mink	1	4.70E+01	chicks	0.534
Iron	2.60E+01	rabbit	3.8	5.00E+01	poultry	1.6
Lead	8.00E+00	rat	0.35	3.85E+00	Am. Kestrel	0.13
Magnesium	1.58E+02	rabbit	3.8	1.50E+02	poultry	1.6
Manganese	8.80E+01	rat	0.35	9.77E+02	Jap. Quail	0.072
Mercury	1.00E+00	mink	1	4.50E-01	Jap. Quail	0.15
Potassium	1.60E+03	rabbit	3.8	1.00E+03	poultry	1.6
Selenium	2.00E-01	rat	0.35	5.00E-01	mallard duck	1
Silver	--	--	--	--	--	--
Sodium	1.60E+03	rabbit	3.8	1.00E+03	poultry	1.6
Zinc	1.60E+02	rat	0.35	1.45E+01	hens	1.935

Table G-1

Plum Brook Ordnance Works
TNT Area A

Omnivorous Rodent: **Deer mouse *(Peromyscus manicalatus)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Plant/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics																
Aroclor-1260	6.71E-02	8.00E+00	8.38E-03	1.00E+00	1.00E+00	9.55E-03	1.14E+00	8.21E-04	9.79E-02	4.99E+00	5.95E+02	5.96E+02	0.00E+00	0.00E+00	5.96E+02	2.60E+01
Carbon disulfide	7.03E+01	8.00E+00	8.79E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.68E-03	1.91E-04	1.91E-04	2.88E-08
Di-n-butyl phthalate	6.56E+02	8.00E+00	8.20E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-04	3.15E-06	3.15E-06	3.09E-05
2-Amino-4,6-DNT	3.07E+01	8.00E+00	3.84E+00	1.00E+00	1.00E+00	3.55E-02	9.25E-03	2.88E+00	7.50E-01	6.81E-02	1.77E-02	7.77E-01	2.91E-04	7.58E-05	7.77E-01	7.49E-05
4-Amino-2,6-DNT	2.11E+01	8.00E+00	2.64E+00	1.00E+00	1.00E+00	2.30E-02	8.71E-03	1.87E+00	7.06E-01	4.41E-02	1.67E-02	7.31E-01	3.48E-04	1.32E-04	7.31E-01	4.85E-05
2,4-DNT	1.04E+00	8.00E+00	1.31E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	1.04E+00	8.00E+00	1.31E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dinitrotoluene	1.04E+00	8.00E+00	1.31E-01	1.00E+00	1.00E+00	2.68E-02	2.06E-01	1.50E+00	1.15E+01	5.14E-02	3.94E-01	1.21E+01	0.00E+00	0.00E+00	1.21E+01	7.69E-05
2-Nitrotoluene	9.92E+01	8.00E+00	1.24E+01	1.00E+00	1.00E+00	1.44E-03	1.16E-04	7.82E-02	6.30E-03	2.76E-03	2.22E-04	6.64E-03	0.00E+00	0.00E+00	6.64E-03	4.23E-06
3-Nitrotoluene	9.92E+01	8.00E+00	1.24E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Nitrotoluene	9.92E+01	8.00E+00	1.24E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	3.53E+00	8.00E+00	4.41E-01	1.00E+00	1.00E+00	5.85E-01	1.33E+00	4.74E+01	1.08E+02	1.12E+00	2.54E+00	1.11E+02	0.00E+00	0.00E+00	1.11E+02	1.23E-03
Inorganics																
Aluminum	2.30E+00	8.00E+00	2.88E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.28E-01	1.49E+00	1.49E+00	7.52E-03
Barium	1.19E+01	8.00E+00	1.48E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-03	4.16E-03	4.16E-03	1.44E-05
Cadmium	2.13E+00	8.00E+00	2.66E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-04	4.36E-04	4.36E-04	5.43E-07
Calcium	4.22E+03	8.00E+00	5.27E+02	1.00E+00	1.00E+00	4.81E+02	9.14E-01	2.74E+04	5.20E+01	9.22E+03	1.75E+01	7.04E+01	2.13E+01	4.03E-02	7.05E+01	8.70E+02
Chromium	7.23E+00	8.00E+00	9.04E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	2.65E+00	8.00E+00	3.31E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-04	1.90E-03	1.90E-03	7.36E-07
Copper	3.35E+01	8.00E+00	4.19E+00	1.00E+00	1.00E+00	2.73E-01	6.50E-02	6.54E+00	1.56E+00	1.31E+00	3.11E-01	1.94E+00	8.95E-04	2.13E-04	1.94E+00	8.55E-01
Iron	1.04E+02	8.00E+00	1.30E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E+00	1.13E-01	1.13E-01	3.43E-01
Lead	1.76E+01	8.00E+00	2.21E+00	1.00E+00	1.00E+00	2.17E+00	9.85E-01	7.16E-02	3.25E-02	3.87E+01	1.75E+01	1.86E+01	5.80E-04	2.63E-04	1.86E+01	1.92E-01
Magnesium	6.32E+02	8.00E+00	7.91E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.17E+00	6.54E-02	6.54E-02	1.21E+00
Manganese	1.94E+02	8.00E+00	2.43E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.53E-01	6.31E-03	6.31E-03	8.97E-04
Mercury	2.87E+00	8.00E+00	3.58E-01	1.00E+00	1.00E+00	2.68E-04	7.48E-04	4.42E-03	1.23E-02	5.14E-03	1.43E-02	2.74E-02	0.00E+00	0.00E+00	2.74E-02	2.88E-02
Potassium	6.39E+03	8.00E+00	7.99E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.69E-01	7.12E-04	7.12E-04	6.67E-02
Selenium	4.41E-01	8.00E+00	5.51E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.91E-04	7.09E-03	7.09E-03	6.87E-05
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	NA	0.00E+00	NA	0.00E+00	NA	NA	1.40E-04	NA	NA	4.91E-06
Sodium	6.39E+03	8.00E+00	7.99E+02	1.00E+00	1.00E+00	1.01E+00	1.26E-03	1.96E+00	2.45E-03	1.93E+01	2.41E-02	2.78E-02	4.52E+00	5.66E-03	3.35E-02	2.51E+01
Zinc	3.53E+02	8.00E+00	4.41E+01	1.00E+00	1.00E+00	2.47E+00	5.61E-02	3.19E+01	7.22E-01	1.42E+01	3.22E-01	1.10E+00	8.80E-03	2.00E-04	1.10E+00	5.69E+01
TOTAL							**4.66E+00**		**1.74E+02**		**6.33E+02**	**8.12E+02**		**1.73E+00**	**8.14E+02**	

Body Weight (kg)	0.0148
Water intake (L/d)	0.0022
Food intake (kg(dw)/d)	0.0028
Soil intake (kg/d)	0.000057
Plant intake (kg(dw)/d) -- 61% of diet	0.001708
Invertebrate intake (kg(dw)/d) -- 39% of diet	0.001092

Table G-1

Plum Brook Ordnance Works
TNT Area A

Opportunistic Omnivore: **Raccoon *(Procyon lotor)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Mouse Intake (mg/kg-d)	Mouse Intake Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics																	
Aroclor-1260	1.56E-02	8.00E+00	1.95E-03	1.00E+00	1.00E+00	5.84E-03	3.00E+00	1.52E-04	7.83E-02	1.03E+00	5.31E+02	6.62E-02	3.40E+01	5.68E+02	0.00E+00	0.00E+00	5.68E+02
Carbon disulfide	1.63E+01	8.00E+00	2.04E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.35E-11	3.60E-11	3.60E-11	4.76E-04	2.34E-04	2.34E-04
Di-n-butyl phthalate	1.52E+02	8.00E+00	1.90E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-08	4.14E-09	4.14E-09	7.34E-05	3.85E-06	3.86E-06
2-Amino-4,6-DNT	7.13E+00	8.00E+00	8.92E-01	1.00E+00	1.00E+00	2.17E-02	2.44E-02	5.34E-01	5.99E-01	1.41E-02	1.58E-02	1.91E-07	2.14E-07	6.39E-01	8.26E-05	9.26E-05	6.39E-01
4-Amino-2,6-DNT	4.91E+00	8.00E+00	6.14E-01	1.00E+00	1.00E+00	1.41E-02	2.29E-02	3.46E-01	5.64E-01	9.15E-03	1.49E-02	1.24E-07	2.02E-07	6.02E-01	9.86E-05	1.61E-04	6.02E-01
2,4-DNT	2.42E-01	8.00E+00	3.03E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	2.42E-01	8.00E+00	3.03E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dinitrotoluene	2.42E-01	8.00E+00	3.03E-02	1.00E+00	1.00E+00	1.64E-02	5.41E-01	2.78E-01	9.19E+00	1.07E-02	3.52E-01	1.96E-07	6.47E-06	1.01E+01	0.00E+00	0.00E+00	1.01E+01
2-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	1.00E+00	1.00E+00	8.80E-04	3.06E-04	1.45E-02	5.04E-03	5.72E-04	1.99E-04	1.08E-08	3.75E-09	5.54E-03	0.00E+00	0.00E+00	5.54E-03
3-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	8.19E-01	8.00E+00	1.02E-01	1.00E+00	1.00E+00	3.58E-01	3.49E+00	8.80E+00	8.60E+01	2.32E-01	2.27E+00	3.14E-06	3.07E-05	9.17E+01	0.00E+00	0.00E+00	9.17E+01
Inorganics																	
Aluminum	5.34E-01	8.00E+00	6.68E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.92E-05	2.87E-04	2.87E-04	1.21E-01	1.82E+00	1.82E+00
Barium	2.76E+00	8.00E+00	3.45E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E-08	1.07E-07	1.07E-07	1.75E-03	5.08E-03	5.08E-03
Cadmium	4.94E-01	8.00E+00	6.17E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-09	2.24E-08	2.24E-08	3.29E-05	5.33E-04	5.33E-04
Calcium	9.78E+02	8.00E+00	1.22E+02	1.00E+00	1.00E+00	2.94E+02	2.41E+00	5.09E+03	4.16E+01	1.91E+03	1.56E+01	2.22E+00	1.81E-02	5.96E+01	6.03E+00	4.93E-02	5.97E+01
Chromium	1.68E+00	8.00E+00	2.10E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	6.14E-01	8.00E+00	7.68E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-09	2.45E-08	2.45E-08	1.78E-04	2.32E-03	2.32E-03
Copper	7.79E+00	8.00E+00	9.73E-01	1.00E+00	1.00E+00	1.67E-01	1.71E-01	1.21E+00	1.25E+00	2.71E-01	2.78E-01	2.18E-03	2.24E-03	1.70E+00	2.54E-04	2.61E-04	1.70E+00
Iron	2.42E+01	8.00E+00	3.02E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.74E-04	2.90E-04	2.90E-04	4.15E-01	1.38E-01	1.38E-01
Lead	4.09E+00	8.00E+00	5.12E-01	1.00E+00	1.00E+00	1.33E+00	2.59E+00	1.33E-02	2.60E-02	8.02E+00	1.57E+01	4.89E-04	9.55E-04	1.83E+01	1.64E-04	3.21E-04	1.83E+01
Magnesium	1.47E+02	8.00E+00	1.83E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.09E-03	1.68E-04	1.68E-04	1.47E+00	8.00E-02	8.01E-02
Manganese	4.50E+01	8.00E+00	5.63E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.29E-06	4.06E-07	4.06E-07	4.34E-02	7.71E-03	7.71E-03
Mercury	6.65E-01	8.00E+00	8.32E-02	1.00E+00	1.00E+00	1.64E-04	1.97E-03	8.20E-04	9.85E-03	1.06E-03	1.28E-02	7.33E-05	8.81E-04	2.55E-02	0.00E+00	0.00E+00	2.55E-02
Potassium	1.48E+03	8.00E+00	1.85E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.70E-04	9.16E-07	9.16E-07	1.61E-01	8.71E-04	8.71E-04
Selenium	1.02E-01	8.00E+00	1.28E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-07	1.37E-05	1.37E-05	1.11E-04	8.66E-03	8.68E-03
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	NA	0.00E+00	NA	0.00E+00	NA	1.25E-08	NA	NA	3.97E-05	0.00E+00	NA
Sodium	1.48E+03	8.00E+00	1.85E+02	1.00E+00	1.00E+00	6.14E-01	3.31E-03	3.63E-01	1.96E-03	3.99E+00	2.15E-02	6.39E-02	3.44E-04	2.71E-02	1.28E+00	6.91E-03	3.40E-02
Zinc	8.19E+01	8.00E+00	1.02E+01	1.00E+00	1.00E+00	1.51E+00	1.48E-01	5.91E+00	5.77E-01	2.95E+00	2.88E-01	1.45E-01	1.42E-02	1.03E+00	2.50E-03	2.44E-04	1.03E+00
TOTAL							**1.23E+01**		**1.39E+02**		**5.66E+02**		**3.40E+01**	**7.51E+02**		**2.12E+00**	**7.53E+02**

Body Weight (kg)	5.1
Water intake (L/d)	0.215
Food intake (kg(dw)/d)	0.26
Soil intake (kg/d)	0.012
Mouse Intake (kg(dw)/d) -- 5 % of diet	0.013
Plant intake (kg(dw)/d) -- 42% of diet	0.1092
Invertebrate intake (kg(dw)/d) -- 30% of diet	0.078

Table G-1

Plum Brook Ordnance Works
TNT Area A

Herbivorous Rodent: **Eastern Cottontail *(Sylvilagus floridanus)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Hazard Quotient	Soil/Plant Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	4.06E-02	8.00E+00	5.08E-03	1.00E+00	1.00E+00	1.31E-02	2.59E+00	6.03E-04	1.19E-01	2.71E+00	0.00E+00	0.00E+00	2.71E+00	2.11E-01
Carbon disulfide	4.26E+01	8.00E+00	5.32E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-03	2.06E-04	2.06E-04	5.58E-08
Di-n-butyl phthalate	3.97E+02	8.00E+00	4.97E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.69E-04	3.40E-06	3.40E-06	5.98E-05
2-Amino-4,6-DNT	1.86E+01	8.00E+00	2.33E+00	1.00E+00	1.00E+00	4.89E-02	2.10E-02	2.12E+00	9.09E-01	9.30E-01	1.90E-04	8.18E-05	9.31E-01	1.61E-04
4-Amino-2,6-DNT	1.28E+01	8.00E+00	1.60E+00	1.00E+00	1.00E+00	3.17E-02	1.98E-02	1.37E+00	8.57E-01	8.76E-01	2.27E-04	1.42E-04	8.76E-01	1.04E-04
2,4-DNT	6.32E-01	8.00E+00	7.91E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	6.32E-01	8.00E+00	7.91E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dinitrotoluene	6.32E-01	8.00E+00	7.91E-02	1.00E+00	1.00E+00	3.69E-02	4.67E-01	1.10E+00	1.40E+01	1.44E+01	0.00E+00	0.00E+00	1.44E+01	1.64E-04
2-Nitrotoluene	6.01E+01	8.00E+00	7.51E+00	1.00E+00	1.00E+00	1.98E-03	2.64E-04	5.75E-02	7.65E-03	7.91E-03	0.00E+00	0.00E+00	7.91E-03	9.04E-06
3-Nitrotoluene	6.01E+01	8.00E+00	7.51E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Nitrotoluene	6.01E+01	8.00E+00	7.51E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	2.14E+00	8.00E+00	2.67E-01	1.00E+00	1.00E+00	8.06E-01	3.02E+00	3.49E+01	1.30E+02	1.34E+02	0.00E+00	0.00E+00	1.34E+02	2.65E-03
Inorganics														
Aluminum	1.39E+00	8.00E+00	1.74E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.80E-01	1.61E+00	1.61E+00	1.46E-02
Barium	7.19E+00	8.00E+00	8.99E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.03E-03	4.49E-03	4.49E-03	2.80E-05
Cadmium	1.29E+00	8.00E+00	1.61E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.58E-05	4.71E-04	4.71E-04	1.05E-06
Calcium	2.55E+03	4.00E+00	6.38E+02	1.00E+00	1.00E+00	6.63E+02	1.04E+00	2.01E+04	3.16E+01	3.26E+01	1.39E+01	2.18E-02	3.26E+01	1.44E+03
Chromium	4.38E+00	8.00E+00	5.48E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	1.60E+00	8.00E+00	2.00E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.11E-04	2.05E-03	2.05E-03	1.43E-06
Copper	2.03E+01	8.00E+00	2.54E+00	1.00E+00	1.00E+00	3.75E-01	1.48E-01	4.80E+00	1.89E+00	2.04E+00	5.85E-04	2.30E-04	2.04E+00	1.62E+00
Iron	6.30E+01	4.00E+00	1.58E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.57E-01	6.07E-02	6.07E-02	6.64E-01
Lead	1.07E+01	8.00E+00	1.34E+00	1.00E+00	1.00E+00	2.99E+00	2.24E+00	5.26E-02	3.94E-02	2.28E+00	3.79E-04	2.84E-04	2.28E+00	4.22E-02
Magnesium	3.83E+02	4.00E+00	9.58E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.38E+00	3.53E-02	3.53E-02	2.35E+00
Manganese	1.18E+02	8.00E+00	1.47E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-01	6.81E-03	6.81E-03	1.74E-03
Mercury	1.74E+00	8.00E+00	2.17E-01	1.00E+00	1.00E+00	3.69E-04	1.70E-03	3.25E-03	1.50E-02	1.67E-02	0.00E+00	0.00E+00	1.67E-02	3.13E-02
Potassium	3.87E+03	4.00E+00	9.68E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.72E-01	3.85E-04	3.85E-04	1.29E-01
Selenium	2.67E-01	8.00E+00	3.34E-02	1.00E+00	1.00E+00	0.00E+00	-0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-04	7.65E-03	7.65E-03	1.33E-04
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	NA	0.00E+00	NA	NA	9.14E-05	0.00E+00	NA	9.51E-06
Sodium	3.87E+03	4.00E+00	9.68E+02	1.00E+00	1.00E+00	1.38E+00	1.43E-03	1.44E+00	1.49E-03	2.92E-03	2.95E+00	3.05E-03	5.97E-03	1.60E+01
Zinc	2.14E+02	8.00E+00	2.67E+01	1.00E+00	1.00E+00	3.40E+00	1.27E-01	2.34E+01	8.76E-01	1.00E+00	5.75E-03	2.15E-04	1.00E+00	9.30E+01
TOTAL							**9.54E+00**		**1.80E+02**	**1.89E+02**		**1.75E+00**	**1.91E+02**	

Body Weight (kg)	1.132
Water intake (L/d)	0.11
Food intake (kg(dw)/d)	0.096
Soil intake (kg/d)	0.006
Plant intake (kg(dw)/d) -- 100% of diet	0.096

Table G-1

Plum Brook Ordnance Works
TNT Area A

Insectivorous mammal: **Short-tailed shrew *(Blarina brevicauda)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	1.07E-01	8.00E+00	1.34E-02	1.00E+00	1.00E+00	7.30E-03	5.47E-01	9.91E+00	7.42E+02	7.43E+02	0.00E+00	0.00E+00	7.43E+02	6.81E+01
Carbon disulfide	1.12E+02	8.00E+00	1.40E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.73E-03	1.24E-04	1.24E-04	3.93E-08
Di-n-butyl phthalate	1.05E+03	8.00E+00	1.31E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.67E-04	2.04E-06	2.04E-06	4.21E-05
2-Amino-4,6-DNT	4.90E+01	8.00E+00	6.12E+00	1.00E+00	1.00E+00	4.19E-02	6.84E-03	1.35E-01	2.21E-02	2.90E-02	3.01E-04	4.91E-05	2.90E-02	5.89E-06
4-Amino-2,6-DNT	3.37E+01	8.00E+00	4.21E+00	1.00E+00	1.00E+00	7.14E-02	1.70E-02	8.77E-02	2.08E-02	3.78E-02	3.59E-04	8.52E-05	3.79E-02	5.29E-06
2,4-DNT	1.66E+00	8.00E+00	2.08E-01	1.00E+00	1.00E+00	1.90E-02	9.13E-02	0.00E+00	0.00E+00	9.13E-02	0.00E+00	0.00E+00	9.13E-02	5.97E-07
2,6-DNT	1.66E+00	8.00E+00	2.08E-01	1.00E+00	1.00E+00	2.40E-02	1.16E-01	0.00E+00	0.00E+00	1.16E-01	0.00E+00	0.00E+00	1.16E-01	1.54E-06
Dinitrotoluene	1.66E+00	8.00E+00	2.08E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	1.02E-01	4.92E-01	4.92E-01	0.00E+00	0.00E+00	4.92E-01	6.58E-06
2-Nitrotoluene	1.58E+02	8.00E+00	1.98E+01	1.00E+00	1.00E+00	1.11E-02	5.60E-04	5.49E-03	2.78E-04	8.38E-04	0.00E+00	0.00E+00	8.38E-04	1.12E-06
3-Nitrotoluene	1.58E+02	8.00E+00	1.98E+01	1.00E+00	1.00E+00	1.11E-02	5.60E-04	0.00E+00	0.00E+00	5.60E-04	0.00E+00	0.00E+00	5.60E-04	1.07E-06
4-Nitrotoluene	1.58E+02	8.00E+00	1.98E+01	1.00E+00	1.00E+00	1.11E-02	5.60E-04	0.00E+00	0.00E+00	5.60E-04	0.00E+00	0.00E+00	5.60E-04	9.96E-07
2,4,6-TNT	5.62E+00	8.00E+00	7.02E-01	1.00E+00	1.00E+00	2.93E+01	4.17E+01	2.23E+00	3.17E+00	4.49E+01	0.00E+00	0.00E+00	4.49E+01	1.05E-03
Inorganics														
Aluminum	3.67E+00	8.00E+00	4.58E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.42E-01	9.63E-01	9.63E-01	1.02E-02
Barium	1.89E+01	8.00E+00	2.36E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.36E-03	2.69E-03	2.69E-03	1.97E-05
Cadmium	3.39E+00	8.00E+00	4.23E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-04	2.82E-04	2.82E-04	7.40E-07
Calcium	6.71E+03	8.00E+00	8.39E+02	1.00E+00	1.00E+00	2.21E+03	2.64E+00	1.83E+04	2.18E+01	2.45E+01	2.19E+01	2.61E-02	2.45E+01	6.36E+02
Chromium	1.15E+01	8.00E+00	1.44E+00	1.00E+00	1.00E+00	7.47E-01	5.19E-01	0.00E+00	0.00E+00	5.19E-01	0.00E+00	0.00E+00	5.19E-01	1.04E-01
Cobalt	4.21E+00	8.00E+00	5.27E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.49E-04	1.23E-03	1.23E-03	1.00E-06
Copper	5.34E+01	8.00E+00	6.68E+00	1.00E+00	1.00E+00	1.32E+00	1.98E-01	2.60E+00	3.89E-01	5.87E-01	9.23E-04	1.38E-04	5.87E-01	5.46E-01
Iron	1.66E+02	8.00E+00	2.07E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E+00	7.29E-02	7.29E-02	4.67E-01
Lead	2.81E+01	8.00E+00	3.51E+00	1.00E+00	1.00E+00	3.45E+01	9.83E+00	7.69E+01	2.19E+01	3.17E+01	5.98E-04	1.70E-04	3.17E+01	6.90E-01
Magnesium	1.01E+03	8.00E+00	1.26E+02	1.00E+00	1.00E+00	2.74E+02	2.18E+00	0.00E+00	0.00E+00	2.18E+00	5.34E+00	4.24E-02	2.22E+00	8.66E+01
Manganese	3.09E+02	8.00E+00	3.86E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-01	4.09E-03	4.09E-03	1.22E-03
Mercury	4.57E+00	8.00E+00	5.71E-01	1.00E+00	1.00E+00	1.86E-03	3.26E-03	1.02E-02	1.79E-02	2.11E-02	0.00E+00	0.00E+00	2.11E-02	4.67E-02
Potassium	1.02E+04	8.00E+00	1.27E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.87E-01	4.61E-04	4.61E-04	9.09E-02
Selenium	7.02E-01	8.00E+00	8.78E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.03E-04	4.59E-03	4.59E-03	9.36E-05
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	NA	0.00E+00	NA	NA	1.44E-04	0.00E+00	NA	6.70E-06
Sodium	1.02E+04	8.00E+00	1.27E+03	1.00E+00	1.00E+00	1.28E+01	1.01E-02	3.83E+01	3.01E-02	4.02E-02	4.66E+00	3.66E-03	4.38E-02	6.90E+01
Zinc	5.62E+02	8.00E+00	7.02E+01	1.00E+00	1.00E+00	9.46E+00	1.35E-01	2.82E+01	4.02E-01	5.37E-01	9.08E-03	1.29E-04	5.37E-01	5.84E+01
TOTAL							**5.79E+01**		**7.90E+02**	**8.48E+02**		**1.12E+00**	**8.49E+02**	

Body Weight (kg)	0.015
Water intake (L/d)	0.0023
Food intake (kg(dw)/d)	0.0022
Soil intake (kg/d)	0.00083
Invertebrate intake (kg(dw)/d)--100% of diet	0.0022

Table G-1

Plum Brook Ordnance Works
TNT Area A

Herbivorous Mammal: **White-tailed deer *(Odocoileus virginianus)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Soil/Plant Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics													
Aroclor-1260	1.65E-02	8.00E+00	2.07E-03	9.00E-02	9.00E-02	1.46E-04	7.08E-02	1.12E-06	5.40E-04	7.13E-02	0.00E+00	0.00E+00	7.13E-02
Carbon disulfide	1.73E+01	8.00E+00	2.17E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.07E-03	1.88E-03	1.88E-03
Di-n-butyl phthalate	1.62E+02	8.00E+00	2.02E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E-04	3.10E-05	3.10E-05
2-Amino-4,6-DNT	7.58E+00	8.00E+00	9.48E-01	9.00E-02	9.00E-02	5.45E-04	5.75E-04	6.04E-03	6.37E-03	6.95E-03	7.06E-04	7.45E-04	7.69E-03
4-Amino-2,6-DNT	5.22E+00	8.00E+00	6.52E-01	9.00E-02	9.00E-02	3.53E-04	5.41E-04	1.03E-02	1.58E-02	1.63E-02	8.42E-04	1.29E-03	1.76E-02
2,4-DNT	2.58E-01	8.00E+00	3.22E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	2.82E-03	8.76E-02	8.76E-02	0.00E+00	0.00E+00	8.76E-02
2,6-DNT	2.58E-01	8.00E+00	3.22E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	2.39E-03	7.42E-02	7.42E-02	0.00E+00	0.00E+00	7.42E-02
Dinitrotoluene	2.58E-01	8.00E+00	3.22E-02	9.00E-02	9.00E-02	4.11E-04	1.28E-02	0.00E+00	0.00E+00	1.28E-02	0.00E+00	0.00E+00	1.28E-02
2-Nitrotoluene	2.45E+01	8.00E+00	3.06E+00	9.00E-02	9.00E-02	2.21E-05	7.21E-06	1.07E-03	3.49E-04	3.57E-04	0.00E+00	0.00E+00	3.57E-04
3-Nitrotoluene	2.45E+01	8.00E+00	3.06E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	8.76E-04	2.86E-04	2.86E-04	0.00E+00	0.00E+00	2.86E-04
4-Nitrotoluene	2.45E+01	8.00E+00	3.06E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	9.13E-04	2.98E-04	2.98E-04	0.00E+00	0.00E+00	2.98E-04
2,4,6-TNT	8.70E-01	8.00E+00	1.09E-01	9.00E-02	9.00E-02	8.97E-03	8.25E-02	4.23E+00	3.89E+01	3.90E+01	0.00E+00	0.00E+00	3.90E+01
Inorganics													
Aluminum	5.68E-01	8.00E+00	7.10E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E+00	1.46E+01	1.46E+01
Barium	2.93E+00	8.00E+00	3.66E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.49E-02	4.08E-02	4.08E-02
Cadmium	5.25E-01	8.00E+00	6.56E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.81E-04	4.28E-03	4.28E-03
Calcium	1.04E+03	8.00E+00	1.30E+02	9.00E-02	9.00E-02	7.38E+00	5.68E-02	2.24E+02	1.73E+00	1.78E+00	5.15E+01	3.96E-01	2.18E+00
Chromium	1.78E+00	8.00E+00	2.23E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	3.98E-05	1.79E-04	1.79E-04	0.00E+00	0.00E+00	1.79E-04
Cobalt	6.53E-01	8.00E+00	8.16E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.52E-03	1.87E-02	1.87E-02
Copper	8.27E+00	8.00E+00	1.03E+00	9.00E-02	9.00E-02	4.18E-03	4.04E-03	5.64E-02	5.46E-02	5.86E-02	2.17E-03	2.10E-03	6.07E-02
Iron	2.57E+01	8.00E+00	3.21E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.55E+00	1.11E+00	1.11E+00
Lead	4.35E+00	8.00E+00	5.44E-01	9.00E-02	9.00E-02	3.33E-02	6.12E-02	2.03E-03	3.72E-03	6.49E-02	1.40E-03	2.58E-03	6.75E-02
Magnesium	1.56E+02	8.00E+00	1.95E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	1.14E+01	5.85E-01	5.85E-01	1.25E+01	6.43E-01	1.23E+00
Manganese	4.79E+01	8.00E+00	5.98E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.71E-01	6.20E-02	6.20E-02
Mercury	7.07E-01	8.00E+00	8.84E-02	9.00E-02	9.00E-02	4.11E-06	4.65E-05	5.45E-05	6.17E-04	6.63E-04	0.00E+00	0.00E+00	6.63E-04
Potassium	1.58E+03	8.00E+00	1.97E+02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E+00	7.00E-03	7.00E-03
Selenium	1.09E-01	8.00E+00	1.36E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.47E-04	6.96E-02	6.96E-02
Silver	0.00E+00	8.00E+00	0.00E+00	9.00E-02	9.00E-02	0.00E+00	NA	0.00E+00	NA	NA	3.39E-04	0.00E+00	NA
Sodium	1.58E+03	8.00E+00	1.97E+02	9.00E-02	9.00E-02	1.54E-02	7.82E-05	4.45E-02	2.26E-04	3.04E-04	1.09E+01	5.55E-02	5.58E-02
Zinc	8.70E+01	8.00E+00	1.09E+01	9.00E-02	9.00E-02	3.79E-02	3.48E-03	2.17E-01	1.99E-02	2.34E-02	2.13E-02	1.96E-03	2.54E-02
TOTAL							**2.89E-01**		**4.14E+01**	**4.17E+01**		**1.70E+01**	**5.87E+01**

Body Weight (kg)	61
Water intake (L/d)	4
Food intake (kg(dw)/d)	2
Soil intake (kg/d)	0.04
Plant intake (kg(dw)/d) -- 100% of diet	2

Table G-1

Plum Brook Ordnance Works
TNT Area A

Insectivorous Bird: **Marsh wren *(Cistothorus palustris)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	1.80E-01	8.00E+00	2.25E-02	1.00E+00	1.00E+00	4.71E-02	2.09E+00	1.96E+01	8.71E+02	8.73E+02	0.00E+00	0.00E+00	8.73E+02	8.81E+01
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.05E-03	0.00E+00	0.00E+00	4.52E-08
Di-n-butyl phthalate	1.10E-01	8.00E+00	1.38E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.70E-04	3.42E-02	3.42E-02	4.84E-05
2-Amino-4,6-DNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	1.75E-01	2.00E+00	2.68E-01	3.06E+00	5.06E+00	5.29E-04	6.05E-03	5.07E+00	9.61E-06
4-Amino-2,6-DNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	1.14E-01	1.30E+00	1.73E-01	1.98E+00	3.28E+00	6.32E-04	7.22E-03	3.29E+00	6.23E-06
2,4-DNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dinitrotoluene	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	1.32E-01	1.51E+00	2.02E-01	2.31E+00	3.82E+00	0.00E+00	0.00E+00	3.82E+00	1.41E-05
2-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	7.11E-03	8.12E-02	1.08E-02	1.24E-01	2.05E-01	0.00E+00	0.00E+00	2.05E-01	7.96E-07
3-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	2.89E+00	3.30E+01	4.41E+00	5.04E+01	8.34E+01	0.00E+00	0.00E+00	8.34E+01	1.58E-04
Inorganics														
Aluminum	1.10E+02	8.00E+00	1.38E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.78E-01	5.66E-02	5.66E-02	1.18E-02
Barium	2.08E+01	8.00E+00	2.60E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-02	4.31E-03	4.31E-03	2.27E-05
Cadmium	1.45E+00	8.00E+00	1.81E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.11E-04	1.16E-03	1.16E-03	8.52E-07
Calcium	2.83E+03	8.00E+00	3.54E+02	1.00E+00	1.00E+00	2.38E+03	6.71E+00	3.63E+04	1.02E+02	1.09E+02	3.86E+01	1.09E-01	1.09E+02	7.82E+02
Chromium	1.00E+00	8.00E+00	1.25E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E-03	0.00E+00	0.00E+00	1.16E-06
Copper	4.70E+01	8.00E+00	5.88E+00	1.00E+00	1.00E+00	1.35E+00	2.29E-01	5.13E+00	8.74E-01	1.10E+00	1.63E-03	2.77E-04	1.10E+00	5.90E-01
Iron	5.00E+01	8.00E+00	6.25E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.66E+00	4.26E-01	4.26E-01	5.38E-01
Lead	3.85E+00	8.00E+00	4.81E-01	1.00E+00	1.00E+00	1.07E+01	2.23E+01	1.52E+02	3.16E+02	3.38E+02	1.05E-03	2.19E-03	3.38E+02	6.59E-01
Magnesium	1.50E+02	8.00E+00	1.88E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.40E+00	5.01E-01	5.01E-01	1.90E+00
Manganese	9.77E+02	8.00E+00	1.22E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E-01	2.28E-03	2.28E-03	1.41E-03
Mercury	4.50E-01	8.00E+00	5.63E-02	1.00E+00	1.00E+00	1.32E-03	2.35E-02	2.02E-02	3.59E-01	3.82E-01	0.00E+00	0.00E+00	3.82E-01	5.44E-02
Potassium	1.00E+03	8.00E+00	1.25E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E+00	8.27E-03	8.27E-03	1.05E-01
Selenium	5.00E-01	8.00E+00	6.25E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.10E-04	1.14E-02	1.14E-02	1.08E-04
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-04	0.00E+00	0.00E+00	7.71E-06
Sodium	1.00E+03	8.00E+00	1.25E+02	1.00E+00	1.00E+00	4.96E+00	3.97E-02	7.57E+01	6.06E-01	6.45E-01	8.21E+00	6.57E-02	7.11E-01	7.19E+01
Zinc	1.45E+01	8.00E+00	1.81E+00	1.00E+00	1.00E+00	1.22E+01	6.73E+00	5.59E+01	3.08E+01	3.75E+01	1.60E-02	8.82E-03	3.76E+01	6.88E+01
TOTAL							**6.93E+01**		**1.35E+03**	**1.42E+03**		**1.24E+00**	**1.42E+03**	

Body Weight (kg)	0.01
Water intake (L/d)	0.0027
Food intake (kg(dw)/d)	0.0029
Soil intake (kg/d)	0.00019
Plant intake (kg(dw)/d) -- 0% of diet	0
Invertebrate intake (kg(dw)/d) -- 100% of diet	0.0029

Table G-1

Plum Brook Ordnance Works
TNT Area A

Avian predator: **Red-tailed hawk (*Buteo jamaicensis*)**

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Bird Intake (mg/kg-d)	Bird Intake Hazard Quotient	Mouse Intake (mg/kg-d)	Mouse Intake Hazard Quotient	Rabbit Intake (mg/kg-d)	Rabbit Intake Hazard Quotient	Shrew Intake (mg/kg-d)	Shrew Intake Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics																			
Aroclor-1260	1.80E-01	8.00E+00	2.25E-02	5.00E-02	5.00E-02	2.59E-04	1.15E-02	6.30E-02	2.80E+00	1.96E-02	8.70E-01	1.60E-04	7.09E-03	5.14E-02	2.28E+00	5.97E+00	0.00E+00	0.00E+00	5.97E+00
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	3.23E-11	0.00E+00	2.17E-11	0.00E+00	4.21E-11	0.00E+00	2.96E-11	0.00E+00	0.00E+00	3.37E-05	0.00E+00	0.00E+00
Di-n-butyl phthalate	1.10E-01	8.00E+00	1.38E-02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	3.46E-08	2.52E-06	2.33E-08	1.69E-06	4.51E-08	3.28E-06	3.18E-08	2.31E-06	9.80E-06	5.18E-06	3.77E-04	3.87E-04
2-Amino-4,6-DNT	7.00E-01	8.00E+00	8.75E-02	5.00E-02	5.00E-02	9.64E-04	1.10E-02	6.87E-09	7.85E-08	5.65E-08	6.46E-07	1.21E-07	1.39E-06	4.44E-09	5.08E-08	1.10E-02	5.84E-06	6.67E-05	1.11E-02
4-Amino-2,6-DNT	7.00E-01	8.00E+00	8.75E-02	5.00E-02	5.00E-02	6.25E-04	7.14E-03	4.46E-09	5.09E-08	3.66E-08	4.18E-07	7.87E-08	8.99E-07	3.99E-09	4.56E-08	7.14E-03	6.97E-06	7.96E-05	7.22E-03
2,4-DNT	7.00E-01	8.00E+00	8.75E-02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E-10	5.14E-09	5.14E-09	0.00E+00	0.00E+00	5.14E-09
2,6-DNT	7.00E-01	8.00E+00	8.75E-02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-09	1.33E-08	1.33E-08	0.00E+00	0.00E+00	1.33E-08
Dinitrotoluene	7.00E-01	8.00E+00	8.75E-02	5.00E-02	5.00E-02	7.28E-04	8.32E-03	1.01E-08	1.15E-07	5.80E-08	6.63E-07	1.24E-07	1.42E-06	4.96E-09	5.67E-08	8.33E-03	0.00E+00	0.00E+00	8.33E-03
2-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	5.00E-02	5.00E-02	3.91E-05	4.47E-04	5.69E-10	6.50E-09	3.19E-09	3.65E-08	6.82E-09	7.79E-08	8.47E-10	9.68E-09	4.47E-04	0.00E+00	0.00E+00	4.47E-04
3-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.08E-10	9.23E-09	9.23E-09	0.00E+00	0.00E+00	9.23E-09
4-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.52E-10	8.59E-09	8.59E-09	0.00E+00	0.00E+00	8.59E-09
2,4,6-TNT	7.00E-01	8.00E+00	8.75E-02	5.00E-02	5.00E-02	1.59E-02	1.82E-01	1.13E-07	1.29E-06	9.30E-07	1.06E-05	2.00E-06	2.29E-05	7.89E-07	9.02E-06	1.82E-01	0.00E+00	0.00E+00	1.82E-01
Inorganics																			
Aluminum	1.10E+02	8.00E+00	1.38E+01	5.00E-02	5.00E-02	0.00E+00	0.00E+00	8.43E-06	6.13E-07	5.67E-06	4.13E-07	1.10E-05	7.99E-07	7.73E-06	5.62E-07	2.39E-06	8.58E-03	6.24E-04	6.26E-04
Barium	2.08E+01	8.00E+00	2.60E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	1.62E-08	6.23E-09	1.09E-08	4.19E-09	2.11E-08	8.12E-09	1.49E-08	5.71E-09	2.43E-08	1.24E-04	4.75E-05	4.76E-05
Cadmium	1.45E+00	8.00E+00	1.81E-01	5.00E-02	5.00E-02	0.00E+00	0.00E+00	6.09E-10	3.36E-09	4.10E-10	2.26E-09	7.93E-10	4.38E-09	5.58E-10	3.08E-09	1.31E-08	2.32E-06	1.28E-05	1.28E-05
Calcium	2.83E+03	8.00E+00	3.54E+02	5.00E-02	5.00E-02	1.31E+01	3.69E-02	5.59E-01	1.58E-03	6.56E-01	1.85E-03	1.09E+00	3.08E-03	4.80E-01	1.36E-03	4.47E-02	4.26E-01	1.20E-03	4.60E-02
Chromium	1.00E+00	8.00E+00	1.25E-01	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.85E-05	6.28E-04	6.28E-04	0.00E+00	0.00E+00	6.28E-04
Cobalt	0.00E+00	8.00E+00	0.00E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	8.26E-10	0.00E+00	5.56E-10	0.00E+00	1.08E-09	0.00E+00	7.57E-10	0.00E+00	0.00E+00	1.26E-05	0.00E+00	0.00E+00
Copper	4.70E+01	8.00E+00	5.88E+00	5.00E-02	5.00E-02	7.40E-03	1.26E-03	4.22E-04	7.18E-05	6.45E-04	1.10E-04	1.22E-03	2.08E-04	4.12E-04	7.01E-05	1.72E-03	1.79E-05	3.05E-06	1.72E-03
Iron	5.00E+01	8.00E+00	6.25E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	3.84E-04	6.15E-05	2.59E-04	4.14E-05	5.01E-04	8.01E-05	3.53E-04	5.64E-05	2.39E-04	2.93E-02	4.69E-03	4.93E-03
Lead	3.85E+00	8.00E+00	4.81E-01	5.00E-02	5.00E-02	5.89E-02	1.22E-01	4.71E-04	9.78E-04	1.45E-04	3.01E-04	3.18E-05	6.62E-05	5.20E-04	1.08E-03	1.25E-01	1.16E-05	2.41E-05	1.25E-01
Magnesium	1.50E+02	8.00E+00	1.88E+01	5.00E-02	5.00E-02	0.00E+00	0.00E+00	1.36E-03	7.24E-05	9.14E-04	4.88E-05	1.77E-03	9.44E-05	6.53E-02	3.48E-03	3.70E-03	1.04E-01	5.53E-03	9.23E-03
Manganese	9.77E+02	8.00E+00	1.22E+02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	1.01E-06	8.23E-09	6.76E-07	5.54E-09	1.31E-06	1.07E-08	9.22E-07	7.55E-09	3.20E-08	3.07E-03	2.51E-05	2.51E-05
Mercury	4.50E-01	8.00E+00	5.63E-02	5.00E-02	5.00E-02	7.27E-06	1.29E-04	3.89E-05	6.91E-04	2.17E-05	3.86E-04	2.36E-05	4.20E-04	3.52E-05	6.26E-04	2.25E-03	0.00E+00	0.00E+00	2.25E-03
Potassium	1.00E+03	8.00E+00	1.25E+02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	7.47E-05	5.98E-07	5.03E-05	4.02E-07	9.74E-05	7.79E-07	6.85E-05	5.48E-07	2.33E-06	1.14E-02	9.12E-05	9.36E-05
Selenium	5.00E-01	8.00E+00	6.25E-02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	7.70E-08	1.23E-06	5.18E-08	8.29E-07	1.00E-07	1.60E-06	7.06E-08	1.13E-06	4.80E-06	7.83E-06	1.25E-04	1.30E-04
Silver	0.00E+00	8.00E+00	0.00E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	5.51E-09	0.00E+00	3.71E-09	0.00E+00	7.18E-09	0.00E+00	5.05E-09	0.00E+00	0.00E+00	2.80E-06	0.00E+00	0.00E+00
Sodium	1.00E+03	8.00E+00	1.25E+02	5.00E-02	5.00E-02	2.73E-02	2.18E-04	5.14E-02	4.11E-04	1.89E-02	1.51E-04	1.21E-02	9.67E-05	5.21E-02	4.17E-04	1.29E-03	9.05E-02	7.24E-04	2.02E-03
Zinc	1.45E+01	8.00E+00	1.81E+00	5.00E-02	5.00E-02	6.71E-02	3.70E-02	4.92E-02	2.71E-02	4.29E-02	2.37E-02	7.02E-02	3.87E-02	4.40E-02	2.43E-02	1.51E-01	1.76E-04	9.73E-05	1.51E-01
TOTAL							**3.81E-01**		**2.80E+00**		**8.73E-01**		**1.12E-02**		**2.29E+00**	**6.36E+00**		**1.36E-02**	**6.37E+00**

Body Weight (kg)	0.957
Water intake (L/d)	0.057
Food intake (kg(dw)/d)	0.057
Soil intake (kg/d)	0.002
Bird intake (kg(dw)/d) -- 24% of diet	0.01368
Mouse intake (kg(dw)/d) -- 25.3% of diet	0.01444
Shrew intake (kg(dw)/d) -- 25.3% of diet	0.01444
Rabbit intake (kg(dw)/d) -- 25.3% of diet	0.01444

Table G-2

Plum Brook Ordnance Works
TNT Area A
(Page 1 of 9)

Chemical Data

Chemical Name	Surface Soil Conc. (mg/kg)	Total Soil Conc. (mg/kg)	Water Conc. (mg/L)	log Kow (organics)	Soil-to-Plant TF	Shallow-rooted Plant Conc. (mg/kgdw)	Deep-rooted Plant Conc. (mg/kgdw)	Soil-to-Invert. BAF	Invert. Conc. (mg/kgdw)	Food-to-Muscle TF
Organics										
Aroclor-1260	2.48E+00	1.32E-01		7.15E+00	2.87E-03	7.11E-03	3.79E-04	2.73E+01	6.76E+01	4.44E-01
Carbon disulfide			1.13E-02	1.84E+00	3.35E+00	0.00E+00	0.00E+00	NA	0.00E+00	1.46E-06
Di-n-butyl phthalate			1.74E-03	5.56E+00	2.37E-02	0.00E+00	0.00E+00	NA	0.00E+00	1.02E-02
2-Amino-4,6-DNT	9.23E+00	7.57E-01	1.96E-03	2.00E+00	2.70E+00	2.50E+01	2.05E+00	1.00E-01	9.23E-01	2.14E-06
4-Amino-2,6-DNT	5.98E+00	1.29E+00	2.34E-03	2.00E+00	2.70E+00	1.62E+01	3.49E+00	1.00E-01	5.98E-01	2.14E-06
2,4-DNT		3.43E-01		1.98E+00	2.79E+00	0.00E+00	9.55E-01	1.00E-01	0.00E+00	2.03E-06
2,6-DNT		4.34E-01		2.28E+00	1.87E+00	0.00E+00	8.10E-01	1.00E-01	0.00E+00	4.16E-06
Dinitrotoluene	6.97E+00			2.28E+00	1.87E+00	1.30E+01	0.00E+00	1.00E-01	6.97E-01	4.16E-06
2-Nitrotoluene	3.74E-01	2.00E-01		2.30E+00	1.81E+00	6.77E-01	3.62E-01	1.00E-01	3.74E-02	4.38E-06
3-Nitrotoluene		2.00E-01		2.45E+00	1.49E+00	0.00E+00	2.97E-01	1.00E-01	0.00E+00	6.25E-06
4-Nitrotoluene		2.00E-01		2.42E+00	1.55E+00	0.00E+00	3.09E-01	1.00E-01	0.00E+00	5.82E-06
2,4,6-TNT	1.52E+02	5.30E+02		2.00E+00	2.70E+00	4.11E+02	1.43E+03	1.00E-01	1.52E+01	2.14E-06
Inorganics										
Aluminum			2.88E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.50E-03
Barium			4.15E-02	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	2.00E-04
Cadmium			7.80E-04	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	4.00E-04
Calcium	1.25E+05	4.00E+04	1.43E+02	---	1.90E+00	2.38E+05	7.60E+04	1.00E+00	1.25E+05	2.00E-03
Chromium		1.35E+01		---	1.00E-03	0.00E+00	1.35E-02	7.00E-02	0.00E+00	9.00E-03
Cobalt			4.23E-03	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.00E-04
Copper	7.08E+01	2.39E+01	6.02E-03	---	8.00E-01	5.66E+01	1.91E+01	2.50E-01	1.77E+01	9.00E-03
Iron			9.85E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	2.00E-02
Lead	5.64E+02	6.24E+02	3.90E-03	---	1.10E-03	6.20E-01	6.86E-01	9.30E-01	5.25E+02	4.00E-04
Magnesium		4.96E+03	3.48E+01	---	7.80E-01	0.00E+00	3.87E+03	1.00E+00	0.00E+00	2.00E-02
Manganese			1.03E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	5.00E-04
Mercury	6.96E-02	3.36E-02		---	5.50E-01	3.83E-02	1.85E-02	1.00E+00	6.96E-02	2.50E-01
Potassium			3.83E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.00E-02
Selenium			2.63E-03	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.50E-02
Silver			9.41E-04	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	3.00E-03
Sodium	2.61E+02	2.32E+02	3.04E+01	---	6.50E-02	1.70E+01	1.51E+01	1.00E+00	2.61E+02	8.00E-02
Zinc	6.42E+02	1.71E+02	5.92E-02	---	4.30E-01	2.76E+02	7.35E+01	3.00E-01	1.93E+02	1.00E-01

Table G-2

Plum Brook Ordnance Works
TNT Area A

Toxicity Data

Chemical Name	Mammals			Birds		
	LOAEL (mg/kg/d)	Test Species	Body Wt. (kg)	LOAEL (mg/kg/d)	Test Species	Body Wt. (kg)
Organics						
Aroclor-1260	6.80E-01	mouse	0.014	1.80E+00	ring-neck pheasant	1
Carbon disulfide	1.59E+02	rat	0.35	--	--	--
Di-n-butyl phthalate	1.83E+03	mouse	0.03	1.10E+00	ringed dove	0.155
2-Amino-4,6-DNT	6.95E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
4-Amino-2,6-DNT	4.80E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
2,4-DNT	1.50E+00	beagle dog	11	1.78E+01	Bobwhite quail	0.19
2,6-DNT	1.50E+00	beagle dog	11	1.78E+01	Bobwhite quail	0.19
Dinitrotoluene	1.50E+00	beagle dog	11	1.78E+01	Bobwhite quail	0.19
2-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
3-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
4-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
2,4,6-TNT	8.00E+00	rat	0.35	1.78E+01	Bobwhite quail	0.19
Inorganics						
Aluminum	1.93E+01	mouse	0.03	1.10E+03	ringed dove	0.155
Barium	1.98E+01	rat	0.35	4.17E+01	chicks	0.121
Cadmium	1.00E+01	rat	0.303	2.00E+01	mallard duck	1.153
Calcium	5.27E+03	rabbit	3.8	1.42E+04	Jap. quail	0.072
Chromium	1.37E+04	rat	0.35	5.00E+00	black duck	1.25
Cobalt	1.20E+01	rat	0.35	--	--	--
Copper	1.51E+01	mink	1	6.20E+01	chicks	0.534
Iron	1.30E+02	rabbit	3.8	2.50E+02	poultry	1.6
Lead	8.00E+01	rat	0.35	3.85E+01	Am. Kestrel	0.13
Magnesium	7.90E+02	rabbit	3.8	7.50E+02	poultry	1.6
Manganese	2.84E+02	rat	0.35	9.77E+03	Jap. Quail	0.072
Mercury	5.00E+00	mink	1	9.00E-01	Jap. Quail	0.15
Potassium	7.90E+03	rabbit	3.8	5.00E+03	poultry	1.6
Selenium	3.30E-01	rat	0.35	1.00E+00	mallard duck	1
Silver	--	--	--	--	--	--
Sodium	7.90E+03	rabbit	3.8	5.00E+03	poultry	1.6
Zinc	3.20E+02	rat	0.35	1.31E+02	hens	1.935

Table G-2

Plum Brook Ordnance Works
TNT Area A

Omnivorous Rodent: **Deer mouse *(Peromyscus manicalatus)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Plant/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics																
Aroclor-1260	6.71E-01	8.00E+00	8.38E-02	1.00E+00	1.00E+00	9.55E-03	1.14E-01	8.21E-04	9.79E-03	4.99E+00	5.95E+01	5.96E+01	0.00E+00	0.00E+00	5.96E+01	2.60E+01
Carbon disulfide	3.52E+02	8.00E+00	4.39E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.68E-03	3.82E-05	3.82E-05	2.88E-08
Di-n-butyl phthalate	2.19E+03	8.00E+00	2.73E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.59E-04	9.46E-07	9.46E-07	3.09E-05
2-Amino-4,6-DNT	1.53E+02	8.00E+00	1.92E+01	1.00E+00	1.00E+00	3.55E-02	1.86E-03	2.88E+00	1.50E-01	6.81E-02	3.55E-03	1.56E-01	2.91E-04	1.52E-05	1.56E-01	7.49E-05
4-Amino-2,6-DNT	1.06E+02	8.00E+00	1.32E+01	1.00E+00	1.00E+00	2.30E-02	1.74E-03	1.87E+00	1.41E-01	4.41E-02	3.33E-03	1.46E-01	3.48E-04	2.63E-05	1.46E-01	4.85E-05
2,4-DNT	7.83E+00	8.00E+00	9.79E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	7.83E+00	8.00E+00	9.79E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dinitrotoluene	7.83E+00	8.00E+00	9.79E-01	1.00E+00	1.00E+00	2.68E-02	2.74E-02	1.50E+00	1.53E+00	5.14E-02	5.25E-02	1.61E+00	0.00E+00	0.00E+00	1.61E+00	7.69E-05
2-Nitrotoluene	1.92E+02	8.00E+00	2.40E+01	1.00E+00	1.00E+00	1.44E-03	6.01E-05	7.82E-02	3.26E-03	2.76E-03	1.15E-04	3.44E-03	0.00E+00	0.00E+00	3.44E-03	4.23E-06
3-Nitrotoluene	1.92E+02	8.00E+00	2.40E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Nitrotoluene	1.92E+02	8.00E+00	2.40E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	1.76E+01	8.00E+00	2.21E+00	1.00E+00	1.00E+00	5.85E-01	2.65E-01	4.74E+01	2.15E+01	1.12E+00	5.09E-01	2.23E+01	0.00E+00	0.00E+00	2.23E+01	1.23E-03
Inorganics																
Aluminum	2.30E+01	8.00E+00	2.88E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.28E-01	1.49E-01	1.49E-01	7.52E-03
Barium	4.37E+01	8.00E+00	5.46E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.17E-03	1.13E-03	1.13E-03	1.44E-05
Cadmium	2.13E+01	8.00E+00	2.66E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-04	4.36E-05	4.36E-05	5.43E-07
Calcium	2.11E+04	8.00E+00	2.63E+03	1.00E+00	1.00E+00	4.81E+02	1.83E-01	2.74E+04	1.04E+01	9.22E+03	3.50E+00	1.41E+01	2.13E+01	8.07E-03	1.41E+01	8.70E+02
Chromium	3.02E+04	8.00E+00	3.77E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	2.65E+01	8.00E+00	3.31E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.29E-04	1.90E-04	1.90E-04	7.36E-07
Copper	4.33E+01	8.00E+00	5.41E+00	1.00E+00	1.00E+00	2.73E-01	5.04E-02	6.54E+00	1.21E+00	1.31E+00	2.41E-01	1.50E+00	8.95E-04	1.65E-04	1.50E+00	8.55E-01
Iron	5.20E+02	8.00E+00	6.50E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E+00	2.25E-02	2.25E-02	3.43E-01
Lead	1.76E+02	8.00E+00	2.21E+01	1.00E+00	1.00E+00	2.17E+00	9.85E-02	7.16E-02	3.25E-03	3.87E+01	1.75E+00	1.86E+00	5.80E-04	2.63E-05	1.86E+00	1.92E-01
Magnesium	3.16E+03	8.00E+00	3.95E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.17E+00	1.31E-02	1.31E-02	1.21E+00
Manganese	6.26E+02	8.00E+00	7.83E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.53E-01	1.96E-03	1.96E-03	8.97E-04
Mercury	1.43E+01	8.00E+00	1.79E+00	1.00E+00	1.00E+00	2.68E-04	1.50E-04	4.42E-03	2.47E-03	5.14E-03	2.87E-03	5.48E-03	0.00E+00	0.00E+00	5.48E-03	2.88E-02
Potassium	3.16E+04	8.00E+00	3.95E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.69E-01	1.44E-04	1.44E-04	6.67E-02
Selenium	7.28E-01	8.00E+00	9.10E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.91E-04	4.30E-03	4.30E-03	6.87E-05
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	NA	0.00E+00	NA	0.00E+00	NA	NA	1.40E-04	NA	NA	4.91E-06
Sodium	3.16E+04	8.00E+00	3.95E+03	1.00E+00	1.00E+00	1.01E+00	2.54E-04	1.96E+00	4.96E-04	1.93E+01	4.87E-03	5.62E-03	4.52E+00	1.14E-03	6.77E-03	2.51E+01
Zinc	7.06E+02	8.00E+00	8.82E+01	1.00E+00	1.00E+00	2.47E+00	2.80E-02	3.19E+01	3.61E-01	1.42E+01	1.61E-01	5.50E-01	8.80E-03	9.98E-05	5.50E-01	5.69E+01
TOTAL							**7.43E-01**		**3.50E+01**		**6.56E+01**	**1.01E+02**		**2.02E-01**	**1.01E+02**	

Body Weight (kg)	0.0148
Water intake (L/d)	0.0022
Food intake (kg(dw)/d)	0.0028
Soil intake (kg/d)	0.000057
Plant intake (kg(dw)/d) -- 61% of diet	0.001708
Invertebrate intake (kg(dw)/d) -- 39% of diet	0.001092

Table G-2

Plum Brook Ordnance Works
TNT Area A

Opportunistic Omnivore: **Raccoon *(Procyon lotor)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Mouse Intake (mg/kg-d)	Mouse Intake Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics																	
Aroclor-1260	1.56E-01	8.00E+00	1.95E-02	1.00E+00	1.00E+00	5.84E-03	3.00E-01	1.52E-04	7.83E-03	1.03E+00	5.31E+01	6.62E-02	3.40E+00	5.68E+01	0.00E+00	0.00E+00	5.68E+01
Carbon disulfide	8.16E+01	8.00E+00	1.02E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.35E-11	7.20E-12	7.20E-12	4.76E-04	4.67E-05	4.67E-05
Di-n-butyl phthalate	5.08E+02	8.00E+00	6.35E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.87E-08	1.24E-09	1.24E-09	7.34E-05	1.16E-06	1.16E-06
2-Amino-4,6-DNT	3.56E+01	8.00E+00	4.45E+00	1.00E+00	1.00E+00	2.17E-02	4.88E-03	5.34E-01	1.20E-01	1.41E-02	3.17E-03	1.91E-07	4.29E-08	1.28E-01	8.26E-05	1.86E-05	1.28E-01
4-Amino-2,6-DNT	2.46E+01	8.00E+00	3.07E+00	1.00E+00	1.00E+00	1.41E-02	4.58E-03	3.46E-01	1.13E-01	9.15E-03	2.98E-03	1.24E-07	4.03E-08	1.20E-01	9.86E-05	3.21E-05	1.20E-01
2,4-DNT	1.82E+00	8.00E+00	2.27E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	1.82E+00	8.00E+00	2.27E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dinitrotoluene	1.82E+00	8.00E+00	2.27E-01	1.00E+00	1.00E+00	1.64E-02	7.22E-02	2.78E-01	1.23E+00	1.07E-02	4.69E-02	1.96E-07	8.63E-07	1.34E+00	0.00E+00	0.00E+00	1.34E+00
2-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	1.00E+00	1.00E+00	8.80E-04	1.58E-04	1.45E-02	2.61E-03	5.72E-04	1.03E-04	1.08E-08	1.94E-09	2.87E-03	0.00E+00	0.00E+00	2.87E-03
3-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	4.09E+00	8.00E+00	5.12E-01	1.00E+00	1.00E+00	3.58E-01	6.99E-01	8.80E+00	1.72E+01	2.32E-01	4.54E-01	3.14E-06	6.14E-06	1.83E+01	0.00E+00	0.00E+00	1.83E+01
Inorganics																	
Aluminum	5.34E+00	8.00E+00	6.68E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.92E-05	2.87E-05	2.87E-05	1.21E-01	1.82E-01	1.82E-01
Barium	1.01E+01	8.00E+00	1.27E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.68E-08	2.91E-08	2.91E-08	1.75E-03	1.38E-03	1.38E-03
Cadmium	4.94E+00	8.00E+00	6.17E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E-09	2.24E-09	2.24E-09	3.29E-05	5.33E-05	5.33E-05
Calcium	4.89E+03	8.00E+00	6.11E+02	1.00E+00	1.00E+00	2.94E+02	4.81E-01	5.09E+03	8.32E+00	1.91E+03	3.13E+00	2.22E+00	3.63E-03	1.19E+01	6.03E+00	9.86E-03	1.19E+01
Chromium	7.01E+03	8.00E+00	8.76E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	6.14E+00	8.00E+00	7.68E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-09	2.45E-09	2.45E-09	1.78E-04	2.32E-04	2.32E-04
Copper	1.00E+01	8.00E+00	1.26E+00	1.00E+00	1.00E+00	1.67E-01	1.33E-01	1.21E+00	9.66E-01	2.71E-01	2.16E-01	2.18E-03	1.74E-03	1.32E+00	2.54E-04	2.02E-04	1.32E+00
Iron	1.21E+02	8.00E+00	1.51E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.74E-04	5.79E-05	5.79E-05	4.15E-01	2.75E-02	2.76E-02
Lead	4.09E+01	8.00E+00	5.12E+00	1.00E+00	1.00E+00	1.33E+00	2.59E-01	1.33E-02	2.60E-03	8.02E+00	1.57E+00	4.89E-04	9.55E-05	1.83E+00	1.64E-04	3.21E-05	1.83E+00
Magnesium	7.34E+02	8.00E+00	9.17E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.09E-03	3.37E-05	3.37E-05	1.47E+00	1.60E-02	1.60E-02
Manganese	1.45E+02	8.00E+00	1.82E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.29E-06	1.26E-07	1.26E-07	4.34E-02	2.39E-03	2.39E-03
Mercury	3.33E+00	8.00E+00	4.16E-01	1.00E+00	1.00E+00	1.64E-04	3.94E-04	8.20E-04	1.97E-03	1.06E-03	2.56E-03	7.33E-05	1.76E-04	5.10E-03	0.00E+00	0.00E+00	5.10E-03
Potassium	7.34E+03	8.00E+00	9.17E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.70E-04	1.85E-07	1.85E-07	1.61E-01	1.76E-04	1.76E-04
Selenium	1.69E-01	8.00E+00	2.11E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.75E-07	8.29E-06	8.29E-06	1.11E-04	5.25E-03	5.26E-03
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	NA	0.00E+00	NA	0.00E+00	NA	1.25E-08	NA	NA	3.97E-05	0.00E+00	NA
Sodium	7.34E+03	8.00E+00	9.17E+02	1.00E+00	1.00E+00	6.14E-01	6.70E-04	3.63E-01	3.96E-04	3.99E+00	4.35E-03	6.39E-02	6.97E-05	5.49E-03	1.28E+00	1.40E-03	6.89E-03
Zinc	1.64E+02	8.00E+00	2.05E+01	1.00E+00	1.00E+00	1.51E+00	7.38E-02	5.91E+00	2.89E-01	2.95E+00	1.44E-01	1.45E-01	7.08E-03	5.13E-01	2.50E-03	1.22E-04	5.14E-01
TOTAL							**1.95E+00**		**2.79E+01**		**5.85E+01**		**3.41E+00**	**9.19E+01**		**2.46E-01**	**9.21E+01**

Body Weight (kg)	5.1
Water intake (L/d)	0.215
Food intake (kg(dw)/d)	0.26
Soil intake (kg/d)	0.012
Mouse Intake (kg(dw)/d) -- 5 % of diet	0.013
Plant intake (kg(dw)/d) -- 42% of diet	0.1092
Invertebrate intake (kg(dw)/d) -- 30% of diet	0.078

Table G-2

Plum Brook Ordnance Works
TNT Area A

Herbivorous Rodent: **Eastern Cottontail *(Sylvilagus floridanus)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Hazard Quotient	Soil/Plant Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	4.06E-01	8.00E+00	5.08E-02	1.00E+00	1.00E+00	1.31E-02	2.59E-01	6.03E-04	1.19E-02	2.71E-01	0.00E+00	0.00E+00	2.71E-01	2.11E-01
Carbon disulfide	2.13E+02	8.00E+00	2.66E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-03	4.13E-05	4.13E-05	5.58E-08
Di-n-butyl phthalate	1.32E+03	8.00E+00	1.66E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.69E-04	1.02E-06	1.02E-06	5.98E-05
2-Amino-4,6-DNT	9.28E+01	8.00E+00	1.16E+01	1.00E+00	1.00E+00	4.89E-02	4.22E-03	2.12E+00	1.82E-01	1.87E-01	1.90E-04	1.64E-05	1.87E-01	1.61E-04
4-Amino-2,6-DNT	6.41E+01	8.00E+00	8.01E+00	1.00E+00	1.00E+00	3.17E-02	3.96E-03	1.37E+00	1.71E-01	1.75E-01	2.27E-04	2.84E-05	1.75E-01	1.04E-04
2,4-DNT	4.74E+00	8.00E+00	5.93E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	4.74E+00	8.00E+00	5.93E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dinitrotoluene	4.74E+00	8.00E+00	5.93E-01	1.00E+00	1.00E+00	3.69E-02	6.23E-02	1.10E+00	1.86E+00	1.92E+00	0.00E+00	0.00E+00	1.92E+00	1.64E-04
2-Nitrotoluene	1.16E+02	8.00E+00	1.45E+01	1.00E+00	1.00E+00	1.98E-03	1.36E-04	5.75E-02	3.96E-03	4.09E-03	0.00E+00	0.00E+00	4.09E-03	9.04E-06
3-Nitrotoluene	1.16E+02	8.00E+00	1.45E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Nitrotoluene	1.16E+02	8.00E+00	1.45E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	1.07E+01	8.00E+00	1.34E+00	1.00E+00	1.00E+00	8.06E-01	6.03E-01	3.49E+01	2.61E+01	2.67E+01	0.00E+00	0.00E+00	2.67E+01	2.65E-03
Inorganics														
Aluminum	1.39E+01	8.00E+00	1.74E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.80E-01	1.61E-01	1.61E-01	1.46E-02
Barium	2.64E+01	8.00E+00	3.31E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.03E-03	1.22E-03	1.22E-03	2.80E-05
Cadmium	1.29E+01	8.00E+00	1.61E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.58E-05	4.71E-05	4.71E-05	1.05E-06
Calcium	1.28E+04	4.00E+00	3.19E+03	1.00E+00	1.00E+00	6.63E+02	2.08E-01	2.01E+04	6.31E+00	6.52E+00	1.39E+01	4.35E-03	6.52E+00	1.44E+03
Chromium	1.83E+04	8.00E+00	2.29E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	1.60E+01	8.00E+00	2.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.11E-04	2.05E-04	2.05E-04	1.43E-06
Copper	2.62E+01	8.00E+00	3.28E+00	1.00E+00	1.00E+00	3.75E-01	1.14E-01	4.80E+00	1.47E+00	1.58E+00	5.85E-04	1.78E-04	1.58E+00	1.62E+00
Iron	3.15E+02	4.00E+00	7.88E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.57E-01	1.21E-02	1.21E-02	6.64E-01
Lead	1.07E+02	8.00E+00	1.34E+01	1.00E+00	1.00E+00	2.99E+00	2.24E-01	5.26E-02	3.94E-03	2.28E-01	3.79E-04	2.84E-05	2.28E-01	4.22E-02
Magnesium	1.92E+03	4.00E+00	4.79E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.38E+00	7.06E-03	7.06E-03	2.35E+00
Manganese	3.79E+02	8.00E+00	4.74E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-01	2.11E-03	2.11E-03	1.74E-03
Mercury	8.68E+00	8.00E+00	1.09E+00	1.00E+00	1.00E+00	3.69E-04	3.40E-04	3.25E-03	2.99E-03	3.33E-03	0.00E+00	0.00E+00	3.33E-03	3.13E-02
Potassium	1.91E+04	4.00E+00	4.79E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.72E-01	7.78E-05	7.78E-05	1.29E-01
Selenium	4.41E-01	8.00E+00	5.51E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.56E-04	4.64E-03	4.64E-03	1.33E-04
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	NA	0.00E+00	NA	NA	9.14E-05	0.00E+00	NA	9.51E-06
Sodium	1.91E+04	4.00E+00	4.79E+03	1.00E+00	1.00E+00	1.38E+00	2.89E-04	1.44E+00	3.01E-04	5.90E-04	2.95E+00	6.17E-04	1.21E-03	1.60E+01
Zinc	4.27E+02	8.00E+00	5.34E+01	1.00E+00	1.00E+00	3.40E+00	6.37E-02	2.34E+01	4.38E-01	5.02E-01	5.75E-03	1.08E-04	5.02E-01	9.30E+01
TOTAL							**1.48E+00**		**3.61E+01**	**3.76E+01**		**1.93E-01**	**3.78E+01**	

Body Weight (kg)	1.132
Water intake (L/d)	0.11
Food intake (kg(dw)/d)	0.096
Soil intake (kg/d)	0.006
Plant intake (kg(dw)/d) -- 100% of diet	0.096

Table G-2

Plum Brook Ordnance Works
TNT Area A

Insectivorous mammal: **Short-tailed shrew *(Blarina brevicauda)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	1.07E+00	8.00E+00	1.34E-01	1.00E+00	1.00E+00	7.30E-03	5.47E-02	9.91E+00	7.42E+01	7.43E+01	0.00E+00	0.00E+00	7.43E+01	6.81E+01
Carbon disulfide	5.60E+02	8.00E+00	7.00E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.73E-03	2.48E-05	2.48E-05	3.93E-08
Di-n-butyl phthalate	3.48E+03	8.00E+00	4.35E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.67E-04	6.13E-07	6.13E-07	4.21E-05
2-Amino-4,6-DNT	2.44E+02	8.00E+00	3.05E+01	1.00E+00	1.00E+00	4.19E-02	1.37E-03	1.35E-01	4.44E-03	5.81E-03	3.01E-04	9.85E-06	5.82E-03	5.89E-06
4-Amino-2,6-DNT	1.69E+02	8.00E+00	2.11E+01	1.00E+00	1.00E+00	7.14E-02	3.39E-03	8.77E-02	4.16E-03	7.55E-03	3.59E-04	1.70E-05	7.57E-03	5.29E-06
2,4-DNT	1.25E+01	8.00E+00	1.56E+00	1.00E+00	1.00E+00	1.90E-02	1.22E-02	0.00E+00	0.00E+00	1.22E-02	0.00E+00	0.00E+00	1.22E-02	5.97E-07
2,6-DNT	1.25E+01	8.00E+00	1.56E+00	1.00E+00	1.00E+00	2.40E-02	1.54E-02	0.00E+00	0.00E+00	1.54E-02	0.00E+00	0.00E+00	1.54E-02	1.54E-06
Dinitrotoluene	1.25E+01	8.00E+00	1.56E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	1.02E-01	6.56E-02	6.56E-02	0.00E+00	0.00E+00	6.56E-02	6.58E-06
2-Nitrotoluene	3.06E+02	8.00E+00	3.82E+01	1.00E+00	1.00E+00	1.11E-02	2.90E-04	5.49E-03	1.44E-04	4.33E-04	0.00E+00	0.00E+00	4.33E-04	1.12E-06
3-Nitrotoluene	3.06E+02	8.00E+00	3.82E+01	1.00E+00	1.00E+00	1.11E-02	2.90E-04	0.00E+00	0.00E+00	2.90E-04	0.00E+00	0.00E+00	2.90E-04	1.07E-06
4-Nitrotoluene	3.06E+02	8.00E+00	3.82E+01	1.00E+00	1.00E+00	1.11E-02	2.90E-04	0.00E+00	0.00E+00	2.90E-04	0.00E+00	0.00E+00	2.90E-04	9.96E-07
2,4,6-TNT	2.81E+01	8.00E+00	3.51E+00	1.00E+00	1.00E+00	2.93E+01	8.35E+00	2.23E+00	6.35E-01	8.98E+00	0.00E+00	0.00E+00	8.98E+00	1.05E-03
Inorganics														
Aluminum	3.67E+01	8.00E+00	4.58E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.42E-01	9.63E-02	9.63E-02	1.02E-02
Barium	6.95E+01	8.00E+00	8.69E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.36E-03	7.32E-04	7.32E-04	1.97E-05
Cadmium	3.39E+01	8.00E+00	4.23E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.20E-04	2.82E-05	2.82E-05	7.40E-07
Calcium	3.36E+04	8.00E+00	4.20E+03	1.00E+00	1.00E+00	2.21E+03	5.28E-01	1.83E+04	4.37E+00	4.90E+00	2.19E+01	5.23E-03	4.90E+00	6.36E+02
Chromium	4.81E+04	8.00E+00	6.01E+03	1.00E+00	1.00E+00	7.47E-01	1.24E-04	0.00E+00	0.00E+00	1.24E-04	0.00E+00	0.00E+00	1.24E-04	1.04E-01
Cobalt	4.21E+01	8.00E+00	5.27E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.49E-04	1.23E-04	1.23E-04	1.00E-06
Copper	6.90E+01	8.00E+00	8.62E+00	1.00E+00	1.00E+00	1.32E+00	1.53E-01	2.60E+00	3.01E-01	4.55E-01	9.23E-04	1.07E-04	4.55E-01	5.46E-01
Iron	8.29E+02	8.00E+00	1.04E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.51E+00	1.46E-02	1.46E-02	4.67E-01
Lead	2.81E+02	8.00E+00	3.51E+01	1.00E+00	1.00E+00	3.45E+01	9.83E-01	7.69E+01	2.19E+00	3.17E+00	5.98E-04	1.70E-05	3.17E+00	6.90E-01
Magnesium	5.04E+03	8.00E+00	6.30E+02	1.00E+00	1.00E+00	2.74E+02	4.36E-01	0.00E+00	0.00E+00	4.36E-01	5.34E+00	8.48E-03	4.44E-01	8.66E+01
Manganese	9.97E+02	8.00E+00	1.25E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.58E-01	1.27E-03	1.27E-03	1.22E-03
Mercury	2.28E+01	8.00E+00	2.85E+00	1.00E+00	1.00E+00	1.86E-03	6.51E-04	1.02E-02	3.58E-03	4.23E-03	0.00E+00	0.00E+00	4.23E-03	4.67E-02
Potassium	5.03E+04	8.00E+00	6.29E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.87E-01	9.33E-05	9.33E-05	9.09E-02
Selenium	1.16E+00	8.00E+00	1.45E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.03E-04	2.78E-03	2.78E-03	9.36E-05
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	NA	0.00E+00	NA	NA	1.44E-04	0.00E+00	NA	6.70E-06
Sodium	5.03E+04	8.00E+00	6.29E+03	1.00E+00	1.00E+00	1.28E+01	2.04E-03	3.83E+01	6.08E-03	8.12E-03	4.66E+00	7.41E-04	8.87E-03	6.90E+01
Zinc	1.12E+03	8.00E+00	1.40E+02	1.00E+00	1.00E+00	9.46E+00	6.74E-02	2.82E+01	2.01E-01	2.68E-01	9.08E-03	6.46E-05	2.68E-01	5.84E+01
TOTAL							**1.05E+01**		**8.18E+01**	**9.24E+01**		**1.31E-01**	**9.25E+01**	

Body Weight (kg)	0.015
Water intake (L/d)	0.0023
Food intake (kg(dw)/d)	0.0022
Soil intake (kg/d)	0.00083
Invertebrate intake (kg(dw)/d)--100% of diet	0.0022

Table G-2

Plum Brook Ordnance Works
TNT Area A

Herbivorous Mammal: **White-tailed deer *(Odocoileus virginianus)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Soil/Plant Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics													
Aroclor-1260	1.65E-01	8.00E+00	2.07E-02	9.00E-02	9.00E-02	1.46E-04	7.08E-03	1.12E-06	5.40E-05	7.13E-03	0.00E+00	0.00E+00	7.13E-03
Carbon disulfide	8.67E+01	8.00E+00	1.08E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.07E-03	3.75E-04	3.75E-04
Di-n-butyl phthalate	5.39E+02	8.00E+00	6.74E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.26E-04	9.29E-06	9.29E-06
2-Amino-4,6-DNT	3.78E+01	8.00E+00	4.72E+00	9.00E-02	9.00E-02	5.45E-04	1.15E-04	6.04E-03	1.28E-03	1.39E-03	7.06E-04	1.49E-04	1.54E-03
4-Amino-2,6-DNT	2.61E+01	8.00E+00	3.26E+00	9.00E-02	9.00E-02	3.53E-04	1.08E-04	1.03E-02	3.15E-03	3.26E-03	8.42E-04	2.58E-04	3.52E-03
2,4-DNT	1.93E+00	8.00E+00	2.41E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	2.82E-03	1.17E-02	1.17E-02	0.00E+00	0.00E+00	1.17E-02
2,6-DNT	1.93E+00	8.00E+00	2.41E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	2.39E-03	9.90E-03	9.90E-03	0.00E+00	0.00E+00	9.90E-03
Dinitrotoluene	1.93E+00	8.00E+00	2.41E-01	9.00E-02	9.00E-02	4.11E-04	1.70E-03	0.00E+00	0.00E+00	1.70E-03	0.00E+00	0.00E+00	1.70E-03
2-Nitrotoluene	4.73E+01	8.00E+00	5.91E+00	9.00E-02	9.00E-02	2.21E-05	3.73E-06	1.07E-03	1.81E-04	1.84E-04	0.00E+00	0.00E+00	1.84E-04
3-Nitrotoluene	4.73E+01	8.00E+00	5.91E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	8.76E-04	1.48E-04	1.48E-04	0.00E+00	0.00E+00	1.48E-04
4-Nitrotoluene	4.73E+01	8.00E+00	5.91E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	9.13E-04	1.54E-04	1.54E-04	0.00E+00	0.00E+00	1.54E-04
2,4,6-TNT	4.35E+00	8.00E+00	5.44E-01	9.00E-02	9.00E-02	8.97E-03	1.65E-02	4.23E+00	7.78E+00	7.79E+00	0.00E+00	0.00E+00	7.79E+00
Inorganics													
Aluminum	5.68E+00	8.00E+00	7.10E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E+00	1.46E+00	1.46E+00
Barium	1.08E+01	8.00E+00	1.35E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.49E-02	1.11E-02	1.11E-02
Cadmium	5.25E+00	8.00E+00	6.56E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.81E-04	4.28E-04	4.28E-04
Calcium	5.20E+03	8.00E+00	6.50E+02	9.00E-02	9.00E-02	7.38E+00	1.14E-02	2.24E+02	3.45E-01	3.57E-01	5.15E+01	7.92E-02	4.36E-01
Chromium	7.45E+03	8.00E+00	9.31E+02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	3.98E-05	4.28E-08	4.28E-08	0.00E+00	0.00E+00	4.28E-08
Cobalt	6.53E+00	8.00E+00	8.16E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.52E-03	1.87E-03	1.87E-03
Copper	1.07E+01	8.00E+00	1.33E+00	9.00E-02	9.00E-02	4.18E-03	3.13E-03	5.64E-02	4.23E-02	4.54E-02	2.17E-03	1.62E-03	4.70E-02
Iron	1.28E+02	8.00E+00	1.60E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.55E+00	2.21E-01	2.21E-01
Lead	4.35E+01	8.00E+00	5.44E+00	9.00E-02	9.00E-02	3.33E-02	6.12E-03	2.03E-03	3.72E-04	6.49E-03	1.40E-03	2.58E-04	6.75E-03
Magnesium	7.80E+02	8.00E+00	9.75E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	1.14E+01	1.17E-01	1.17E-01	1.25E+01	1.29E-01	2.46E-01
Manganese	1.54E+02	8.00E+00	1.93E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.71E-01	1.92E-02	1.92E-02
Mercury	3.54E+00	8.00E+00	4.42E-01	9.00E-02	9.00E-02	4.11E-06	9.29E-06	5.45E-05	1.23E-04	1.33E-04	0.00E+00	0.00E+00	1.33E-04
Potassium	7.79E+03	8.00E+00	9.74E+02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.38E+00	1.42E-03	1.42E-03
Selenium	1.79E-01	8.00E+00	2.24E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.47E-04	4.22E-02	4.22E-02
Silver	0.00E+00	8.00E+00	0.00E+00	9.00E-02	9.00E-02	0.00E+00	NA	0.00E+00	NA	NA	3.39E-04	0.00E+00	NA
Sodium	7.79E+03	8.00E+00	9.74E+02	9.00E-02	9.00E-02	1.54E-02	1.58E-05	4.45E-02	4.57E-05	6.15E-05	1.09E+01	1.12E-02	1.13E-02
Zinc	1.74E+02	8.00E+00	2.18E+01	9.00E-02	9.00E-02	3.79E-02	1.74E-03	2.17E-01	9.97E-03	1.17E-02	2.13E-02	9.80E-04	1.27E-02
TOTAL							**4.61E-02**		**8.31E+00**	**8.35E+00**		**1.98E+00**	**1.03E+01**

Body Weight (kg)	61
Water intake (L/d)	4
Food intake (kg(dw)/d)	2
Soil intake (kg/d)	0.04
Plant intake (kg(dw)/d) -- 100% of diet	2

Table G-2

Plum Brook Ordnance Works
TNT Area A

Insectivorous Bird: **Marsh wren *(Cistothorus palustris)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	1.80E+00	8.00E+00	2.25E-01	1.00E+00	1.00E+00	4.71E-02	2.09E-01	1.96E+01	8.71E+01	8.73E+01	0.00E+00	0.00E+00	8.73E+01	8.81E+01
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.05E-03	0.00E+00	0.00E+00	4.52E-08
Di-n-butyl phthalate	1.10E+00	8.00E+00	1.38E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.70E-04	3.42E-03	3.42E-03	4.84E-05
2-Amino-4,6-DNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	1.75E-01	7.88E-02	2.68E-01	1.20E-01	1.99E-01	5.29E-04	2.38E-04	1.99E-01	9.61E-06
4-Amino-2,6-DNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	1.14E-01	5.11E-02	1.73E-01	7.79E-02	1.29E-01	6.32E-04	2.84E-04	1.29E-01	6.23E-06
2,4-DNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dinitrotoluene	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	1.32E-01	5.95E-02	2.02E-01	9.08E-02	1.50E-01	0.00E+00	0.00E+00	1.50E-01	1.41E-05
2-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	7.11E-03	3.19E-03	1.08E-02	4.87E-03	8.07E-03	0.00E+00	0.00E+00	8.07E-03	7.96E-07
3-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
4-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	2.89E+00	1.30E+00	4.41E+00	1.98E+00	3.28E+00	0.00E+00	0.00E+00	3.28E+00	1.58E-04
Inorganics														
Aluminum	1.10E+03	8.00E+00	1.38E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.78E-01	5.66E-03	5.66E-03	1.18E-02
Barium	4.17E+01	8.00E+00	5.21E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-02	2.15E-03	2.15E-03	2.27E-05
Cadmium	2.00E+01	8.00E+00	2.50E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.11E-04	8.42E-05	8.42E-05	8.52E-07
Calcium	1.42E+04	8.00E+00	1.77E+03	1.00E+00	1.00E+00	2.38E+03	1.34E+00	3.63E+04	2.05E+01	2.18E+01	3.86E+01	2.18E-02	2.18E+01	7.82E+02
Chromium	5.00E+00	8.00E+00	6.25E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.14E-03	0.00E+00	0.00E+00	1.16E-06
Copper	6.20E+01	8.00E+00	7.75E+00	1.00E+00	1.00E+00	1.35E+00	1.74E-01	5.13E+00	6.62E-01	8.36E-01	1.63E-03	2.10E-04	8.36E-01	5.90E-01
Iron	2.50E+02	8.00E+00	3.13E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.66E+00	8.51E-02	8.51E-02	5.38E-01
Lead	3.85E+01	8.00E+00	4.81E+00	1.00E+00	1.00E+00	1.07E+01	2.23E+00	1.52E+02	3.16E+01	3.38E+01	1.05E-03	2.19E-04	3.38E+01	6.59E-01
Magnesium	7.50E+02	8.00E+00	9.38E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.40E+00	1.00E-01	1.00E-01	1.90E+00
Manganese	9.77E+03	8.00E+00	1.22E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E-01	2.28E-04	2.28E-04	1.41E-03
Mercury	9.00E-01	8.00E+00	1.13E-01	1.00E+00	1.00E+00	1.32E-03	1.18E-02	2.02E-02	1.79E-01	1.91E-01	0.00E+00	0.00E+00	1.91E-01	5.44E-02
Potassium	5.00E+03	8.00E+00	6.25E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E+00	1.65E-03	1.65E-03	1.05E-01
Selenium	1.00E+00	8.00E+00	1.25E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.10E-04	5.68E-03	5.68E-03	1.08E-04
Silver	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-04	0.00E+00	0.00E+00	7.71E-06
Sodium	5.00E+03	8.00E+00	6.25E+02	1.00E+00	1.00E+00	4.96E+00	7.93E-03	7.57E+01	1.21E-01	1.29E-01	8.21E+00	1.31E-02	1.42E-01	7.19E+01
Zinc	1.31E+02	8.00E+00	1.64E+01	1.00E+00	1.00E+00	1.22E+01	7.45E-01	5.59E+01	3.41E+00	4.16E+00	1.60E-02	9.76E-04	4.16E+00	6.88E+01
TOTAL							**5.46E+00**		**1.42E+02**	**1.48E+02**		**2.40E-01**	**1.48E+02**	

Body Weight (kg)	0.01
Water intake (L/d)	0.0027
Food intake (kg(dw)/d)	0.0029
Soil intake (kg/d)	0.00019
Plant intake (kg(dw)/d) -- 0% of diet	0
Invertebrate intake (kg(dw)/d) -- 100% of diet	0.0029

Table G-2

Plum Brook Ordnance Works
TNT Area A

Avian predator: **Red-tailed hawk (*Buteo jamaicensis*)**

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Bird Intake (mg/kg-d)	Bird Intake Hazard Quotient	Mouse Intake (mg/kg-d)	Mouse Intake Hazard Quotient	Rabbit Intake (mg/kg-d)	Rabbit Intake Hazard Quotient	Shrew Intake (mg/kg-d)	Shrew Intake Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics																			
Aroclor-1260	1.80E+00	8.00E+00	2.25E-01	5.00E-02	5.00E-02	2.59E-04	1.15E-03	6.30E-02	2.80E-01	1.96E-02	8.70E-02	1.60E-04	7.09E-04	5.14E-02	2.28E-01	5.97E-01	0.00E+00	0.00E+00	5.97E-01
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	3.23E-11	0.00E+00	2.17E-11	0.00E+00	4.21E-11	0.00E+00	2.96E-11	0.00E+00	0.00E+00	3.37E-05	0.00E+00	0.00E+00
Di-n-butyl phthalate	1.10E+00	8.00E+00	1.38E-01	5.00E-02	5.00E-02	0.00E+00	0.00E+00	3.46E-08	2.52E-07	2.33E-08	1.69E-07	4.51E-08	3.28E-07	3.18E-08	2.31E-07	9.80E-07	5.18E-06	3.77E-05	3.87E-05
2-Amino-4,6-DNT	1.78E+01	8.00E+00	2.23E+00	5.00E-02	5.00E-02	9.64E-04	4.33E-04	6.87E-09	3.09E-09	5.65E-08	2.54E-08	1.21E-07	5.46E-08	4.44E-09	2.00E-09	4.34E-04	5.84E-06	2.62E-06	4.36E-04
4-Amino-2,6-DNT	1.78E+01	8.00E+00	2.23E+00	5.00E-02	5.00E-02	6.25E-04	2.81E-04	4.46E-09	2.00E-09	3.66E-08	1.65E-08	7.87E-08	3.54E-08	3.99E-09	1.79E-09	2.81E-04	6.97E-06	3.13E-06	2.84E-04
2,4-DNT	1.78E+01	8.00E+00	2.23E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.50E-10	2.02E-10	2.02E-10	0.00E+00	0.00E+00	2.02E-10
2,6-DNT	1.78E+01	8.00E+00	2.23E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-09	5.24E-10	5.24E-10	0.00E+00	0.00E+00	5.24E-10
Dinitrotoluene	1.78E+01	8.00E+00	2.23E+00	5.00E-02	5.00E-02	7.28E-04	3.27E-04	1.01E-08	4.52E-09	5.80E-08	2.61E-08	1.24E-07	5.57E-08	4.96E-09	2.23E-09	3.27E-04	0.00E+00	0.00E+00	3.27E-04
2-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	5.00E-02	5.00E-02	3.91E-05	1.76E-05	5.69E-10	2.56E-10	3.19E-09	1.43E-09	6.82E-09	3.06E-09	8.47E-10	3.81E-10	1.76E-05	0.00E+00	0.00E+00	1.76E-05
3-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.08E-10	3.63E-10	3.63E-10	0.00E+00	0.00E+00	3.63E-10
4-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.52E-10	3.38E-10	3.38E-10	0.00E+00	0.00E+00	3.38E-10
2,4,6-TNT	1.78E+01	8.00E+00	2.23E+00	5.00E-02	5.00E-02	1.59E-02	7.14E-03	1.13E-07	5.08E-08	9.30E-07	4.18E-07	2.00E-06	8.99E-07	7.89E-07	3.55E-07	7.14E-03	0.00E+00	0.00E+00	7.14E-03
Inorganics																			
Aluminum	1.10E+03	8.00E+00	1.38E+02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	8.43E-06	6.13E-08	5.67E-06	4.13E-08	1.10E-05	7.99E-08	7.73E-06	5.62E-08	2.39E-07	8.58E-03	6.24E-05	6.26E-05
Barium	4.17E+01	8.00E+00	5.21E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	1.62E-08	3.11E-09	1.09E-08	2.09E-09	2.11E-08	4.05E-09	1.49E-08	2.85E-09	1.21E-08	1.24E-04	2.37E-05	2.37E-05
Cadmium	2.00E+01	8.00E+00	2.50E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	6.09E-10	2.44E-10	4.10E-10	1.64E-10	7.93E-10	3.17E-10	5.58E-10	2.23E-10	9.48E-10	2.32E-06	9.29E-07	9.30E-07
Calcium	1.42E+04	8.00E+00	1.77E+03	5.00E-02	5.00E-02	1.31E+01	7.38E-03	5.59E-01	3.16E-04	6.56E-01	3.71E-04	1.09E+00	6.15E-04	4.80E-01	2.71E-04	8.95E-03	4.26E-01	2.41E-04	9.19E-03
Chromium	5.00E+00	8.00E+00	6.25E-01	5.00E-02	5.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.85E-05	1.26E-04	1.26E-04	0.00E+00	0.00E+00	1.26E-04
Cobalt	0.00E+00	8.00E+00	0.00E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	8.26E-10	0.00E+00	5.56E-10	0.00E+00	1.08E-09	0.00E+00	7.57E-10	0.00E+00	0.00E+00	1.26E-05	0.00E+00	0.00E+00
Copper	6.20E+01	8.00E+00	7.75E+00	5.00E-02	5.00E-02	7.40E-03	9.55E-04	4.22E-04	5.44E-05	6.45E-04	8.33E-05	1.22E-03	1.57E-04	4.12E-04	5.31E-05	1.30E-03	1.79E-05	2.31E-06	1.31E-03
Iron	2.50E+02	8.00E+00	3.13E+01	5.00E-02	5.00E-02	0.00E+00	0.00E+00	3.84E-04	1.23E-05	2.59E-04	8.28E-06	5.01E-04	1.60E-05	3.53E-04	1.13E-05	4.79E-05	2.93E-02	9.39E-04	9.87E-04
Lead	3.85E+01	8.00E+00	4.81E+00	5.00E-02	5.00E-02	5.89E-02	1.22E-02	4.71E-04	9.78E-05	1.45E-04	3.01E-05	3.18E-05	6.62E-06	5.20E-04	1.08E-04	1.25E-02	1.16E-05	2.41E-06	1.25E-02
Magnesium	7.50E+02	8.00E+00	9.38E+01	5.00E-02	5.00E-02	0.00E+00	0.00E+00	1.36E-03	1.45E-05	9.14E-04	9.75E-06	1.77E-03	1.89E-05	6.53E-02	6.97E-04	7.40E-04	1.04E-01	1.11E-03	1.85E-03
Manganese	9.77E+03	8.00E+00	1.22E+03	5.00E-02	5.00E-02	0.00E+00	0.00E+00	1.01E-06	8.23E-10	6.76E-07	5.54E-10	1.31E-06	1.07E-09	9.22E-07	7.55E-10	3.20E-09	3.07E-03	2.51E-06	2.51E-06
Mercury	9.00E-01	8.00E+00	1.13E-01	5.00E-02	5.00E-02	7.27E-06	6.46E-05	3.89E-05	3.45E-04	2.17E-05	1.93E-04	2.36E-05	2.10E-04	3.52E-05	3.13E-04	1.13E-03	0.00E+00	0.00E+00	1.13E-03
Potassium	5.00E+03	8.00E+00	6.25E+02	5.00E-02	5.00E-02	0.00E+00	0.00E+00	7.47E-05	1.20E-07	5.03E-05	8.05E-08	9.74E-05	1.56E-07	6.85E-05	1.10E-07	4.66E-07	1.14E-02	1.82E-05	1.87E-05
Selenium	1.00E+00	8.00E+00	1.25E-01	5.00E-02	5.00E-02	0.00E+00	0.00E+00	7.70E-08	6.16E-07	5.18E-08	4.15E-07	1.00E-07	8.02E-07	7.06E-08	5.65E-07	2.40E-06	7.83E-06	6.27E-05	6.51E-05
Silver	0.00E+00	8.00E+00	0.00E+00	5.00E-02	5.00E-02	0.00E+00	0.00E+00	5.51E-09	0.00E+00	3.71E-09	0.00E+00	7.18E-09	0.00E+00	5.05E-09	0.00E+00	0.00E+00	2.80E-06	0.00E+00	0.00E+00
Sodium	5.00E+03	8.00E+00	6.25E+02	5.00E-02	5.00E-02	2.73E-02	4.36E-05	5.14E-02	8.22E-05	1.89E-02	3.02E-05	1.21E-02	1.93E-05	5.21E-02	8.33E-05	2.59E-04	9.05E-02	1.45E-04	4.04E-04
Zinc	1.31E+02	8.00E+00	1.64E+01	5.00E-02	5.00E-02	6.71E-02	4.10E-03	4.92E-02	3.00E-03	4.29E-02	2.62E-03	7.02E-02	4.29E-03	4.40E-02	2.69E-03	1.67E-02	1.76E-04	1.08E-05	1.67E-02
TOTAL							**3.00E-02**		**2.81E-01**		**8.78E-02**		**1.76E-03**		**2.30E-01**	**6.30E-01**		**2.65E-03**	**6.33E-01**

Body Weight (kg)	0.957
Water intake (L/d)	0.057
Food intake (kg(dw)/d)	0.057
Soil intake (kg/d)	0.002
Bird intake (kg(dw)/d) -- 24% of diet	0.01368
Mouse intake (kg(dw)/d) -- 25.3% of diet	0.01444
Shrew intake (kg(dw)/d) -- 25.3% of diet	0.01444
Rabbit intake (kg(dw)/d) -- 25.3% of diet	0.01444

Table G-3

Plum Brook Ordnance Works
TNT Area A

Chemical Data

Chemical Name	Sediment Conc. (mg/kg)	Water Conc. (mg/L)	log Kow (organics)	Kow (organics)	log Koc (organics) (mL/g)	Koc (organics) (mL/g)	Kd (inorganics) (mL/g)	Foc	Water-to-Invert. BCF	Sediment-to-Invertebrate TF	Sediment-to-Plant TF	Plant Concentration (mg/kgdw)	Pore water Conc. (mg/L)	Solubility (mg/L)	< of the PoreH2O or Solubility	Invert. Conc. (mg/kgww)	Invert Conc. (mg/kgdw)	Food-to-Muscle TF
Organics																		
Aroclor 1260	7.31E-01		7.15E+00	1.40E+07	7.02E+00	1.06E+07	---	6.70E-02	1.40E+07	NA	2.87E-03	2.10E-03	1.03E-06		1.03E-06	1.44E+01	5.77E+01	4.44E-01
2-Amino-4,6-DNT	2.92E+00	1.96E-03	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	7.90E+00	4.71E-01		4.71E-01	4.71E+01	1.88E+02	2.14E-06
4-Amino-2,6-DNT	1.18E+00	2.34E-03	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	3.19E+00	1.90E-01		1.90E-01	1.90E+01	7.61E+01	2.14E-06
Benzo(a)anthracene	2.45E-01		5.61E+00	4.10E+05	5.52E+00	3.29E+05	---	6.70E-02	4.10E+05	NA	2.21E-02	5.41E-03	1.11E-05		1.11E-05	4.55E+00	1.82E+01	1.16E-02
Benzo(a)pyrene	1.36E-01		6.06E+00	1.15E+06	5.96E+00	9.08E+05	---	6.70E-02	1.15E+06	NA	1.22E-02	1.65E-03	2.24E-06		2.24E-06	2.57E+00	1.03E+01	3.36E-02
Carbon disulfide		1.13E-02	1.84E+00	6.92E+01	1.81E+00	6.44E+01	---	6.70E-02	6.92E+01	NA	3.35E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	1.46E-06
Chrysene	1.63E-01		5.61E+00	4.10E+05	5.52E+00	3.29E+05	---	6.70E-02	4.10E+05	NA	2.21E-02	3.60E-03	7.39E-06		7.39E-06	3.03E+00	1.21E+01	1.16E-02
2,4-DNT																		
2,6-DNT																		
Di-n-butyl phthalate		1.74E-03	5.56E+00	3.60E+05	5.46E+00	2.90E+05	---	6.70E-02	3.60E+05	NA	2.38E-02	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	1.01E-02
Dinitrotoluene	5.76E-01		2.28E+00	1.90E+02	2.24E+00	1.74E+02	---	6.70E-02	1.90E+02	NA	1.87E+00	1.07E+00	4.94E-02		4.94E-02	9.39E+00	3.76E+01	4.16E-06
Fluoranthene	6.88E-01		4.90E+00	7.90E+04	4.81E+00	6.53E+04	---	6.70E-02	7.90E+04	NA	5.72E-02	3.93E-02	1.57E-04		1.57E-04	1.24E+01	4.97E+01	2.11E-03
2-Nitrotoluene	1.68E-01		2.30E+00	2.00E+02	2.26E+00	1.83E+02	---	6.70E-02	2.00E+02	NA	1.81E+00	3.04E-01	1.37E-02		1.37E-02	2.74E+00	1.10E+01	4.38E-06
Phenanthrene	1.07E-01		4.45E+00	2.80E+04	4.37E+00	2.35E+04	---	6.70E-02	2.80E+04	NA	1.04E-01	1.11E-02	6.78E-05		6.78E-05	1.90E+00	7.60E+00	7.23E-04
Pyrene	4.58E-01		4.90E+00	8.00E+04	4.82E+00	6.61E+04	---	6.70E-02	8.00E+04	NA	5.68E-02	2.60E-02	1.03E-04		1.03E-04	8.28E+00	3.31E+01	2.14E-03
2,4,6-TNT	4.60E+00		2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	1.24E+01	7.42E-01		7.42E-01	7.42E+01	2.97E+02	2.14E-06
Inorganics																		
Aluminum		2.88E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.50E-03
Barium		4.15E-02	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.40E-04
Beryllium	1.25E+00		---	---	---	---	6.50E+02	6.70E-02	1.00E+02	NA	5.80E-03	7.25E-03	1.92E-03		1.92E-03	1.92E-01	7.69E-01	1.00E-03
Cadmium	6.36E-01	7.80E-04	---	---	---	---	6.40E+00	6.70E-02	1.00E+02	NA	3.50E-01	2.23E-01	9.94E-02		9.94E-02	9.94E+00	3.98E+01	4.00E-04
Calcium	6.87E+04	1.43E+02	---	---	---	---	4.00E+00	6.70E-02	1.00E+02	3.30E-02	1.90E+00	1.31E+05	--		--	2.27E+03	9.07E+03	2.00E-03
Cobalt		4.23E-03	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.00E-02
Copper		6.02E-03	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	9.00E-03
Iron		9.85E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-02
Lead	4.97E+01	3.90E-03	---	---	---	---	4.00E+02	6.70E-02	3.00E+02	2.50E-02	1.10E-03	5.47E-02	--		--	1.24E+00	4.97E+00	4.00E-04
Magnesium		3.48E+01	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-02
Manganese		1.03E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	5.00E-04
Mercury	2.07E-01		---	---	---	---	1.00E+01	6.70E-02	1.00E+03	NA	5.50E-01	1.14E-01	2.07E-02		2.07E-02	2.07E+01	8.28E+01	2.50E-01
Nickel	1.01E+02		---	---	---	---	1.50E+02	6.70E-02	1.00E+02	1.80E-02	3.60E-01	3.64E+01	--		--	1.82E+00	7.27E+00	5.00E-03
Potassium		3.83E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.00E-02
Selenium		2.63E-03	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.50E-02
Silver		9.41E-04	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	3.00E-03
Sodium	1.84E+02	3.04E+01	---	---	---	---	1.00E+02	6.70E-02	2.00E+01	7.70E-01	6.50E-02	1.20E+01	--		--	1.42E+02	5.67E+02	8.00E-02
Zinc		5.92E-02	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.00E-01

Table G-3

Toxicity Data

Plum Brook Ordnance Works
TNT Area A

Chemical Name	Mammals NOAEL (mg/kg/d)	Mammals Test Species	Mammals Body Wt. (kg)	Birds NOAEL (mg/kg/d)	Birds Test Species	Birds Body Wt. (kg)
Organics						
Aroclor 1260	6.80E-02	mouse	0.014	1.80E-01	ring neck pheasant	1
2-Amino-4,6-DNT	1.39E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
4-Amino-2,6-DNT	9.60E+00	rat	0.35	7.00E-01	Bobwhite quail	0.19
Benzo(a)anthracene	1.00E+00	mouse	0.03	--	--	--
Benzo(a)pyrene	1.00E+00	mouse	0.03	--	--	--
Carbon disulfide	3.19E+01	rat	0.35	--	--	--
Chrysene	1.00E+00	mouse	0.03	--	--	--
2,4-DNT	2.00E-01	beagle dog	11	7.00E-01	Bobwhite quail	0.19
2,6-DNT	2.00E-01	beagle dog	11	7.00E-01	Bobwhite quail	0.19
Di-n-butyl phthalate	5.50E+02	mouse	0.03	1.10E-01	ringed dove	0.155
Dinitrotoluene	2.00E-01	beagle dog	11	7.00E-01	Bobwhite quail	0.19
Fluoranthene	1.00E+00	mouse	0.03	--	--	--
2-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
Phenanthrene	1.00E+00	mouse	0.03	--	--	--
Pyrene	1.00E+00	mouse	0.03	--	--	--
2,4,6-TNT	1.60E+00	rat	0.35	7.00E-01	Bobwhite quail	0.19
Inorganics						
Aluminum	1.93E+00	mouse	0.03	1.10E+02	ringed dove	0.155
Barium	5.10E+00	rat	0.435	2.08E+01	chicks	0.121
Beryllium	6.60E-01	rat	0.35	--	--	--
Cadmium	1.00E+00	rat	0.303	1.45E+00	Mallard duck	1.153
Calcium	1.05E+03	rabbit	3.8	2.83E+03	Jap. Quail	0.072
Cobalt	1.20E+00	rat	0.35	--	--	--
Copper	1.17E+01	mink	1	4.70E+01	chicks	0.534
Iron	2.60E+01	rabbit	3.8	5.00E+01	poultry	1.6
Lead	8.00E+00	rat	0.35	3.85E+00	Am. Kestrel	0.13
Magnesium	1.58E+02	rabbit	3.8	1.50E+02	poultry	1.6
Manganese	8.80E+01	rat	0.35	9.77E+02	Jap. Quail	0.072
Mercury	1.00E+00	mink	1	4.50E-01	Jap. Quail	0.15
Nickel	4.00E+01	rat	0.35	7.74E+01	Mallard duck	0.782
Potassium	1.60E+03	rabbit	3.8	1.00E+03	poultry	1.6
Selenium	2.00E-01	rat	0.35	5.00E-01	Mallard duck	1
Silver	--	--	--	--	--	--
Sodium	1.60E+03	rabbit	3.8	1.00E+03	poultry	1.6
Zinc	1.60E+02	rat	0.35	1.45E+01	hens	1.935

Table G-3

Plum Brook Ordnance Works
TNT Area A

Omnivorous Bird: **Mallard duck *(Anas platyrhynchos)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (sed./sw.)	Sediment Intake (mg/kg-d)	Sediment Hazard Quotient	Plant Intake (mg/kg-d)	Plant Hazard Quotient	Macroinvert Intake (mg/kg-d)	Macroinvert Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics														
Aroclor 1260	1.80E-01	8.00E+00	2.25E-02	2.00E-01	1.68E-04	7.48E-03	1.46E-05	6.49E-04	2.41E-01	1.07E+01	1.07E+01	0.00E+00	0.00E+00	1.07E+01
2-Amino-4,6-DNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	6.72E-04	7.68E-03	5.50E-02	6.29E-01	7.88E-01	9.00E+00	9.64E+00	2.22E-05	2.54E-04	9.64E+00
4-Amino-2,6-DNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	2.72E-04	3.10E-03	2.22E-02	2.54E-01	3.18E-01	3.64E+00	3.90E+00	2.65E-05	3.03E-04	3.90E+00
Benzo(a)anthracene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	5.64E-05	NA	3.77E-05	NA	7.61E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	3.13E-05	NA	1.15E-05	NA	4.30E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	0.00E+00	NA	0.00E+00	NA	0.00E+00	1.28E-04	0.00E+00	0.00E+00
Chrysene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	3.75E-05	NA	2.51E-05	NA	5.07E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4-DNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate	1.10E-01	8.00E+00	1.38E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-05	1.43E-03	1.43E-03
Dinitrotoluene	7.00E-01	8.00E+00	8.75E-02	2.00E-01	1.33E-04	1.51E-03	7.49E-03	8.56E-02	1.57E-01	1.80E+00	1.88E+00	0.00E+00	0.00E+00	1.88E+00
Fluoranthene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.58E-04	NA	2.74E-04	NA	2.08E-01	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	2.00E-01	3.87E-05	4.42E-04	2.12E-03	2.42E-02	4.59E-02	5.24E-01	5.49E-01	0.00E+00	0.00E+00	5.49E-01
Phenanthrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	2.46E-05	NA	7.76E-05	NA	3.18E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.05E-04	NA	1.81E-04	NA	1.38E-01	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	1.06E-03	1.21E-02	8.67E-02	9.91E-01	1.24E+00	1.42E+01	1.52E+01	0.00E+00	0.00E+00	1.52E+01
Inorganics														
Aluminum	1.10E+02	8.00E+00	1.38E+01	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	3.26E-02	2.37E-03	2.37E-03
Barium	2.08E+01	8.00E+00	2.60E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	4.70E-04	1.81E-04	1.81E-04
Beryllium	0.00E+00	8.00E+00	0.00E+00	2.00E-01	2.88E-04	NA	NA	NA	3.22E-03	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	1.45E+00	1.00E+00	1.45E+00	2.00E-01	1.46E-04	1.01E-04	1.55E-03	1.07E-03	1.66E-01	1.15E-01	1.16E-01	8.84E-06	6.09E-06	1.16E-01
Calcium	2.83E+03	8.00E+00	3.54E+02	2.00E-01	1.58E+01	4.46E-02	9.10E+02	2.57E+00	3.79E+01	1.07E-01	2.72E+00	1.62E+00	4.57E-03	2.73E+00
Cobalt	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	NA	NA	0.00E+00	NA	0.00E+00	4.79E-05	0.00E+00	0.00E+00
Copper	4.70E+01	8.00E+00	5.88E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	6.82E-05	1.16E-05	1.16E-05
Iron	5.00E+01	8.00E+00	6.25E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	1.12E-01	1.79E-02	1.79E-02
Lead	3.85E+00	8.00E+00	4.81E-01	2.00E-01	1.14E-02	2.38E-02	3.81E-04	7.92E-04	2.08E-02	4.32E-02	6.77E-02	4.42E-05	9.18E-05	6.78E-02
Magnesium	1.50E+02	8.00E+00	1.88E+01	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	3.94E-01	2.10E-02	2.10E-02
Manganese	9.77E+02	8.00E+00	1.22E+02	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	1.17E-02	9.55E-05	9.55E-05
Mercury	4.50E-01	8.00E+00	5.63E-02	2.00E-01	4.76E-05	8.47E-04	7.93E-04	1.41E-02	3.46E-01	6.16E+00	6.17E+00	0.00E+00	0.00E+00	6.17E+00
Nickel	7.74E+01	1.00E+00	7.74E+01	2.00E-01	2.32E-02	3.00E-04	2.53E-01	3.27E-03	3.04E-02	3.93E-04	3.97E-03	0.00E+00	0.00E+00	3.97E-03
Potassium	1.00E+03	8.00E+00	1.25E+02	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	4.34E-02	3.47E-04	3.47E-04
Selenium	5.00E-01	1.00E+00	5.00E-01	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	2.98E-05	5.96E-05	5.96E-05
Silver	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	NA	NA	0.00E+00	NA	0.00E+00	1.07E-05	0.00E+00	0.00E+00
Sodium	1.00E+03	8.00E+00	1.25E+02	2.00E-01	4.23E-02	3.39E-04	8.33E-02	6.67E-04	2.37E+00	1.90E-02	2.00E-02	3.44E-01	2.75E-03	2.27E-02
Zinc	1.45E+01	8.00E+00	1.81E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	6.71E-04	3.70E-04	3.70E-04
TOTAL						**1.02E-01**		**4.57E+00**		**4.63E+01**	**5.10E+01**		**5.17E-02**	**5.10E+01**

Body Weight (kg)	1.13
Water intake (L/d)	0.064
Food intake (kg(dw)/d)	0.063
Sediment intake (kg/d)	0.0013
Plant intake (kg(dw)/d) -- 62.5% of diet	0.039375
Macroinvert intake (kg(dw)/d) -- 37.5% of diet	0.023625

Table G-3

Plum Brook Ordnance Works
TNT Area A

Omnivorous mammal: **Raccoon *(Procyon lotor)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (sed./sw.)	Sediment Intake (mg/kg-d)	Sediment Hazard Quotient	Aq. Invert. Intake (mg/kg-d)	Aq. Invert. Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics												
Aroclor 1260	1.56E-02	8.00E+00	1.95E-03	2.00E-01	3.44E-04	1.77E-01	1.24E-01	6.35E+01	6.37E+01	0.00E+00	0.00E+00	6.37E+01
2-Amino-4,6-DNT	7.13E+00	8.00E+00	8.92E-01	2.00E-01	1.37E-03	1.54E-03	4.03E-01	4.52E-01	4.54E-01	1.65E-05	1.85E-05	4.54E-01
4-Amino-2,6-DNT	4.91E+00	8.00E+00	6.14E-01	2.00E-01	5.55E-04	9.04E-04	1.63E-01	2.65E-01	2.66E-01	1.97E-05	3.21E-05	2.66E-01
Benzo(a)anthracene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	1.15E-04	3.33E-03	3.90E-02	1.13E+00	1.13E+00	0.00E+00	0.00E+00	1.13E+00
Benzo(a)pyrene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	6.40E-05	1.85E-03	2.20E-02	6.36E-01	6.38E-01	0.00E+00	0.00E+00	6.38E-01
Carbon disulfide	1.63E+01	8.00E+00	2.04E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.53E-05	4.67E-05	4.67E-05
Chrysene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	7.67E-05	2.22E-03	2.59E-02	7.49E-01	7.52E-01	0.00E+00	0.00E+00	7.52E-01
2,4-DNT	2.42E-01	8.00E+00	3.03E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	2.42E-01	8.00E+00	3.03E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate	1.52E+02	8.00E+00	1.90E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.47E-05	7.71E-07	7.71E-07
Dinitrotoluene	2.42E-01	8.00E+00	3.03E-02	2.00E-01	2.71E-04	8.95E-03	8.04E-02	2.66E+00	2.66E+00	0.00E+00	0.00E+00	2.66E+00
Fluoranthene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	3.24E-04	9.35E-03	1.06E-01	3.08E+00	3.08E+00	0.00E+00	0.00E+00	3.08E+00
2-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	2.00E-01	7.91E-05	2.75E-05	2.35E-02	8.16E-03	8.18E-03	0.00E+00	0.00E+00	8.18E-03
Phenanthrene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	5.04E-05	1.45E-03	1.63E-02	4.70E-01	4.71E-01	0.00E+00	0.00E+00	4.71E-01
Pyrene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	2.16E-04	6.23E-03	7.09E-02	2.05E+00	2.05E+00	0.00E+00	0.00E+00	2.05E+00
2,4,6-TNT	8.19E-01	8.00E+00	1.02E-01	2.00E-01	2.16E-03	2.11E-02	6.35E-01	6.21E+00	6.23E+00	0.00E+00	0.00E+00	6.23E+00
Inorganics												
Aluminum	5.34E-01	8.00E+00	6.68E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.43E-02	3.63E-01	3.63E-01
Barium	2.76E+00	8.00E+00	3.45E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E-04	1.02E-03	1.02E-03
Beryllium	3.38E-01	8.00E+00	4.22E-02	2.00E-01	5.88E-04	1.39E-02	1.65E-03	3.90E-02	5.29E-02	0.00E+00	0.00E+00	5.29E-02
Cadmium	4.94E-01	8.00E+00	6.17E-02	2.00E-01	2.99E-04	4.85E-03	8.51E-02	1.38E+00	1.38E+00	6.58E-06	1.07E-04	1.38E+00
Calcium	9.78E+02	8.00E+00	1.22E+02	2.00E-01	3.23E+01	2.64E-01	1.94E+01	1.59E-01	4.23E-01	1.21E+00	9.86E-03	4.33E-01
Cobalt	6.14E-01	8.00E+00	7.68E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.57E-05	4.65E-04	4.65E-04
Copper	7.79E+00	8.00E+00	9.73E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.08E-05	5.22E-05	5.22E-05
Iron	2.42E+01	8.00E+00	3.02E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.30E-02	2.75E-02	2.75E-02
Lead	4.09E+00	8.00E+00	5.12E-01	2.00E-01	2.34E-02	4.57E-02	1.06E-02	2.08E-02	6.65E-02	3.29E-05	6.42E-05	6.66E-02
Magnesium	1.47E+02	8.00E+00	1.83E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-01	1.60E-02	1.60E-02
Manganese	4.50E+01	8.00E+00	5.63E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.68E-03	1.54E-03	1.54E-03
Mercury	6.65E-01	8.00E+00	8.32E-02	2.00E-01	9.74E-05	1.17E-03	1.77E-01	2.13E+00	2.13E+00	0.00E+00	0.00E+00	2.13E+00
Nickel	2.05E+01	8.00E+00	2.56E+00	2.00E-01	4.75E-02	1.86E-02	1.56E-02	6.08E-03	2.47E-02	0.00E+00	0.00E+00	2.47E-02
Potassium	1.48E+03	8.00E+00	1.85E+02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.23E-02	1.74E-04	1.74E-04
Selenium	1.02E-01	8.00E+00	1.28E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.22E-05	1.73E-03	1.73E-03
Silver	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	0.00E+00	NA	NA	7.93E-06	0.00E+00	0.00E+00
Sodium	1.48E+03	8.00E+00	1.85E+02	2.00E-01	8.66E-02	4.67E-04	1.21E+00	6.54E-03	7.01E-03	2.56E-01	1.38E-03	8.39E-03
Zinc	8.19E+01	8.00E+00	1.02E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.99E-04	4.88E-05	4.88E-05
TOTAL						**5.83E-01**		**8.49E+01**	**8.55E+01**		**4.23E-01**	**8.59E+01**

Body Weight (kg)	5.1
Water intake (L/d)	0.215
Food intake (kg(dw)/d)	0.26
Sediment intake (kg/d)	0.012
Aquatic Invert. Intake (kg(dw)/d -- 21% of diet	0.0546

Table G-4

Plum Brook Ordnance Works
TNT Area A

Chemical Data

Chemical Name	Sediment Conc. (mg/kg)	Water Conc. (mg/L)	log Kow (organics)	Kow (organics)	log Koc (organics) (mL/g)	Koc (organics) (mL/g)	Kd (inorganics) (mL/g)	Foc	Water-to-Invert. BCF	Sediment-to-Invertebrate TF	Sediment-to-Plant TF	Plant Concentration (mg/kgdw)	Pore water Conc. (mg/L)	Solubility (mg/L)	< of the PoreH2O or Solubility	Invert. Conc. (mg/kgww)	Invert Conc. (mg/kgdw)	Food-to-Muscle TF
Organics																		
Aroclor 1260	7.31E-01		7.15E+00	1.40E+07	7.02E+00	1.06E+07	---	6.70E-02	1.40E+07	NA	2.87E-03	2.10E-03	1.03E-06		1.03E-06	1.44E+01	5.77E+01	4.44E-01
2-Amino-4,6-DNT	2.92E+00	1.96E-03	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	7.90E+00	4.71E-01		4.71E-01	4.71E+01	1.88E+02	2.14E-06
4-Amino-2,6-DNT	1.18E+00	2.34E-03	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	3.19E+00	1.90E-01		1.90E-01	1.90E+01	7.61E+01	2.14E-06
Benzo(a)anthracene	2.45E-01		5.61E+00	4.10E+05	5.52E+00	3.29E+05	---	6.70E-02	4.10E+05	NA	2.21E-02	5.41E-03	1.11E-05		1.11E-05	4.55E+00	1.82E+01	1.16E-02
Benzo(a)pyrene	1.36E-01		6.06E+00	1.15E+06	5.96E+00	9.08E+05	---	6.70E-02	1.15E+06	NA	1.22E-02	1.65E-03	2.24E-06		2.24E-06	2.57E+00	1.03E+01	3.36E-02
Carbon disulfide		1.13E-02	1.84E+00	6.92E+01	1.81E+00	6.44E+01	---	6.70E-02	6.92E+01	NA	3.35E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	1.46E-06
Chrysene	1.63E-01		5.61E+00	4.10E+05	5.52E+00	3.29E+05	---	6.70E-02	4.10E+05	NA	2.21E-02	3.60E-03	7.39E-06		7.39E-06	3.03E+00	1.21E+01	1.16E-02
2,4-DNT																		
2,6-DNT																		
Di-n-butyl phthalate		1.74E-03	5.56E+00	3.60E+05	5.46E+00	2.90E+05	---	6.70E-02	3.60E+05	NA	2.38E-02	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	1.01E-02
Dinitrotoluene	5.76E-01		2.28E+00	1.90E+02	2.24E+00	1.74E+02	---	6.70E-02	1.90E+02	NA	1.87E+00	1.07E+00	4.94E-02		4.94E-02	9.39E+00	3.76E+01	4.16E-06
Fluoranthene	6.88E-01		4.90E+00	7.90E+04	4.81E+00	6.53E+04	---	6.70E-02	7.90E+04	NA	5.72E-02	3.93E-02	1.57E-04		1.57E-04	1.24E+01	4.97E+01	2.11E-03
2-Nitrotoluene	1.68E-01		2.30E+00	2.00E+02	2.26E+00	1.83E+02	---	6.70E-02	2.00E+02	NA	1.81E+00	3.04E-01	1.37E-02		1.37E-02	2.74E+00	1.10E+01	4.38E-06
Phenanthrene	1.07E-01		4.45E+00	2.80E+04	4.37E+00	2.35E+04	---	6.70E-02	2.80E+04	NA	1.04E-01	1.11E-02	6.78E-05		6.78E-05	1.90E+00	7.60E+00	7.23E-04
Pyrene	4.58E-01		4.90E+00	8.00E+04	4.82E+00	6.61E+04	---	6.70E-02	8.00E+04	NA	5.68E-02	2.60E-02	1.03E-04		1.03E-04	8.28E+00	3.31E+01	2.14E-03
2,4,6-TNT	4.60E+00		2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	1.24E+01	7.42E-01		7.42E-01	7.42E+01	2.97E+02	2.14E-06
Inorganics																		
Aluminum		2.88E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.50E-03
Barium		4.15E-02	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.40E-04
Beryllium	1.25E+00		---	---	---	---	6.50E+02	6.70E-02	1.00E+02	NA	5.80E-03	7.25E-03	1.92E-03		1.92E-03	1.92E-01	7.69E-01	1.00E-03
Cadmium	6.36E-01	7.80E-04	---	---	---	---	6.40E+00	6.70E-02	1.00E+02	NA	3.50E-01	2.23E-01	9.94E-02		9.94E-02	9.94E+00	3.98E+01	4.00E-04
Calcium	6.87E+04	1.43E+02	---	---	---	---	4.00E+00	6.70E-02	1.00E+02	3.30E-02	1.90E+00	1.31E+05	--		--	2.27E+03	9.07E+03	2.00E-03
Cobalt		4.23E-03	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.00E-02
Copper		6.02E-03	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	9.00E-03
Iron		9.85E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-02
Lead	4.97E+01	3.90E-03	---	---	---	---	4.00E+02	6.70E-02	3.00E+02	2.50E-02	1.10E-03	5.47E-02	--		--	1.24E+00	4.97E+00	4.00E-04
Magnesium		3.48E+01	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-02
Manganese		1.03E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	5.00E-04
Mercury	2.07E-01		---	---	---	---	1.00E+01	6.70E-02	1.00E+03	NA	5.50E-01	1.14E-01	2.07E-02		2.07E-02	2.07E+01	8.28E+01	2.50E-01
Nickel	1.01E+02		---	---	---	---	1.50E+02	6.70E-02	1.00E+02	1.80E-02	3.60E-01	3.64E+01	--		--	1.82E+00	7.27E+00	5.00E-03
Potassium		3.83E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.00E-02
Selenium		2.63E-03	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.50E-02
Silver		9.41E-04	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	3.00E-03
Sodium	1.84E+02	3.04E+01	---	---	---	---	1.00E+02	6.70E-02	2.00E+01	7.70E-01	6.50E-02	1.20E+01	--		--	1.42E+02	5.67E+02	8.00E-02
Zinc		5.92E-02	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.00E-01

Table G-4

Plum Brook Ordnance Works
TNT Area A

Toxicity Data

Chemical Name	Mammals LOAEL (mg/kg/d)	Mammals Test Species	Mammals Body Wt. (kg)	Birds LOAEL (mg/kg/d)	Birds Test Species	Birds Body Wt. (kg)
Organics						
Aroclor 1260	6.80E-01	mouse	0.014	1.80E+00	ring neck pheasant	1
2-Amino-4,6-DNT	6.95E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
4-Amino-2,6-DNT	4.80E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
Benzo(a)anthracene	1.00E+01	mouse	0.03	--	--	--
Benzo(a)pyrene	1.00E+01	mouse	0.03	--	--	--
Carbon disulfide	1.59E+02	rat	0.35	--	--	--
Chrysene	1.00E+01	mouse	0.03	--	--	--
2,4-DNT	1.50E+00	beagle dog	11	1.78E+01	Bobwhite quail	0.19
2,6-DNT	1.50E+00	beagle dog	11	1.78E+01	Bobwhite quail	0.19
Di-n-butyl phthalate	1.83E+03	mouse	0.03	1.10E+00	ringed dove	0.155
Dinitrotoluene	1.50E+00	beagle dog	11	1.78E+01	Bobwhite quail	0.19
Fluoranthene	1.00E+01	mouse	0.03	--	--	--
2-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
Phenanthrene	1.00E+01	mouse	0.03	--	--	--
Pyrene	1.00E+01	mouse	0.03	--	--	--
2,4,6-TNT	8.00E+00	rat	0.35	1.78E+01	Bobwhite quail	0.19
Inorganics						
Aluminum	1.93E+01	mouse	0.03	1.10E+03	ringed dove	0.155
Barium	1.98E+01	rat	0.35	4.17E+01	chicks	0.121
Beryllium	3.30E+00	rat	0.35	--	--	--
Cadmium	1.00E+01	rat	0.303	2.00E+01	Mallard duck	1.153
Calcium	5.27E+03	rabbit	3.8	1.42E+04	Jap. Quail	0.072
Cobalt	1.20E+01	rat	0.35	--	--	--
Copper	1.51E+01	mink	1	6.20E+01	chicks	0.534
Iron	1.30E+02	rabbit	3.8	2.50E+02	poultry	1.6
Lead	8.00E+01	rat	0.35	3.85E+01	Am. Kestrel	0.13
Magnesium	7.90E+02	rabbit	3.8	7.50E+02	poultry	1.6
Manganese	2.84E+02	rat	0.35	9.77E+03	Jap. Quail	0.072
Mercury	5.00E+00	mink	1	9.00E-01	Jap. Quail	0.15
Nickel	8.00E+01	rat	0.35	1.07E+02	Mallard duck	0.782
Potassium	7.90E+03	rabbit	3.8	5.00E+03	poultry	1.6
Selenium	3.30E-01	rat	0.35	1.00E+00	Mallard duck	1
Silver	--	--	--	--	--	--
Sodium	7.90E+03	rabbit	3.8	5.00E+03	poultry	1.6
Zinc	3.20E+02	rat	0.35	1.31E+02	hens	1.935

Table G-4

Plum Brook Ordnance Works
TNT Area A

Omnivorous Bird: **Mallard duck *(Anas platyrhynchos)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (sed./sw.)	Sediment Intake (mg/kg-d)	Sediment Hazard Quotient	Plant Intake (mg/kg-d)	Plant Hazard Quotient	Macroinvert Intake (mg/kg-d)	Macroinvert Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics														
Aroclor 1260	1.80E+00	8.00E+00	2.25E-01	2.00E-01	1.68E-04	7.48E-04	1.46E-05	6.49E-05	2.41E-01	1.07E+00	1.07E+00	0.00E+00	0.00E+00	1.07E+00
2-Amino-4,6-DNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	6.72E-04	3.02E-04	5.50E-02	2.47E-02	7.88E-01	3.54E-01	3.79E-01	2.22E-05	9.98E-06	3.79E-01
4-Amino-2,6-DNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	2.72E-04	1.22E-04	2.22E-02	9.99E-03	3.18E-01	1.43E-01	1.53E-01	2.65E-05	1.19E-05	1.53E-01
Benzo(a)anthracene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	5.64E-05	NA	3.77E-05	NA	7.61E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	3.13E-05	NA	1.15E-05	NA	4.30E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	0.00E+00	NA	0.00E+00	NA	0.00E+00	1.28E-04	0.00E+00	0.00E+00
Chrysene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	3.75E-05	NA	2.51E-05	NA	5.07E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4-DNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate	1.10E+00	8.00E+00	1.38E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.97E-05	1.43E-04	1.43E-04
Dinitrotoluene	1.78E+01	8.00E+00	2.23E+00	2.00E-01	1.33E-04	5.96E-05	7.49E-03	3.37E-03	1.57E-01	7.06E-02	7.40E-02	0.00E+00	0.00E+00	7.40E-02
Fluoranthene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.58E-04	NA	2.74E-04	NA	2.08E-01	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	2.00E-01	3.87E-05	1.74E-05	2.12E-03	9.53E-04	4.59E-02	2.06E-02	2.16E-02	0.00E+00	0.00E+00	2.16E-02
Phenanthrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	2.46E-05	NA	7.76E-05	NA	3.18E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Pyrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.05E-04	NA	1.81E-04	NA	1.38E-01	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,4,6-TNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	1.06E-03	4.76E-04	8.67E-02	3.90E-02	1.24E+00	5.58E-01	5.97E-01	0.00E+00	0.00E+00	5.97E-01
Inorganics														
Aluminum	1.10E+03	8.00E+00	1.38E+02	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	3.26E-02	2.37E-04	2.37E-04
Barium	4.17E+01	8.00E+00	5.21E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	4.70E-04	9.02E-05	9.02E-05
Beryllium	0.00E+00	8.00E+00	0.00E+00	2.00E-01	2.88E-04	NA	NA	NA	3.22E-03	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cadmium	2.00E+01	1.00E+00	2.00E+01	2.00E-01	1.46E-04	7.32E-06	1.55E-03	7.76E-05	1.66E-01	8.31E-03	8.40E-03	8.84E-06	4.42E-07	8.40E-03
Calcium	1.42E+04	8.00E+00	1.77E+03	2.00E-01	1.58E+01	8.93E-03	9.10E+02	5.14E-01	3.79E+01	2.14E-02	5.44E-01	1.62E+00	9.15E-04	5.45E-01
Cobalt	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	NA	NA	0.00E+00	NA	0.00E+00	4.79E-05	0.00E+00	0.00E+00
Copper	6.20E+01	8.00E+00	7.75E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	6.82E-05	8.80E-06	8.80E-06
Iron	2.50E+02	8.00E+00	3.13E+01	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	1.12E-01	3.57E-03	3.57E-03
Lead	3.85E+01	8.00E+00	4.81E+00	2.00E-01	1.14E-02	2.38E-03	3.81E-04	7.92E-05	2.08E-02	4.32E-03	6.77E-03	4.42E-05	9.18E-06	6.78E-03
Magnesium	7.50E+02	8.00E+00	9.38E+01	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	3.94E-01	4.20E-03	4.20E-03
Manganese	9.77E+03	8.00E+00	1.22E+03	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	1.17E-02	9.55E-06	9.55E-06
Mercury	9.00E-01	8.00E+00	1.13E-01	2.00E-01	4.76E-05	4.23E-04	7.93E-04	7.05E-03	3.46E-01	3.08E+00	3.08E+00	0.00E+00	0.00E+00	3.08E+00
Nickel	1.07E+02	1.00E+00	1.07E+02	2.00E-01	2.32E-02	2.17E-04	2.53E-01	2.37E-03	3.04E-02	2.84E-04	2.87E-03	0.00E+00	0.00E+00	2.87E-03
Potassium	5.00E+03	8.00E+00	6.25E+02	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	4.34E-02	6.94E-05	6.94E-05
Selenium	1.00E+00	1.00E+00	1.00E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	2.98E-05	2.98E-05	2.98E-05
Silver	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	NA	NA	0.00E+00	NA	0.00E+00	1.07E-05	0.00E+00	0.00E+00
Sodium	5.00E+03	8.00E+00	6.25E+02	2.00E-01	4.23E-02	6.77E-05	8.33E-02	1.33E-04	2.37E+00	3.79E-03	3.99E-03	3.44E-01	5.51E-04	4.54E-03
Zinc	1.31E+02	8.00E+00	1.64E+01	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	NA	0.00E+00	6.71E-04	4.10E-05	4.10E-05
TOTAL						**1.37E-02**		**6.02E-01**		**5.33E+00**	**5.95E+00**		**9.90E-03**	**5.96E+00**

Body Weight (kg)	1.13
Water intake (L/d)	0.064
Food intake (kg(dw)/d)	0.063
Sediment intake (kg/d)	0.0013
Plant intake (kg(dw)/d) -- 62.5% of diet	0.039375
Macroinvert intake (kg(dw)/d) -- 37.5% of diet	0.023625

Table G-4

Plum Brook Ordnance Works
TNT Area A

Omnivorous mammal: **Raccoon *(Procyon lotor)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (sed./sw.)	Sediment Intake (mg/kg-d)	Sediment Hazard Quotient	Aq. Invert. Intake (mg/kg-d)	Aq. Invert. Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics												
Aroclor 1260	1.56E-01	8.00E+00	1.95E-02	2.00E-01	3.44E-04	1.77E-02	1.24E-01	6.35E+00	6.37E+00	0.00E+00	0.00E+00	6.37E+00
2-Amino-4,6-DNT	3.56E+01	8.00E+00	4.45E+00	2.00E-01	1.37E-03	3.09E-04	4.03E-01	9.07E-02	9.10E-02	1.65E-05	3.72E-06	9.10E-02
4-Amino-2,6-DNT	2.46E+01	8.00E+00	3.07E+00	2.00E-01	5.55E-04	1.81E-04	1.63E-01	5.31E-02	5.33E-02	1.97E-05	6.42E-06	5.33E-02
Benzo(a)anthracene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	1.15E-04	3.33E-04	3.90E-02	1.13E-01	1.13E-01	0.00E+00	0.00E+00	1.13E-01
Benzo(a)pyrene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	6.40E-05	1.85E-04	2.20E-02	6.36E-02	6.38E-02	0.00E+00	0.00E+00	6.38E-02
Carbon disulfide	8.16E+01	8.00E+00	1.02E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.53E-05	9.34E-06	9.34E-06
Chrysene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	7.67E-05	2.22E-04	2.59E-02	7.49E-02	7.52E-02	0.00E+00	0.00E+00	7.52E-02
2,4-DNT	1.82E+00	8.00E+00	2.27E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2,6-DNT	1.82E+00	8.00E+00	2.27E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate	5.08E+02	8.00E+00	6.35E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.47E-05	2.31E-07	2.31E-07
Dinitrotoluene	1.82E+00	8.00E+00	2.27E-01	2.00E-01	2.71E-04	1.19E-03	8.04E-02	3.54E-01	3.55E-01	0.00E+00	0.00E+00	3.55E-01
Fluoranthene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	3.24E-04	9.35E-04	1.06E-01	3.08E-01	3.08E-01	0.00E+00	0.00E+00	3.08E-01
2-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	2.00E-01	7.91E-05	1.42E-05	2.35E-02	4.22E-03	4.23E-03	0.00E+00	0.00E+00	4.23E-03
Phenanthrene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	5.04E-05	1.45E-04	1.63E-02	4.70E-02	4.71E-02	0.00E+00	0.00E+00	4.71E-02
Pyrene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	2.16E-04	6.23E-04	7.09E-02	2.05E-01	2.05E-01	0.00E+00	0.00E+00	2.05E-01
2,4,6-TNT	4.09E+00	8.00E+00	5.12E-01	2.00E-01	2.16E-03	4.23E-03	6.35E-01	1.24E+00	1.25E+00	0.00E+00	0.00E+00	1.25E+00
Inorganics												
Aluminum	5.34E+00	8.00E+00	6.68E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.43E-02	3.63E-02	3.63E-02
Barium	1.01E+01	8.00E+00	1.27E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E-04	2.76E-04	2.76E-04
Beryllium	1.69E+00	8.00E+00	2.11E-01	2.00E-01	5.88E-04	2.79E-03	1.65E-03	7.80E-03	1.06E-02	0.00E+00	0.00E+00	1.06E-02
Cadmium	4.94E+00	8.00E+00	6.17E-01	2.00E-01	2.99E-04	4.85E-04	8.51E-02	1.38E-01	1.38E-01	6.58E-06	1.07E-05	1.38E-01
Calcium	4.89E+03	8.00E+00	6.11E+02	2.00E-01	3.23E+01	5.29E-02	1.94E+01	3.18E-02	8.46E-02	1.21E+00	1.97E-03	8.66E-02
Cobalt	6.14E+00	8.00E+00	7.68E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.57E-05	4.65E-05	4.65E-05
Copper	1.00E+01	8.00E+00	1.26E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.08E-05	4.04E-05	4.04E-05
Iron	1.21E+02	8.00E+00	1.51E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.30E-02	5.50E-03	5.50E-03
Lead	4.09E+01	8.00E+00	5.12E+00	2.00E-01	2.34E-02	4.57E-03	1.06E-02	2.08E-03	6.65E-03	3.29E-05	6.42E-06	6.66E-03
Magnesium	7.34E+02	8.00E+00	9.17E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.93E-01	3.20E-03	3.20E-03
Manganese	1.45E+02	8.00E+00	1.82E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.68E-03	4.78E-04	4.78E-04
Mercury	3.33E+00	8.00E+00	4.16E-01	2.00E-01	9.74E-05	2.34E-04	1.77E-01	4.26E-01	4.27E-01	0.00E+00	0.00E+00	4.27E-01
Nickel	4.09E+01	8.00E+00	5.12E+00	2.00E-01	4.75E-02	9.29E-03	1.56E-02	3.04E-03	1.23E-02	0.00E+00	0.00E+00	1.23E-02
Potassium	7.34E+03	8.00E+00	9.17E+02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.23E-02	3.52E-05	3.52E-05
Selenium	1.69E-01	8.00E+00	2.11E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.22E-05	1.05E-03	1.05E-03
Silver	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	0.00E+00	NA	NA	7.93E-06	0.00E+00	0.00E+00
Sodium	7.34E+03	8.00E+00	9.17E+02	2.00E-01	8.66E-02	9.44E-05	1.21E+00	1.32E-03	1.42E-03	2.56E-01	2.80E-04	1.70E-03
Zinc	1.64E+02	8.00E+00	2.05E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.99E-04	2.44E-05	2.44E-05
TOTAL						**9.64E-02**		**9.51E+00**	**9.61E+00**		**4.93E-02**	**9.66E+00**

Body Weight (kg)	5.1
Water intake (L/d)	0.215
Food intake (kg(dw)/d)	0.26
Sediment intake (kg/d)	0.012
Aquatic Invert. Intake (kg(dw)/d -- 21% of diet	0.0546

APPENDIX H

APPLICATION OF ESSENTIAL NUTRIENTS IN ECOLOGICAL RISK ASSESSMENT

Appendix H

Application of Essential Nutrients in Ecological Risk Assessment

H.1.0 Introduction

All forms of living matter require inorganic elements, or minerals, for their normal life processes. All animal tissues and feeds contain inorganic or mineral elements in widely varying amounts and proportions. Minerals that are needed in relatively large amounts are referred to as major or macrominerals; those that are needed in very small amounts are referred to as trace minerals or microminerals. These terms represent quantity designations of the amounts required in an animal's diet and their generally low or trace concentrations in tissues. The major minerals are required in concentrations of greater than 100 parts per million (ppm) and are often reported as a percentage of diet, while trace elements are required at less than 100 ppm and are sometimes reported at the parts per billion level. Table H-1 presents 24 elements known to be required by at least some animal species (McDowell, 1992).

Table H-1
General Macro and Microminerals

Major or Macrominerals	Trace or Microminerals		
Calcium (Ca)	Arsenic (As)*	Iodine (I)	Nickel (Ni)*
Chlorine (Cl)	Boron (B)*	Iron (Fe)	Selenium (Se)
Magnesium (Mg)	Chromium (Cr)	Lead (Pb)*	Silicon (Si)*
Phosphorus (P)	Cobalt (Co)	Lithium (Li)*	Tin (Sn)*
Potassium (K)	Copper (Cu)	Manganese (Mn)	Vanadium (V)*
Sodium (Na)	Fluorine (F)	Molybdenum (Mo)	Zinc (Zn)
Sulfur (S)			

* These elements have not been shown to be essential for livestock or humans consuming typical diets.

The listing of some of the trace elements as essential is difficult and sometimes tentative, and rest on experiments with one or more species. In these experiments, diets adequate in all nutrients except the mineral in question produced clinical signs that were prevented or overcome by adding that mineral to the diets (McDowell, 1992).

Unlike other nutrients, mineral elements cannot be synthesized by living organisms. Minerals act as: (1) structural components of body organs and tissues, (2) constituents of body fluids and tissues as electrolytes, and (3) catalysts in enzyme and hormone systems. The most obvious function of mineral elements in the body is to provide structural support (skeleton) for the body. Calcium, phosphorus, magnesium, fluoride, and silicon in bones and teeth all contribute to mechanical stability. Birds use calcium to produce egg shells, phosphorus, sulfur, and silicon are found in muscle proteins. Minerals are interrelated and balanced against each other, and most often cannot be considered as single elements with independent and self-sufficient roles in the organized bodily processes. The definite relationship of cadmium and phosphorus in the formation of bones and teeth and the interrelationships of iron, copper, and cobalt (in vitamin B_{12}) in hemoglobin synthesis and red blood cell formation are examples. Sodium, potassium, calcium, phosphorus, and chlorine serve individually and collectively in the body fluids. A number of trace elements (i.e., copper, zinc, and selenium) in addition to certain vitamins (i.e., A, D, E, B_6, and folacin) and other nutrients, are strongly related to adequate immune response (McDowell, 1992).

H.2.0 Mineral Requirements

A series of "safe" dietary levels of potentially toxic elements has been established on the extent to which other elements that affect their absorption and retention are present (McDowell, 1992). Table H-2 presents some of these "safe" dietary levels or mineral requirements for selected species.

Table H-2
Mineral Requirements for Selected Species

Species	Mineral (mg/kg of feed)									
	Ca	Mg	K	Na	Cu	Fe	Mn	P	Se	Zn
Japanese Quail	25,000	500	4,000	1,500	6	100	70	5,000	0.2	50
Rat	5,000	400	3,600	500	5	35	50	4,000	0.10	0.25
Mouse	4,000	500	2000	---	4.5	25	44	4,000	---	30
Cat	8,000	400	4,000	500	5	80	5	6,000	0.1	50
Mink	6,000	440	3,000	---	6	80	44	5,500	0.1	66

To determine whether concentrations of these minerals in the environment exceed safe dietary levels, the mineral requirements were converted to dietary doses using the following equation:

$$\text{Dose (mg/kg-day)} = \text{Diet (mg/kg)} \times \text{FI (kg/day)} \times 1/\text{BW (kg)}$$

where:

Diet (mg/kg) = mineral requirement for each nutrient
FI (kg/day) = food ingestion rate
BW (kg/day) = body weight.

Variables for the species are shown in Table H-3.

Table H-3
Food Ingestion and Body Weights

Species	Food Ingestion (FI) (kg/day)	Body Weight (Kg)
Japanese Quail	0.017 derived from $FI(kg/day) = 0.0582*BW(kg)^{0.651}$ [b]	0.15[a]
Rat	0.08[a]	0.35[a]
Mouse	0.0055[a]	0.03[a]
Cat	0.24 derived from $FI(kg/day)=0.0687*BW(kg)^{0.822}$ [b]	4.5 derived from 10lbs*0.4535923 conversion factor.[c]
Mink	0.137[a]	1.0[a]

[a]Oak Ridge National Laboratory (ORNL), 1996.
[b]U.S. Environmental Protection Agency (EPA), 1993.
[c]IT Corporation, 1999.

Table H-4 presents the mineral requirements calculated as dietary doses for selected species presented in Table H-3.

Table H-4
Mineral Requirements as a Dietary Dose for Selected Species

Species	Mineral Dose (mg/kg-day)									
	Ca	Mg	K	Na	Cu	Fe	Mn	P	Se	Zn
Japanese Quail	2,833	56.7	453	170	0.7	11.3	7.9	567	0.02	5.7
Rat	1,143	91.4	823	114	1.1	8	11.4	914	0.02	0.06
Mouse	733	92	367	---	0.8	4.6	8.1	733	---	5.5
Cat	427	21	213	26.7	0.3	4.3	0.3	320	0.01	2.7
Mink	822	60	411	---	0.8	11	6	753	0.01	9

H.3.0 Maximum Tolerance Levels

Information concerning the toxicity or tolerance of minerals is incomplete. According to available information, the toxic level of most major minerals is about 10 times the recommended level for young, growing livestock. The toxic levels of trace minerals appear to be highly variable, ranging between 10 and 1,500 times the recommended level. The National Research Council publishes maximum tolerance levels for domestic animals. The maximum tolerance level is defined as that dietary level that, when fed for a limited period, will not impair animal performance and should not produce unsafe residues in human food derived from animals. The levels listed in Table H-5 were derived from toxicity data on the designated species. Tolerance levels vary with the species, adaptation, duration of receiving the toxicants, age, physical condition of the animal, and many other factors (McDowell, 1992).

Table H-5
Maximum Tolerance Levels for Domestic Animals

Species	Maximum Tolerance Levels of Dietary Minerals (ppm)									
	Ca[a]	Mg	K	Na (as NaCl)	Cu	Fe	Mn	P	Se	Zn
Poultry	40,000[b] 12,000[c]	(3,000)	(20,000)	20,000	300	1,000	2,000	8,000	20,000	1,000
Rabbits	20,000	(3,000)	(30,000)	(30,000)	200	(500)	(400)	10,000	(20,000)	(500)

Source: McDowell, 1992.
The levels in parentheses were derived by interspecific species extrapolation.

[a] Ratio of calcium to phosphorus is important.
[b] Laying hen.
[c]Other poultry.

Using the same procedure described in Section H.2.0, the maximum tolerance levels are converted into dietary doses to determine whether concentrations of these minerals in the environment exceed safe dietary levels. Variables for the domestic animals are shown in Table H-6.

Table H-6
Food Ingestion and Body Weights for Domestic Animals

Species	Food Ingestion (FI) (kg/day)	Body Weight (kg)
Poultry	0.08 derived from $FI(kg/day) = 0.0582*BW(kg)^{0.651}$ [a]	1.6 (mean weight of male and female chicken) [b]
Rabbits	0.2 derived from $FI(kg/day)=0.0687*BW(kg)^{0.822}$ [a]	3.8 [b]

[a]EPA, 1993.
[b]ORNL, 1996.

Table H-7 presents the calculated dietary doses for selected species presented in Table H-6.

Table H-7
Maximum Tolerance Level as a Dietary Dose for Domestic Animals

	Dietary Doses (mg/kg-day)									
Species	Ca	Mg	K	Na (as NaCl)	Cu	Fe	Mn	P	Se	Zn
Poultry	600	150	1,000	1,000	15	50	100	400	1,000	50
Rabbits	1,053	158	1,579	1,579	11	26	21	526	1,053	26

H.4.0 Data Use

Mineral requirements or maximum tolerance levels will be used in ecological risk assessments, as appropriate.

H.5.0 References

IT, 1999. Best professional judgment for cat's (***Felis domesticus***) body weight being 10 lbs.

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Final
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TNT Area C Remedial Investigation
Former Plum Brook Ordnance Works
Sandusky, Ohio

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Table of Contents

Page

List of Tables iii
List of Figures v
List of Appendices vi
List of Acronyms vii
Executive Summary ES-1
1.0 Introduction 1-1
2.0 Problem Formation 2-1
2.1 Ecological Site Description 2-1
2.1.1 General Site Background 2-1
2.1.2 Surface Water 2-3
2.1.3 Wetlands 2-3
2.1.4 Vegetative Communities 2-3
2.1.5 Species Inventory 2-5
2.1.6 Threatened and Endangered Species Information 2-6
2.2 Selection of Chemicals of Potential Ecological Concern 2-9
2.2.1 Data Organization 2-9
2.2.2 Descriptive Statistical Calculations 2-11
2.2.3 Frequency of Detection 2-13
2.2.4 Natural Site Constituents (Background and Essential Nutrients) 2-13
2.2.5 Comparison to Risk-Based Screening Ecotoxicity Values 2-15
2.2.6 Summary of COPEC Selection 2-16
2.3 Selection of Assessment Receptors 2-17
2.3.1 Terrestrial Receptors 2-18
2.3.2 Aquatic Receptors 2-20
2.4 Ecological Endpoint (Assessment and Measurement) Identification 2-21
2.4.1 Assessment Endpoints 2-22
2.4.2 Measurement Endpoints 2-24
2.5 Ecological Site Conceptual Model 2-24

Table of Contents (Continued)

Page

3.0 Exposure Characterization 3-1
3.1 Exposure Analysis 3-1
3.2 Exposure Characterization Summary 3-10
4.0 Ecological Effects Characterization 4-1
4.1 Selection of Literature Benchmark Values 4-1
4.2 Development of Reference Toxicity Values 4-1
5.0 Risk Characterization 5-1
5.1 Terrestrial Plant Impact Assessment 5-1
5.2 Aquatic Biota Impact Assessment 5-1
5.3 Predictive Risk Estimation for Terrestrial and Aquatic Wildlife 5-3
5.4 Uncertainty Analysis 5-5
5.5 Risk Description 5-7
6.0 Risk Summary and Identification of Preliminary Remedial Action Objectives 6-1
7.0 Conclusions and Recommendations 7-1
8.0 References 8-1

List of Tables

Number	Title	Follows Tab
2-1	Vegetative Community Types	
2-2	Common and/or Frequent Vascular Plant Species Observed at TNT Area C	
2-3	Mammals Observed On Site and Likely to be Found in Erie County, Ohio	
2-4	Birds Observed On Site and/or Likely to be Breeding in Erie County, Ohio	
2-5	Reptiles Observed On Site and Likely to be Found at Plum Brook Ordnance Works	
2-6	Amphibians Observed On Site and Likely to be Found at Plum Brook Ordnance Works	
2-7	Fish Observed On Site at Plum Brook Ordnance Works	
2-8	TNT Area C Sample List	
2-9	Background Concentrations of Metals in Soil	
2-10	Statistical Summary and COPEC Selection of Surface Soil Sample Analyses	
2-11	Statistical Summary and COPEC Selection of Total Soil Sample Analyses	
2-12	Statistical Summary and COPEC Selection of Surface Water Sample Analyses	
2-13	Statistical Summary and COPEC Selection of Sediment Sample Analyses	
2-14	Assessment and Measurement Endpoints and Exposure Delineation	
3-1	Data Used to Model Exposure in the Indicator Wildlife Species	
3-2	Octanol-Water Partition Coefficients for Organic Chemicals of Potential Ecological Concern	
3-3	Fate and Transport Factors for Inorganic Chemicals of Potential Ecological Concern	
3-4	BCF Selection, Sediment to Invertebrate BCF	
3-5	BAF Selection, Soil to Invertebrate BAF	
4-1	NOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern	
4-2	LOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for Chemicals of Potential Ecological Concern	
4-3	Uncertainty Factors for Ecological RTV Extrapolations	
5-1	Terrestrial Plant Impact Assessment	
5-2	Aquatic Biota Surface Water Impact Assessment	
5-3	Summary of Surface Water Field Parameters	
5-4	Aquatic Biota Sediment Impact Assessment	
5-5	Terrestrial Receptors NOAEL-based Hazard Index Summary for TNT Area C	

List of Tables *(Continued)*

Number	Title	Follows Tab
5-6	Terrestrial Receptors LOAEL-based Hazard Index Summary for TNT Area C	
5-7	Aquatic NOAEL-based Hazard Index Summary for TNT Area C	
5-8	Aquatic LOAEL-based Hazard Index Summary for TNT Area C	
5-9	Uncertainty Analysis	

List of Figures

Number	Title	Follows Tab
2-1	Site Photographs (Nos. 1-2)	
2-2	Site Photographs (Nos. 3-4)	
2-3	Site Photographs (Nos. 5-6)	
2-4	Site Photographs (Nos. 7-8)	
2-5	Vegetative Communities, TNT Area C	
2-6	Simplified Terrestrial Food Web Conceptual Site Model	
2-7	Simplified Aquatic Food Web Conceptual Site Model	
4-1	Procedural Flow Chart for Deriving Reference Toxicity Values from Class-Specific Toxicity Data	

List of Appendices

Appendix A	Vascular Plant Species Observed On Site
Appendix B	Letter from Botanical Expert
Appendix C	Compilation of Risk-Based Screening Ecotoxicity Values
Appendix D	Ecological Toxicity Profiles
Appendix E	Assessment Receptor Profiles (ARP)
Appendix F	Glossary of Terms (Ecological)
Appendix G	Ecological Risk Characterization Spreadsheets
Appendix H	Application of Essential Nutrients in Ecological Risk Assessment

List of Acronyms

AOC	area(s) of concern
ARP	assessment receptor profile
BAF	bioaccumulation factor
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
BTAG	Biological Technical Assistance Group
COPEC	chemical(s) of potential ecological concern
CT	central tendency
°C	degrees Celsius
DO	Dissolved oxygen
DNAP	Ohio Division of Natural Areas and Preserves
DNT	dinitrotoluene
EDQL	ecological data quality levels
Eh	redox potential
ESBSNP	Erie Sand Barrens State Nature Preserve
EPA	U.S. Environmental Protection Agency
ESCM	ecological site conceptual model
FCM	food-chain multiplier
FRE	early successional woods
H_o	null hypotheses
HQ	hazard quotient
IT	IT Corporation
LC_{50}	lethal concentration for 50 percent of population
LD_{50}	lethal dose for 50 percent of population
L/kg	liters per kilogram
LOAEL	lowest observable adverse effects level
MDC	maximum detectable concentration
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
msl	mean sea level
mS/cm	microSiemens per centimeter

List of Acronyms *(Continued)*

MSU	moderate shrub thicket
mV	millivolts
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observable adverse effects level
NTU	Nephelometric turbidity units
NWI	National Wetland Inventory
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
OFE	old field (early)
OFL	old field (late)
OME	Ontario Ministry of the Environment and Energy
PAH	polycyclic aromatic hydrocarbons
RME	Reasonable maximum exposure
PBOW	Plum Brook Ordnance Works
RBSEV	risk-based screening ecotoxicity value
PRG	Preliminary remediation goal
RTE	rare, threatened, or endangered
RTEC	Registry of Toxic Effects Concentrations
RTV	reference toxicity value
SQL	sample quantitation limit
SU	Standard units
TF	transfer factor
TNT	trinitrotoluene
UCL	upper confidence limit
USFWS	U.S. Fish and Wildlife Service
UTL	upper tolerance limit
WQC	water quality criteria

Executive Summary

A baseline ecological risk assessment was performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases within trinitrotoluene Area C at the former Plum Brook Ordnance Works in Sandusky, Ohio. The results of the baseline ecological risk assessment contribute to the overall characterization of the site and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives, if necessary. The primary objective of the assessment was to determine whether the potential for unacceptable risks are posed to ecological receptors as a result of potential hazardous substance releases. This objective was met by characterizing the ecological communities in the vicinity of the site, determining the particular hazardous substances being released from the site, identifying pathways for receptor exposure, and estimating the magnitude and likelihood of potential risk to identified receptors. The assessment addresses the potential for adverse effects to the vegetation, wildlife, aquatic life (aquatic macro-invertebrates), endangered and threatened species, and wetlands or other sensitive habitats associated with the site.

Vegetative communities at the site were classified during two site reconnaissance trips. The three largest community types observed at the site were upland old fields, shrub thicket, and successional woods. Limited wetland plants occur along some drainage ditches at the site, but populations are considered too small to be characterized as a separate vegetative community. Vegetative stress attributable to chemicals was not observed at the site, even at the trinitrotoluene hot spots. The site reconnaissance documented the following threatened species of plant at the site:

- Closed gentian (*Gentiana clausa*) - Ohio potentially threatened species.

Based on site reconnaissance information, it does not appear that significant ecological threats exist at the site, as there was no definitive absence of biota or animal life in areas expected to support these ecological components.

A comparison was made between the maximum detected concentrations of chemicals in sampled media and the risk-based screening ecotoxicity values for ecological endpoints of concern.

Chemicals that exceeded the screening values, or for which no screening values were available, were retained as "chemicals of potential ecological concern" and were assessed further. Twenty-two chemicals of potential ecological concern were selected for surface soil, twenty-six were selected for total soil, twenty-one were chosen for surface water, and twenty-one were chosen for sediment. For these chemicals, exposure point concentrations were estimated using the 95 percent upper confidence limit methodology.

Seven representative receptor species that are expected or possible at the site were selected as indicator species for the potential effects of the chemicals of potential ecological concern. The seven species selected included the deer mouse, short-tailed shrew, Eastern cottontail rabbit, marsh wren, white-tailed deer, raccoon, and red-tailed hawk. Two aquatic representative receptors were selected, including the raccoon (also considered as a terrestrial receptor) and the mallard.

The assessment endpoints for the site were the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds. Measurement assessment endpoints, or measurable responses to stressors, included lowest observed adverse effect levels and no observed adverse effect levels, collectively termed "toxicity endpoint values." In addition, critical effect values for surface water, sediment, and soil were also selected as measurement endpoints.

The assessment developed an estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to chemicals that are present at or migrating from the site, considering both current and reasonably plausible future use of the site. The exposure assessment was conducted by linking the magnitude (concentration) and distribution (locations) of the chemicals detected in the media sampled during the investigation, evaluating pathways by which chemicals could be transported through the environment, and determining the points at which organisms found in the study area could contact chemicals. For terrestrial and aquatic receptors, the calculation of exposure rates relied upon determination of an organism's exposure to chemicals measured in surface water, sediment, and/or soil, and on transfer factors used for food-chain

exposure. Both literature values, and site-specific values from Red Water Pond studies at Plum Brook Ordnance Works, were used as transfer factors for food-chain exposure.

The risk characterization phase integrated information on exposure, exposure-effects relationships, and defined or presumed target populations. This resulted in a determination of the likelihood, severity, and characteristics of adverse effects to environmental stressors present at the site. Qualitative and semiquantitative approaches were taken to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to chemicals. Potential adverse affects to terrestrial plants were qualitatively assessed by comparing plant toxicity benchmarks with chemical concentrations. Potential adverse impacts to aquatic biota were qualitatively assessed by comparing surface water and sediment quality criteria for the protection of aquatic life with surface water and sediment chemical concentrations.

For the semiquantitative predictive assessment, reference toxicity values and exposure rates were calculated and were used to generate hazard quotients, by dividing the receptor exposure rate for each chemical by the calculated reference toxicity values. Hazard quotients are a means of estimating the potential for adverse effects to organisms at a contaminated site, and for assessing the potential that toxicological effects will occur among site receptors.

Soil chemical impacts to terrestrial plants were estimated to be generally insignificant, except for perhaps elevated levels of 2,4,6-trinitrotoluene, lead, manganese, and zinc. No vegetative stress was observed on site. Potential surface water chemical impacts to aquatic biota were of most concern for carbon disulfide, aluminum, barium, cadmium, calcium, copper, iron, and manganese. Potential sediment chemical impacts for aquatic biota were of most concern for 1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, Aroclor-1260, and lead. Considerations of small sample size suggested that these findings should be confirmed based on additional sampling before any remedial actions are considered. In addition, limited aquatic habitat at the site reduces the concern for impact to aquatic biota, and generally low dissolved oxygen, elevated turbidity, and other nonchemical stressors measured in surface water suggests that overall water quality is poor. Terrestrial receptors (especially mice, rabbits, shrews, raccoons, and wrens) were predicted to incur elevated hazards from exposure to 2,4,6-trinitrotoluene, Aroclor-1260, and lead in soil, based on both no observed adverse effect level- and lowest observed adverse effect level-based

hazard quotient approaches. Based on uncertainties of toxicity, and on the fact that no rare, threatened, or endangered wildlife species have been confirmed at the site, remedial actions solely to address ecological concerns are not warranted at this time for soil. However, as estimated hazards were above 30,000 for some receptors using the no observed adverse effect level-based approach, and above 5,000 for some receptors using the lowest observed adverse effect level-based approach, additional study is recommended. Alternatively, if human health risks or hazards are unacceptable and chemical-specific human health preliminary remediation goals are being developed for the site, these remediation goals may be evaluated to (1) determine if they are also protective of the environment; or (2) determine if they will reduce the estimated baseline ecological hazards by a significant amount.

Aquatic receptors were predicted to have elevated hazards from exposure to 2,4,6-trinitrotoluene, selenium, aluminum, and Aroclor-1260 in sediment, based on both no observed adverse effect level- and lowest observed adverse effect level-based hazard quotient approaches. Although hazards were estimated to be 2,350 and 1,130 for mallard and raccoon using the no observed adverse effect level-based approach, when the lowest observed adverse effect level-based approach was used, estimated hazards dropped to 97 and 265, respectively. Based on uncertainties associated with estimating chemical concentrations in aquatic insects, the limited amount and low quality of aquatic habitat at the site, remedial action is not recommended for surface water and sediment at the site at this time. However, given the elevated hazard estimates, additional study is recommended. Alternatively, if human health risks or hazards are unacceptable and chemical-specific human health preliminary remediation goals are being developed for the site, these remediation goals may be evaluated to (1) determine if they are also protective of the environment; or (2) determine if they will reduce the estimated baseline ecological hazards by a significant amount.

1.0 Introduction

A baseline ecological risk assessment (BERA) has been performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases within trinitrotoluene (TNT) Area C at the former Plum Brook Ordnance Works (PBOW) in Sandusky, Ohio. The results of the BERA contribute to the overall characterization of the site and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives, if necessary. The BERA has been performed following the Ohio Environmental Protection Agency (OEPA)-approved work plan (IT, 2001a) that was based on general guidelines of the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel, et al., 1996), with secondary guidance from *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (U.S. Environmental Protection Agency [EPA], 1997), and *Region 5 Biotechnical Assistance Group (BTAG) Ecological Risk Assessment Guidance Bulletin No. 1* (EPA, 1996a).

The primary objective of the BERA is to determine whether the potential for unacceptable risks are posed to ecological receptors as a result of potential hazardous substance releases. This objective is met by characterizing the ecological communities in the vicinity of the site, determining the particular hazardous substances being released from the site, identifying pathways for receptor exposure, and estimating the magnitude and likelihood of potential risk to identified receptors. The BERA addresses the potential for adverse effects to the vegetation, wildlife, aquatic life (aquatic macro-invertebrates), endangered and threatened species, and wetlands or other sensitive habitats associated with the site.

Concentrations of chemicals have been measured in relevant environmental media including soil, surface water, and sediment. No groundwater data have been collected for the TNT Area C site, however, groundwater data are irrelevant for use in aquatic assessments as surface water data are used to assess aquatic exposure. Using available concentration data, IT Corporation (IT) has performed a BERA, including a problem formulation (Section 2.0); an exposure characterization (Section 3.0); an ecological effects characterization (Section 4.0); a risk characterization (Section 5.0); a risk summary and identification of preliminary remedial action objectives (Section 6.0); and conclusions and recommendations (Section 7.0). References are presented in Section 8.0.

IT has evaluated the chemicals of potential ecological concern (COPEC), the ecosystems and receptors at risk, the ecotoxicity of the contaminants known or suspected to be present, and observed or anticipated ecological effects. This evaluation has been conducted in two steps: (1) a screening assessment step and (2) a predictive assessment step. Ecological endpoints to be addressed in both steps have been identified. The results and conclusions of the screening assessment determine whether a predictive assessment is required. The criteria by which a predictive assessment is needed have been formalized as (H_0) to be accepted (in which case a predictive assessment is not needed) or rejected (in which case a predictive assessment is needed).

2.0 Problem Formulation

The screening assessment (H_0) are stated as follows:

- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **viable habitat** for potential ecological receptors.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **potential ecological receptors**.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **potential exposure pathways**.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of **potential chemical stressors**.

If one or more of these null hypotheses (H_0) are accepted, a predictive assessment is not triggered. All four H_0 must be rejected for a predictive assessment to be triggered. The first three H_0 are tested with the results of the ecological site description (Section 2.1). The fourth H_0 is tested with the results of COPEC selection (Sections 2.2 and 2.3).

If a predictive assessment is triggered, terrestrial and aquatic ecological conceptual site models are developed, as appropriate, and additional problem formulation tasks are performed, as described in Sections 2.4 to 2.6.

2.1 Ecological Site Description

This ecological site description section includes a general discussion of site background and areas of concern (AOC), surface water resources, wetlands, vegetative communities, a species inventory, and a discussion on threatened and endangered species.

2.1.1 General Site Background

PBOW, approximately 6,453 acres in size, is located within the Eastern Lake Plains physiographic region of the Eastern Huron/Erie Lake Plain Ecoregion (Lafferty 1979; Omernik, 1986). This region is generally characterized as containing flat plains as the predominant land-surface form and as having a dominant natural vegetation of elm and ash in undisturbed areas.

Approximately two-thirds of Erie County was once covered by a glacial lake that produced features such as beach ridges and wave-cut cliffs. Much of the region is poorly drained due to the flat topography and low stream gradients. Many of the wetlands adjacent to Lake Erie in this region have been preserved by various federal, state, and private organizations (Peterjohn and Rice, 1991), thereby providing important wetland habitat for wildlife.

Across PBOW, the land slopes gently to the north-northeast towards Lake Erie. Elevations range from 675 feet above mean sea level (msl) at the southwest edge of the site to 625 feet msl in the northern portion of the property at Bogart Road, resulting in an average slope of approximately 0.3 percent. The Lake Plains region itself is over 69 percent cropland, 2.7 percent pasture land, and 10.5 percent forest (Ohio Department of Natural Resources [ODNR], 1985). However, since the Trojan Power Company (the previous PBOW owner) acquired the site in the early 1940s and removed the land from agricultural production, undeveloped portions of the former PBOW have become second generation forest and open fields. This has resulted in PBOW becoming an island of forest and open fields within a sea of agricultural land in north central Ohio.

TNT Area C, approximately 120 acres in size, is relatively flat with a few low hummocks. Elevations at the site range from a low of 644 feet along the northern boundary of the site to 681.5 feet on the southern side of TNT Area C. The native overburden and the soil found at most of the boring locations at TNT Area C consists predominantly of glacial derived silt overlying silty clay. The upper few feet of the silts and clays in the vicinity of TNT Area C have been grouped into the Castalia-Millsdale-Milton-Ritchey soil Association (Soil Conservation Services, 1971). The Castalia-Millsdale-Milton-Ritchey soils are characterized as shallow to moderately deep, well drained and very poorly drained soils formed in glacial till, lacustrine sediments, and limestone residuum (ODNR, 1994; IT, 2000). The depth of overburden soils at TNT Area C ranges from approximately 10 feet in the southern portion of the site to depths greater than 18 feet along the western edge of the site. The base of the overburden consists of weathered shale.

Surface water drains off the site to the north into a tributary to Pipe Creek. On the eastern side of the site, north of Buildings 692, 693, and 683, a stone-lined drainage ditch was found that allowed surface water to drain to the east or west of these specified buildings. Based on site reconnaissance performed by IT ecologists on September 11 through 13, 2000 and May 21,

2001, a photographic record of the site was prepared and is presented in Figures 2-1 through 2-4. Prior to arrival at the site, IT personnel obtained relevant information on the site, including topographic maps; township, county, or other appropriate maps; and determined the location of potential ecological units such as streams, creeks, ponds, grasslands, forest, and wetlands on or near the site. Additionally, the 1994 biological inventory of PBOW (National Aeronautics and Space Administration [NASA], 1995), which identifies and shows the locations of threatened and endangered species at PBOW, was reviewed. IT personnel completed a checklist similar to EPA's checklist for ecological assessment/sampling (EPA, 1997); and information from this checklist was used to complete Section 2.0 herein. The location of known or potential contaminant sources affecting the site and the probable gradient of the pathway by which contaminants may be released from the site to the surrounding environment were identified. IT personnel used the reconnaissance to evaluate the site for more subtle clues of potential effects from contaminant release.

2.1.2 Surface Water

Generally, surface water drains off the site to the north into a tributary to Pipe Creek. Given the nature of the surface waters at the site, they are not likely to support significant populations of forage fish due to their shallow depth and intermittent nature.

2.1.3 Wetlands

According to the National Wetland Inventory (NWI) Maps for the area (U.S. Fish and Wildlife Services [USFWS], 1977), there are no designated wetlands at the TNT Area C site. It should be noted that the accuracy of NWI maps are limited, especially in relatively flat landscapes (such as PBOW) because minor depressions often contain isolated wetlands not easily identified through air photo interpretation (the process used by the USFWS in preparing NWI maps). As discussed in the following section, small wetland areas do exist at the site.

2.1.4 Vegetative Communities

Vegetative communities at the site were classified during the site reconnaissance trips using the 16 possible community types presented in Table 2-1. The three largest community types observed at the site were upland early and late old field (OFE, OFL), moderate shrub thicket (MSU), and early successional woods (FRE), as shown in Figures 2-1 through 2-4. Limited

wetland plants occur along some drainage ditches (Photo No. 4 in Figure 2-2), but populations of wetland plants are considered too small to be characterized as a separate vegetative community.

The general habitat figure (Figure 2-5) presents the type and extent of biological communities present within the site. The most common plant species found in the major vegetative communities are as follows:

Upland Old Field (OFE, OFL)
redtop
Canada thistle
grass-leaved goldenrod
sorrel
blackberry
dewberry
foxtail grass
Canada goldenrod
horse nettle

Shrub Thickets (MSU)
cottonwood
dogwoods
Tatarian honeysuckle
green ash
American elm
Virginia knotweed

Successional Woods (FRE)
green ash
black cherry
Virginia knotweed
white snakeroot
dogwoods
cottonwood
American elm

Each of these habitat types can be expected to support different wildlife species assemblages; however, given the close proximity of the habitats to each other, many of the species (discussed below) would be expected to spend some amount of time within each community type for foraging, resting, and loafing activities, depending on the season.

During the site reconnaissance, the study area was examined for vegetative stress, including looking for plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage. Vegetative stress attributable to chemicals was not observed at TNT Area C, even at the TNT hot spots near Buildings 682 and 686 (Photo Nos. 6 through 8 in Figures 2-3 and 2-4). A few locations were devoid of vegetation, however, these areas occurred in disturbed areas where trenches were installed and backfilled during soil sampling. Potential adverse impacts of chemical stressors on plant growth are discussed further in Section 5.1. Based on site reconnaissance information, it does not appear that significant ecological threats exist at the site, as there is no definitive absence of biota or animal life in areas expected to support these ecological components.

2.1.5 Species Inventory

Based on information from ODNR (1995) and collected during the site reconnaissance, species lists were prepared for plants, mammals, birds, reptiles, amphibians, and fish (Tables 2-2 through 2-7). Unless noted on the tables, the species listed in Tables 2-3 through 2-7 are for the former PBOW, and not TNT Area C itself.

Of the 365 plant species documented at the 6,453 acre former PBOW by the ODNR (Appendix A), 60 of the common or frequently observed species at the site are listed in Table 2-2.

Of the 43 species of mammals that may be found in the region based on species range maps, white-tailed deer were observed onsite during site reconnaissance (Table 2-3). Numerous deer tracks were also observed during the site reconnaissance. Other mammals observed included an unidentified species of squirrel. It is likely that other species were present but not observed due to the short duration of the field visits.

Of the 129 species of birds that may be found in the region based on species range maps, 105 species (81 percent) have been recorded at the former PBOW by the ODNR during their multi-year studies (Table 2-4). Seven bird species were documented at TNT Area C during the site reconnaissances performed by IT. Of the species recorded by the ODNR, 49 were neotropical migrants and would not be expected to nest at the former PBOW. ODNR (1995) notes that of the top 50 bird species recorded at the former PBOW, only 6 were ground nesters and 3 others occasionally nest on the ground, suggesting that ground nesters are having problems at the former PBOW. Burning practices used by NASA at the former PBOW, as well as the large deer

population that feeds on much of the ground cover, limits the ground cover available for nesting birds and results in increased predation for these species (ODNR, 1995). It should be noted that NASA has recently altered its burning practices, burning approximately one-third of the former PBOW lands every year, rather than one-half of the lands as was performed in the past (Peecook, 1998). The 15 most abundant bird species recorded at the former PBOW by the ODNR included American robin; red-winged blackbird; European starling; song sparrow; common grackle; field sparrow; American goldfinch; indigo bunting; blue jay; common yellowthroat; brown-headed cowbird; house wren; gray catbird; northern cardinal; and cedar waxwing.

Of the 14 species of reptile that may be found in the region based on species range maps, ten species (71 percent) have been observed at the former PBOW, including turtles and snakes (ODNR, 1995; Table 2-5). During the site reconnaissance an unidentified species of snake was observed.

Of the 10 species of amphibians that may be found in the region based on species range maps, nine species (90 percent) have been observed at the former PBOW (ODNR, 1995; Table 2-6), including salamanders, toads, and frogs. During the site reconnaissance no amphibians were observed.

According to ODNR (1995), a combination of electro shocking and seining was conducted during the field investigation that identified fourteen species of fish at PBOW. Species observed included suckers, sunfish, minnows, sticklebacks, and bullheads (Table 2-7). However, none are expected at TNT Area C given the limited surface water habitat.

In addition to the above wildlife, additional species observed during site reconnaissance included ants (active ant mounds), cicadae, and unidentified snail species.

2.1.6 Threatened and Endangered Species Information

According to an Ohio Division of Natural Areas and Preserves (DNAP) review of their natural heritage maps and files (Woischke, 1998), there are records of legal status threatened or endangered species within a two-mile radius of the site. These species include the following:

- Sedge wren (*Cistothorus platensis*) - endangered
- Dwarf bulrush (*Lipocarpha micrantha*) - threatened
- Twisted yellow-eye-grass (*Xyris torta*) - threatened

- Field sedge (*Carex conoidea*) - threatened
- Least St. John's-wort (*Hypericum gymnanthum*) - endangered
- Flat-leaved rush (*Juncus platyphyllus*) - endangered
- Bushy aster (*Aster dumosus*) - threatened.

In addition, based on information contained in ODNR (1995), there are several species of threatened or endangered plants, potentially threatened plants, and threatened or endangered birds that have been recorded at PBOW, as follows:

- Grove sandwort (*Arenaria lateriflora*) - threatened
- Thin-leaved sedge (*C. cephaloidea*) - endangered
- Ashy sunflower (*Helianthus mollis*) - threatened
- Prairie false indigo (*Baptisia lactea*) - potentially threatened
- Broad-winged sedge (*C. alata*) - potentially threatened
- Round-fruited hedge-hyssop (*Gratiola virginiana*) - potentially threatened
- Tall St. John's wort (*H. majus*) - potentially threatened
- Virginia meadow beauty (*Rhexia virginica*) - potentially threatened
- Tall nut rush (*Scleria triglomerata*) - potentially threatened
- Lance-leaved violet (*Viola lanceolata*) - potentially threatened
- Winter wren (*Trogoldytes troglodytes*) - endangered
- Cattle egret (*Bublucus ibis*) - endangered
- Black-crowned night heron (*Nycticorax nycticorax*) - threatened
- Trumpeter swan (*Cygnus buccinator*) - endangered
- Upland sandpiper (plover) (*Bartramia longicauda*) - threatened
- Indiana bat (*Mytolis sodalis*) - endangered.

Furthermore, wild white lettuce - a species considered extinct in Ohio but common in prairie states - was recently found on site, although more than a mile from TNT Area C (Peecook, 1998). Based on the results of the site reconnaissance, no threatened or endangered species were found, except for a few plant species, discussed in the next paragraph.

The site reconnaissance included detailed searches performed by a highly qualified botanist subcontractor during the late summer and spring site visits. After a careful evaluation, IT's subcontractor botanist documented the closed gentian (*Gentiana clausa*), an Ohio potentially threatened species of plant at TNT Area C (Figure 2-1, Figure 2-3 [Photo No. 5], and Appendix B).

None of the threatened or endangered bird species, with the possible exception of the sedge wren (also called the short-billed marsh wren) and the black-crowned night heron, would typically be expected to be found at the site. The winter wren, cattle egret, trumpeter swan, and upland sandpiper are all considered rare visitors or migrants at the former PBOW (ODNR, 1995), and have not been documented nesting within 1-mile of the site (Woischke, 1998).

Six sedge wren nesting sites were documented in the ODNR DNAP's database for an area near the Pentolite Road Red Water Ponds area in old grassy field habitat during 1994 (Woischke, 1998). In the June 1994 sighting, eight sedge wrens were observed near the Pentolite Road Red Water Ponds and two were observed near the West Area Red Water Ponds, with 24 territorial birds and several fledglings identified at the PBOW (ODNR, 1995). Sedge wrens, an Ohio endangered species, have a preferred breeding habitat that consists of wet meadows, grassy marshes, and old grassy fields (Peterson, 1947) and moist grasses and sedge marshes or wet meadows with scattered low bushes (Bent, 1948). These habitat types are limited at TNT Area C, although there are a few limited wetland areas along some of the drainage ditches at the site (Figure 2-2 [Photo No. 4] and Figure 2-5). Sedge wrens are very sporadic nesters, and birds may not arrive at a breeding colony until July or August and nesting continues into September (Trautman and Trautman, 1968). Draining of marshes has eliminated considerable breeding habitat in Ohio and many recent colonies have been located in wet meadows and hayfields and have disappeared after these fields have been mowed (ODNR DNAP information).

The black-crowned night heron, an Ohio threatened species, is a regular visitor at ponds, streams, and ditches within the former PBOW, however, it does not nest at the former PBOW (ODNR, 1995; Woischke, 1998). The species is typically found near water and wetlands, and since the early 1980s there has been a nesting colony of approximately 100 pairs located on an island in Sandusky Bay approximately 10 miles north northwest of the study area (Peterjohn and Rice, 1991).

The Indiana bat has not been documented at the site, and is generally not expected in the area based on the fact that its preferred habitat (e.g., caves along streams or trees with exfoliated bark) is not present at TNT Area C. Trees with exfoliated bark, such as shagbark or shellbark hickory, are rare or not present at the site, thereby providing little bat roosting habitat (Appendix A).

With the exception of the Erie Sand Barrens State Nature Preserve (ESBSNP), there are no existing or proposed state nature preserves or scenic rivers near the site, and ODNR is unaware of any unique ecological sites, geological features, breeding or nonbreeding animal concentrations, champion trees, or state parks, forests, or wildlife areas within a 2-mile radius of the site (Woischke, 1998). The ESBSNP is located southwest of TNT Area C. The 32-acre preserve is a remnant sand beach of Lake Warren, the fifth ancestral Lake Erie, that supports many species of threatened and endangered plant species such as field sedge, Least St. John's wort, dwarf bullrush, twisted yellow-eyed-grass, flat-leaved rush, bushy aster, and Virginia meadow beauty. Many of the preserve's rare plant species thrive in open wind-swept conditions such as those found on the sand barrens. The DNAP actively manages the preserve to ensure that the open wind-swept areas remain and do not become overgrown with woody vegetation.

2.2 Selection of Chemicals of Potential Ecological Concern

A list of TNT Area C media samples is presented in Table 2-8. From the chemical results of samples on this list, IT has identified a subset of chemicals detected at the site that have data of good quality and are not naturally occurring or a result of nonsite sources. These chemicals are also present at sufficient frequency, concentration, and location to pose a potential risk to ecological receptors. Examples of screening criteria that have been used include the following: analytical detection limit; frequency of detection less than 5 percent; comparability with background (Table 2-9); and comparison with risk-based screening ecotoxicity values. This selection process is described in more detail in the following subsections.

2.2.1 Data Organization

The data for each chemical have been sorted by medium. For ecological impacts, soil from 0 to 6 feet have been considered. The 0 to 6 feet depth interval was selected for three primary reasons, (1) to maintain consistency with other PBOW ecological risk assessments (e.g., TNT Area B and the Red Water Ponds) that used this depth interval; (2) to include potential exposure to the shrew, a representative burrowing insectivorous mammal; and (3) to increase the size of the total soil data base by including samples collected from a depth interval of 4 to 6 feet. Although the shrew itself may not actually burrow to a depth of 6 feet, there may be other burrowing mammals that do burrow this deep. Chemicals which are not detected at least once in a medium have not been included in the risk assessment. Available background data have been

determined for each medium. Sources of background information include data from previous investigations.

The analytical data may have qualifiers from the analytical laboratory quality control or from the data validation process that reflect the level of confidence in the data. Some of the more common qualifiers and their meanings are (EPA, 1989):

- U - Chemical was analyzed for but not detected; the associated value is the sample quantitation limit.
- J - Value is estimated, probably below the contract-required quantitation limit.
- R - Quality control indicates that the data are unusable (chemical may or may not be present).
- B - Concentration of chemical in sample is not sufficiently higher than concentration in the blank (using five-times, ten-times rule).

"J" qualified data are used in the risk assessment; "R" and "B" qualified data are not. The handling of "U" qualified data (nondetects) is described in Section 2.2.2.

Occasionally, chemicals were analyzed under two different analytical programs. For example, the dinitrotoluenes (DNT) were analyzed by EPA Method 8330 for nitroaromatics as well as EPA Method 8270B for semivolatile organic compounds. EPA Method 8330 returns concentration values for total DNT, but does not return isomer-specific data. EPA Method 8270B, on the other hand, returns concentrations for 2,4- and 2,6-DNT isomers, but does not return a value for total DNT. For each medium evaluated it was necessary to choose the results provided by one analytical method, rather than both to avoid double-counting and overestimating ecological hazard. Therefore, a rationale was developed to ensure that the most appropriate choice is consistently made.

Examination of the raw data (TNT Area A: Volume 1 *Report of Findings*, Part II, Appendix D; TNT Area C: Volume 1 *Report of Findings*, Part III, Appendix D) reveals that concentrations reported for total DNT sometimes exceed the sum of concentrations of the 2,4- and 2,6-isomers. In other cases, the sum of the concentrations of the 2,4- and 2,6-isomers exceeds the concentration reported for total DNT. No explanation is immediately apparent for this

inconsistency, but it is clear that the analytical results from one given method cannot be selected for use in all cases because the full potential for hazards may be overlooked. Therefore, the method that yields the more conservative result is selected for each medium on an individual basis. In other words, the maximum detectable concentration (MDC) for total DNT is compared with the sum of the MDCs for 2,4- and 2,6-DNT. The method yielding the larger value is used.

2.2.2 Descriptive Statistical Calculations

Because of the uncertainty associated with characterizing contamination in environmental media, both the mean and the 95 percent upper confidence limit (UCL) of the mean have been estimated for each chemical in each medium of interest (Tables 2-10 through 2-13) . In general, "outliers" are included in the calculation of the UCL because high values in environmental data are seldom true statistical outliers. Inclusion of outliers increases the overall conservatism of the risk estimate, and the likelihood of rejecting the H_0 (i.e., there are no chemical stressors at the site).

Datasets have been tested for normality and lognormality based on the Shapiro-Wilk test (EPA, 1992a). Statistical analysis has been performed on all detected chemicals. If statistical tests support the assumption that the dataset is normally distributed, the UCL for a normal distribution is calculated. If the statistical analysis shows the data to be lognormally distributed, the UCL is calculated for a lognormal distribution. If a dataset passes both the normal and lognormal distribution tests, the distribution with the best fit is selected.

The UCL is calculated for a normal distribution as follows (EPA, 1992b):

$$UCL = \bar{x} + t_{1-\alpha,\, n-1} \; x \; (s/\sqrt{n}) \qquad \text{Eq. 2.1}$$

where:

$\bar{x}$ = sample arithmetic mean
t = critical value for student's t distribution
$1-\alpha$ =0.05 (95 percent confidence limit for a one-tailed test)
n = number of samples in the set
s = sample standard deviation.

The UCL is calculated for a lognormal distribution as follows (Gilbert, 1987):

$$UCL = e^{\left(\bar{y} + (0.5 \cdot s_y^2) + \left[H_{0.95} \cdot \frac{s_y}{(n-1)^{0.5}}\right]\right)} \qquad \text{Eq. 2.2}$$

where:

$\bar{y}$ = $\sum y/n$=sample arithmetic mean of the log-transformed data, y = ln x
s_y = sample standard deviation of the log-transformed data
n = number of samples in the data set
$H_{0.95}$ = value for computing the one-sided 95 percent UCL on a lognormal mean from standard statistical tables (Land, 1975).

A nonparametric confidence limit is used when the dataset fits neither a normal or a lognormal distribution. The nonparametric UCL is estimated as the 95 percent UCL rank order on the arithmetic mean of the dataset. It is estimated by ranking the data observations from smallest to largest. The arithmetic mean is converted to a percentile by interpolation. The rank order of the observation selected as the UCL is estimated from the following equation (Gilbert, 1987):

$$u = p(n + 1) + Z_{1-\alpha}\sqrt{np(1 - p)} \qquad \text{Eq. 2.3}$$

where:

u = upper confidence limit
p = percentile corresponding to the arithmetic mean
n = number of samples in the set
α = confidence limit; 95 percent
$Z_{1-\alpha}$ = normal deviate variable.

Analytical results are presented as "nondetects" ("U" qualifier) whenever chemical concentrations in samples do not exceed the detection or quantitation limits for the analytical procedures for those samples. Generally, the detection limit is the lowest concentration of a chemical that can be "seen" above the normal, random noise of an analytical instrument or analytical method. To apply the previously mentioned statistical procedures to a dataset with nondetects, a concentration value must be assigned to nondetects. Nondetects are assumed to be present at one-half the sample quantitation limit (SQL), although judgement is used in those cases where matrix

interference or other phenomena drive the SQL unusually high. In the current assessment, all nondetect sample results including samples with elevated detection limits, were treated numerically as one-half of the analytical detection limit when calculating the 95 percent UCL. The UCL or MDC, whichever is smaller, is selected as the source-term concentration, and is understood to represent a conservative estimate of average for use in the risk assessment or in various transport models used to estimate exposure-point concentrations.

2.2.3 Frequency of Detection

Chemicals that are detected infrequently may be artifacts in the data that may not reflect site-related activity or disposal practices. These chemicals have not been included in the risk evaluation. Generally, chemicals that are detected only at low concentrations in less than 5 percent of the samples from a given medium are dropped from further consideration, unless their presence is expected based on historical information about the site. For the current assessment, nitroaromatics have not been dropped as COPECs as this group of constituents is site related. Chemicals detected infrequently at elevated concentrations as compared with applicable risk-based thresholds may identify the existence of "hot spots" and have been retained in the evaluation, unless other information exists to suggest that their presence is unlikely to be related to site activities.

2.2.4 Natural Site Constituents (Background and Essential Nutrients)

Chemical concentrations have been compared to background concentrations as an indication of whether a chemical is present from site-related activity or as natural background. This comparison is generally valid for inorganic chemicals, but not for organic chemicals, because inorganic chemicals are naturally occurring and most organic chemicals, besides polycyclic aromatic hydrocarbons (PAH), are not. Statistical techniques are used as tools to aid the exercise of professional judgement in resolving site-related issues for metals, since metals are naturally present in most environmental media. The statistical techniques generally involve comparing the site data with background data.

The first statistical technique is the development of an upper tolerance limit (UTL) for background and comparing the MDC with the UTL. Chemicals with MDCs less than the background UTL are eliminated from further consideration. If the MDC exceeds the UTL, the chemical is retained as a COPEC, or a more rigorous statistical analysis may be performed. The more

rigorous statistical analysis would consist of comparing the site and background data sets to determine if both are drawn from the same population. The Wilcoxon Rank Sum test is often used for this purpose. For the current BERA, this more rigorous statistical analysis was not performed.

The UTL was calculated as follows:

$$UTL = \bar{X} + k(a) \qquad \text{Eq. 2.4}$$

where:

UTL	=	upper tolerance limit (confidence factor of 0.95 and coverage of 95 percent)
$\bar{x}$	=	arithmetic mean
a	=	standard deviation
k	=	tolerance factor.

The same equation is used to estimate the UTL for lognormal distributions, but the data are log-transformed before the arithmetic mean and standard deviation are calculated.

As recommended by OEPA, if the estimated UTL was greater than the MDC, the MDC was used as the default background screening concentration. In addition, if the data were shown to be neither normal nor lognormal, a nonparametric distribution was assumed and the MDC was selected as the background UTL. Results are presented in Table 2-9. Background surface water results were not available. For background sediment, background soil values were used, as the shallow ditches at TNT Area C most likely accumulate sediment as a result of overland runoff from site soils.

It must be understood that statistical analysis is only a tool to aid the exercise of professional judgement. Site data from uncontaminated areas with concentrations at the high end of background may "fail" statistical testing because of the limitations of sample size, i.e., the full range of actual background and site variation was not captured. Statistical testing is based on absolute values, but the approximately 20 metals generally analyzed together constitute only approximately 4 to 5 percent of a given sample. Apparently high values of one or more metals may

arise from a diminished amount of other constituents in soil, e.g., silica or organic matter, that may be more abundant in background areas. Therefore, it may be necessary to normalize the metal concentrations in site and background data before performing comparisons. However, for the current BERA, this additional analysis was not performed.

Essential nutrients such as calcium, chloride, iodine, magnesium, phosphorus, potassium and sodium (McDowell, 1992) were eliminated as COPEC only if their MDC did not exceed the background level, or they were infrequently detected (e.g., < 5 percent). Potential toxicity of these nutrients has been considered (Section 4.0).

2.2.5 Comparison to Risk-Based Screening Ecotoxicity Values

A comparison has made between MDCs of chemicals in sampled media and the risk-based screening ecotoxicity value (RBSEV) for ecological endpoints following recommendations received from OEPA and as discussed in EPA Region V BTAG Bulletin No. 1 (EPA, 1996a). Chemicals that exceeded the RBSEVs, or for which no RBSEV are available, have been retained as COPECs. The following RBSEVs, or RBSEV hierarchy (as noted) have been used for the ecological evaluation:

- ***Soil.*** Soil screening values have been selected using the following hierarchy: (1) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et. al. 1997a); (2); *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process* (Efroymson, Suter, and Will, 1997b); (3) *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants* (Efroymson et. al. 1997c); and (4) *Ecological Data Quality Levels* (EDQL) (EPA, 1999). It should be noted that effects on heterotrophic processes may not be relevant to ecological receptors of concern at the site.

- ***Groundwater.*** If groundwater is known to impact surface water at the site, surface water RBSEVs will be used, as presented below.

- ***Surface Water.*** The lowest surface water screening value has been selected from the following three sources: (1) Ohio EPA Water Quality Criteria (WQC) for the protection of aquatic life; (2) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et. al. 1997a); and (3) *Ecological Data Quality Levels* (EPA, 1999). Use of a hierarchy has not been used because this type of approach would potentially eliminate important surface water COPECs due to the fact that OEPA WQC do not consider food-chain effects.

- ***Sediment.*** Sediment screening values have been selected using the following hierarchy: (1) *Ecological Data Quality Levels* (EPA, 1999); (2) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et. al. 1997a); and (3) *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* (Ontario Ministry of the Environment and Energy [OME], 1993).

Nonchemical stressors have also been assessed, using available surface water data collected on pH, turbidity, conductivity, dissolved oxygen (DO), redox potential (Eh), and temperature.

The results of the screening of the selected COPECs with RBSEV for ecological endpoints of concern are presented in Tables 2-10 through 2-13. COPECs are only selected for further consideration in the BERA if the MDC exceeded the available RBSEV. If no RBSEV was available, the constituent was carried forward for consideration in the BERA, unless it was within background or less than 5 percent occurrence. Note: Appendix C presents a compilation of the RBSEVs for each medium and shows the final values that are used in the screening assessment.

2.2.6 Summary of COPEC Selection

Tables 2-10 through 2-13 have been prepared for each medium with the following information:

- Chemical name
- Frequency of detection
- Arithmetic mean of site concentrations
- Range of detected concentrations
- Range of detection limits
- Statistical distribution
- 95 percent UCL of the arithmetic mean
- Background screening criterion, if available
- Risk-based screening criterion, if available
- COPEC selection conclusion: YES or NO
- Rationale for selection or rejection of the COPEC
- Source-term exposure concentration that was used in the BERA.

Footnotes in the tables provide the rationale for selecting or rejecting a chemical as a COPEC. An evaluation of all of the constituents that were eliminated for further consideration was performed to determine whether any should be reinstated as COPECs due to other considerations. Examples of these exceptions include: potential break-down products; chemicals known

to have been used onsite historically; chemicals with detection limits greater than the RBSEV; and chemicals with high bioconcentration and/or bioaccumulation factors. Based on this evaluation, no additional COPECs are recommended. Although several constituents had some samples with elevated detection limits (e.g., bis(2-ethylhexyl)phthalate in soil samples SO-151 [Sample AC0438] and SO-171 [Sample AC0171] and bis(2-ethylhexyl)phthalate in most of the sediment samples); in general, detection limits were acceptable. The treatment of nondetect results is discussed in Section 2.2.2.

Twenty-two COPECs have been selected for surface soil, twenty-six have been selected for total soil, twenty-one have been chosen for surface water, and twenty-one have been chosen for sediment. As discussed at the beginning of Section 2.0, given this selection of potential chemical stressors, and on the finding that viable habitat, potential receptors, and potential exposure pathways exist at the site, a predictive assessment is triggered. Chemicals not eliminated using the screening procedures previously presented are considered final COPECs and have been quantitatively evaluated in the predictive BERA. The relevant and important physical, chemical, and toxicological properties of the identified COPEC risk drivers have been reviewed from the scientific literature and are presented as COPEC profiles in Appendix D.

2.3 Selection of Assessment Receptors

IT has selected assessment receptors for evaluation during the predictive BERA. In order to focus the exposure characterization portion of the BERA on species or components that are the most likely to be affected, given the toxicological and mobility characteristics of the COPECs, and on those COPECs that, if affected, are most likely to produce greater effects in the on-site ecosystem, IT has focused the selection process on species, groups of species, or functional groups, rather than higher organization levels such as communities or ecosystems. Site biota are organized into major functional groups. For terrestrial communities, the major groups are plants and wildlife, including terrestrial invertebrates, mammals, and birds. For aquatic and/or wetland communities, the major groups are flora and fauna, including vertebrates (water fowl and fish), aquatic invertebrates, and wetland/terrestrial mammals. Species presence at the site was determined during a literature review and during the site reconnaissance (Section 2.1.5 and 2.1.6) prior to identification of target receptor species.

Primary criteria for selecting appropriate assessment receptors included, but were not limited to, the following.

- The assessment receptor will have a relatively high likelihood of contacting chemicals via direct or indirect exposure.
- The assessment receptor will exhibit marked sensitivity to the COPECs given their mode of toxicity, propensity to bioaccumulate, etc.
- The assessment receptor will be a key component of ecosystem structure or function (e.g., importance in the food web, ecological relevance).
- The assessment receptor may be listed as rare, threatened, or endangered (RTE) by a governmental organization; or the receptor will consist of critical habitat for RTE species. Based on the availability of species-specific data, a RTE surrogate species may be selected (Section 2.3.1).

Additional criteria for selection of assessment receptors was used to identify species that offer the most favorable combination of characteristics for determining the implications of on-site contaminants. These criteria included: (1) limited home range; (2) role in local nonhuman food chains; (3) potential high abundance and wide distribution at the site; (4) sufficient toxicological information available in the literature for comparative and interpretive purposes; (5) sensitivity to COPECs; (6) relatively high likelihood of occurrence on site following remediation (if required); (7) suitability for long-term monitoring; (8) importance to the stability of the ecological food chain or biotic community of concern; and (9) relatively high likelihood that they will be present at the site or that habitats present at the site could support the species.

It is important that sufficient toxicological information is available in the literature on the receptor species, or that a closely related species may be selected. While the ecological communities at the site have species with many desirable characteristics for use as receptor species, not all of these species have been used extensively for toxicological testing.

2.3.1 Terrestrial Receptors

Seven representative receptor species that are expected or possible in the area of TNT Area C (Section 2.1) were selected as indicator species for the potential effects of COPECs. These indicator species represent two classes of vertebrate wildlife (mammals and birds) and a range of both body size and food habits, including herbivory, omnivory, and carnivory. Note: potential

impacts to terrestrial plants are considered in Section 5.1. The seven species selected include the deer mouse (*Peromyscus maniculatus*) (small, omnivorous mammal), short-tailed shrew (*Blarina brevicauda*) (small, insectivorous mammal), Eastern cottontail rabbit (*Sylvilagus floridanus*) (medium-sized herbivorous mammal), marsh wren (*Cistothorus palustris*) (small insectivorous bird), white-tailed deer (*Odocoileus virginianus*) (large herbivorous mammal), raccoon (*Procyon lotor*) (medium-sized omnivorous mammal), and red-tailed hawk (*Buteo jamaicensis*) (large, carnivorous bird). The marsh wren was selected as a surrogate for the sedge wren, an Ohio endangered species that has been documented in the general area and a species that may be expected on site given the availability of some preferred nesting habitat.

The deer mouse, shrew, Eastern cottontail, and wren represent the prey base for the larger predators of the area (represented by the red-tailed hawk). A terrestrial food web is presented in Figure 2-6. Many of these species have limited home ranges, particularly the deer mouse, cottontail, shrew, and marsh wren, which make them particularly vulnerable to exposure to site contaminants. All of the selected terrestrial receptor species have a potential high abundance and wide distribution at the site and sufficient toxicological information (with the exception of some bird species) is available in the literature for comparative and interpretive purposes. In addition, all of the selected species are likely to occur after site remediation (if risk management decisions require it), and all are important to the stability of the local ecological food chain and biotic community. Finally, all the selected species have readily-available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (EPA, 1993).

Larger mammal species were generally not selected as sensitive receptors due to their large home ranges, however, the far-ranging red-tailed hawk was retained due to its unique role as a top predator in the food chain and the white-tailed deer was retained due to its high abundance at the site. Smaller birds were generally not included because most are migratory. The potential risk to species with larger home ranges and migratory avian species will be included within the predicted risks to the selected terrestrial indicator receptors. Area use factors were conservatively set to 100 percent for the mouse, shrew, rabbit, wren, and raccoon, due to their relatively small home ranges (Section 3.1). However, for the deer and hawk, the area use factor was set at 0.09 and 0.06 (or 9 and 6 percent), respectively, based on these two species' relatively large home ranges (518 and 842 hectares, or 1,280 and 2,081 acres, respectively), compared with the size of the site (approximately 120 acres, Figure 2-5).

Results of the assessment receptor selection process are presented in detailed biological and ecological descriptions called assessment receptor profiles (ARP). Additionally, the biologically relevant criteria used to select the seven terrestrial assessment receptors are discussed and summarized in the ARP (Appendix E).

2.3.2 Aquatic Receptors

The only aquatic habitats at the site include the surface water drainage ditches that drain off the site to the north into a tributary to Pipe Creek, in addition to limited wetland areas that occur along some of these drainage ditches (Photo No. 4 in Figure 2-2). Exposure to aquatic organisms within the water bodies and/or wetlands is assumed to occur via direct exposure to contaminants in the water column and via ingestion of benthic invertebrates as well as littoral and pelagic prey exposed to contaminants in surface water and sediment. Note: potential effects to macroinvertebrates and phytoplankton (algae) have been assessed using available surface water and sediment quality criteria for the protection of aquatic life (Section 5.2). Potential uptake through the food chain is evaluated for two representative receptors, including the raccoon (also considered as a terrestrial receptor) and the mallard (*Anas platyrhynchos*) (medium-sized aquatic omnivore).

Aquatic organisms represent some of the prey base for aquatic receptors (represented by the mallard and raccoon). A food web is presented in Figure 2-7. The selected receptor species have relatively small home ranges, which makes them particularly vulnerable to exposure to site contaminants. Foraging factors were set to 20 percent for both of the aquatic receptors evaluated in this BERA because of the limited amount of surface water and sediment at the site (less than about 1 acre, Section 2.1.2). It should be noted that the term 'foraging factor" is similar to the term "area use factor" that is used for terrestrial receptors. Both of the selected aquatic receptor species have been documented near the site (Section 2.1), have a potential high abundance and wide distribution at the site, and sufficient toxicological information (with the exception of the mallard bird species) is available in the literature for comparative and interpretive purposes. In addition, both of the selected species are likely to occur after site remediation (if risk management decisions require it), and both are important to the stability of the local ecological food-chain and biotic community. Finally, the selected species have readily available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (EPA, 1993).

Results of the assessment receptor selection process are presented in detailed biological and ecological descriptions known as ARP. The biological relevant criteria used to select the aquatic assessment receptors are discussed and summarized in the ARPs (Appendix E).

2.4 Ecological Endpoint (Assessment and Measurement) Identification

The protection of ecological resources, such as habitats and species of plants and animals, is a principal motivation for conducting the BERA. Key aspects of ecological protection are presented as policy goals. These are general goals established by legislation or agency policy that are based on societal concern for the protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and government agency policies (e.g., Comprehensive Environmental Response, Compensation, and Liability Act, National Environmental Policy Act). Other legislation includes the Endangered Species Act 16 U.S.C. 1531-1544 (1993, as amended) and the Migratory Bird Treaty Act 16 U.S.C. 703-711 (1993, as amended). To determine whether these protection goals are met at the site, assessment and measurement endpoints have been formulated to define the specific ecological values to be protected and to define the degree to which each may be protected.

Unlike the human health risk assessment process, which focuses on individual receptors, the BERA focuses on populations or groups of interbreeding nonhuman, nondomesticated receptors. In the BERA process, the risks to individuals are assessed only if they are protected under the Endangered Species Act, are species that are candidates for protection, or are species that are considered rare.

Given the diversity of the biological world and the multiple values placed on it by society, there is no universally applicable list of assessment endpoints. Suggested criteria that may be considered in selecting assessment endpoints suitable for a specific ecological risk assessment are: (1) ecological relevance; (2) susceptibility to the contaminant(s); (3) accessibility to prediction and/or measurement; and (4) definable in clear, operational terms (Suter, 1993). Selected assessment endpoints should reflect environmental values that are protected by law, are critical resources, or have relevance to ecological functions that may be impaired. Both the entity and attribute are identified for each assessment endpoint.

Assessment endpoints are inferred from effects to one or more measurement endpoints. The measurement endpoint is a measurable response to a stressor that is related to the valued attribute of the chosen assessment endpoint. It serves as a surrogate attribute of the ecological entity of interest (or of a closely related ecological entity) that can be used to draw a predictive conclusion about the potential for effects to the assessment endpoint. Information gained during the site reconnaissance was used to assist in the selection of assessment and measurement endpoints. These endpoints, formal expressions of the environmental values to be protected (Suter, 1993), have been used to focus the goals of the BERA (Table 2-14).

Measurement endpoints for this BERA are based on toxicity values from the available literature and not statistical or arithmetic summaries of actual field or laboratory observations or measurements. When possible, receptors and endpoints have been concurrently selected by identifying those that are known to be adversely affected by chemicals at the site based on published literature. COPECs for those receptors and endpoints have been identified by drawing on the scientific literature to obtain information regarding potential toxic effects of site chemicals to site species. This process ensures that a conservative approach is taken in selecting endpoints and evaluating receptors that are likely to be adversely affected by the potentially most toxic chemicals at the site.

2.4.1 Assessment Endpoints

The assessment endpoints for the TNT Area C are stated as "the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds." The corresponding H_0 for each of the assessment endpoints is stated as: "the presence of site contaminants within soil, surface water, sediment, vegetation, and prey will have no effect on the survival or reproductive capabilities of terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds."

Assessment receptor species were selected based on the likelihood of finding the species at the TNT Area C. Historical information, the site reconnaissance (performed September 11 through 13, 2000 and May 21, 2001), and the availability of toxicological data were used to select

terrestrial and aquatic receptor species. These receptors species are depicted in food web models (Figures 2-6 and 2-7). Food web models are simplified versions of the possible movement of contaminants through the food chain present or potentially present at the site. Due to lack of data for all possible species, key species have been selected to represent broad classes, or guilds.

The food web conceptual site models were developed to illustrate how the selected terrestrial and aquatic species are ecologically linked within food webs. One species was used to represent each of the major trophic levels and habitats at the site. The decision was made not to complicate the food web models with detailed species selection at the base of the food web (*i.e.* specific terrestrial/benthic invertebrates or aquatic vertebrates). Thus, generic terrestrial invertebrates, benthic invertebrates, and aquatic invertebrates were used to represent the bottom of the food chain. For terrestrial invertebrates and plants, partitioning coefficients and simple empirical uptake models were employed to estimate COPEC concentrations within tissues (Section 3.0). These tissue concentrations were then used as input values for exposure to higher trophic level receptors through the dietary ingestion route. Brief life-history descriptions for the selected area receptor species are provided in Appendix E.

All trophic levels may be exposed to COPECs, either by direct exposure to contaminated abiotic media or through ingestion of lower trophic level food items. Primary producers (plants) absorb COPECs (as well as nutrients) from soil and/or water. Through abiotic processes COPECs can adsorb to the sediment and detritus particles. When these particles settle and become part of the benthic substrate they may also become a source of COPECs to benthic communities. Various species of aquatic biota fulfill the role of aquatic herbivorous (feeding on aquatic plants and suspended detritus) and predatory invertebrates (feeding on benthic invertebrate species). The combination of COPEC bioconcentration from water, ingestion of contaminated prey, and generally restricted ranges for aquatic organisms provides ideal conditions for significant bioconcentration of COPECs. For this reason the mallard was included in the aquatic food web as a top trophic-level omnivore capable of bioaccumulating COPECs. In terrestrial species bioconcentration occurs in plants and invertebrates, and higher food chain receptors bioaccumulate COPECs through the ingestion of food items.

2.4.2 Measurement Endpoints

Measurement endpoints are frequently numerical expressions of observations (*e.g.* toxicity test results or community diversity indices) that can be compared statistically to detect adverse responses to a site contaminant. Examples of typical measurement endpoints include mortality, growth or reproduction in toxicity tests; individual abundance; species diversity; and the presence or absence of indicator data in field surveys of existing impacts (EPA, 1997).

For assessments, measurable responses to stressors may include lowest observed adverse effect levels (LOAEL), no observed adverse effect levels (NOAEL), lethal concentration to 50 (LC_{50}) percent of the test population, lethal dose to 50 (LD_{50}) percent of the test population, or effect concentration for 20 percent of population effective concentration for 20 percent of the test population, collectively termed "toxicity endpoint values" (see Section 4.2 for further explanation). In addition, critical effect values for surface water, sediment, and soil were selected as measurement endpoints (Table 2-14). The most appropriate measurement endpoints were chosen based on exposure pathways as well as ecotoxicity of the contaminant.

2.5 Ecological Site Conceptual Model

IT has prepared pictorial representations of potential exposure. These food web pictorials (Figures 2-6 and 2-7) and accompanying text presented in Section 3.1, clarify the representations that are the ecological site conceptual models (ESCM). The ESCMs trace the contaminant pathways through both abiotic components and biotic food web components of the environment. The ESCMs present all potentially complete exposure pathways. The ESCMs have been used as a tool for judging the appropriateness and usefulness of the selected measurement endpoints in evaluating the assessment endpoints, and for identifying sources of uncertainty in the exposure characterization.

3.0 Exposure Characterization

IT has developed an estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to COPECs that are present at or migrating from the site, considering both current and reasonably plausible future use of the site. Exposure characterization is critical in further evaluating the risk of compounds identified as COPECs during the selection process (Section 2.3). The exposure assessment has been conducted by linking the magnitude (concentration) and distribution (locations) of the contaminants detected in the media sampled during the investigation, evaluating pathways by which chemicals may be transported through the environment, and determining the points at which organisms found in the study area may contact contaminants.

3.1 Exposure Analysis

IT has performed an exposure analysis, which combines the spatial and temporal distribution of the ecological receptors with those of the COPEC to evaluate exposure. The exposure analysis focuses on the chemical amounts that are assumed to be bioavailable, and the means by which the ecological receptors are exposed (e.g., exposure pathways). The focus of the analysis is dependent on the assessment receptors being evaluated as well as the assessment and measurement endpoints.

Ecological routes of exposure for biota may be direct (bioconcentration) or through the food web via the consumption of contaminated organisms (biomagnification). Food web exposure can occur when terrestrial or aquatic fauna consume contaminated biota. Examples of food web exposure include animals at higher trophic levels consuming plants or animals that bioaccumulate contaminants. The concepts of bioconcentration, bioaccumulation, and biomagnification are used throughout this document. Definitions describing their application are presented in the Glossary of Terms (Appendix F). Direct exposure routes include dermal contact, absorption, inhalation, and ingestion. Examples of direct exposure include animals incidentally ingesting contaminated soil or sediment (e.g., during burrowing or dust-bathing activities); animals ingesting surface water; plants absorbing contaminants by uptake from contaminated sediment or soil; and the dermal contact of aquatic organisms with contaminated surface water or sediment.

Contamination of biota could result from exposure to one or more COPEC. Bioavailability is an important contaminant characteristic that influences the degree of chemical-receptor interaction. Bioavailable compounds are those that a receptor can take in from the environment. Bioavailability of a chemical is a function of several physical and chemical factors such as grain size and organic carbon content.

Exposure pathways consist of four primary components: source and mechanism of contaminant release, transport medium, potential receptors, and exposure route. A chemical may also be transferred between several intermediate media before reaching the potential receptor. All of these components have been addressed within this BERA. If any of these components are not complete, then contaminants in those media do not constitute an environmental risk at that specific site. As discussed in Section 2.3, however, these four components are complete for all sampled site media. The major fate and transport properties associated with typical site contaminants are presented in subsequent sections. These properties directly affect a contaminant's behavior in each of the exposure pathway components.

For terrestrial faunal receptors, calculation of exposure rates relies upon determination of an organism's exposure to COPECs found in surface water, surface soil, and on transfer factors used for food-chain exposure. Exposure rates for terrestrial wildlife receptors are based solely upon ingestion of contaminants from these media and from consumption of other organisms. Given the scarcity of data available for wildlife dermal and/or inhalation exposure pathways, potential risk from these pathways has not been estimated. In addition, dermal and inhalation pathways are generally considered to be incidental for most species, with the possible exception of burrowing animals and dust-bathing birds.

The first step in estimating exposure rates for terrestrial wildlife involves the calculation of food ingestion and drinking water intake rates for site receptors. EPA (1993) includes a variety of exposure information for a number of avian and mammalian species. Information regarding feeding and watering rates, and dietary composition are available for many species, or may be estimated using allometric equations (Nagy, 1987). Data have also been gathered on incidental ingestion of soil, and are incorporated for the receptor species. This information is summarized in Table 3-1.

Algorithms have been evaluated for calculating exposure for terrestrial vertebrates that account for exposure via ingestion of contaminated water, incidental ingestion of contaminated soil, ingestion of plants grown in contaminated soil, and prey items. Singular algorithms have been developed for soil to plant uptake and for animal bioaccumulation (transfer factors).

The basic equation for estimating dose through the dietary pathway is:

$$D_p = \sum_{k=1}^{m} (C_k \cdot F_k \cdot I_k)/W \qquad \text{Eq. 3.1}$$

where:

D_p = the potential average daily dose (milligrams per kilogram [mg/kg]-day),
C_k = the average COPEC concentration in the kth food type (mg/kg dry weight)
F_k = the fraction of the kth food type that is contaminated
I_k = the ingestion rate of the kth food type (kg dry weight/day)
W = the body weight of the receptor (kg wet weight).

For aquatic faunal receptors, the calculation of exposure rates depends on the determination of the contaminant concentration in water and sediment, and on food-chain multipliers, bioconcentration factors (BCF), and bioaccumulation factors (BAF). If appropriate, an evaluation can be made of the time each organism spends associated with surface water or sediment pore water in order to modify exposure rates, however, this refined approach was not used in the current BERA.

Literature values for animal-specific sediment ingestion have been used if available. However, such values generally are not available in the literature. Where sediment ingestion rates could not be found, the animal-specific incidental soil ingestion rate is used for sediment ingestion as well, if the receptor's life history profile suggests a significant aquatic component (e.g., raccoons' use of surface water in foraging activities).

For species exposed to organic contaminants found in sediment, calculations have been performed to quantify interstitial (pore) water contaminant concentrations given a known sediment concentration. Suter's (1993) algorithm to calculate pore water concentrations for nonionic organic chemicals was used, as follows:

$$\text{Pore water concentration (milligrams per liter)} = (SC)/[(F_{oc})\ (K_{oc})] \qquad \text{Eq. 3.2}$$

where:

SC = sediment concentration (mg/kg)
F_{oc} = fraction organic carbon in sediment (kg organic carbon/kg sediment)
K_{oc} = chemical-specific organic carbon partition coefficient (liters per kilogram [L/kg]).

For sediment, K_{ow} values (Table 3-2) have been converted to K_{oc} values (EPA, 1996b) as follows:

$$\log K_{oc} = 0.00028 + (0.983 \times \log K_{ow}) \qquad \text{Eq. 3.3}$$

where:

K_{ow} = the octanol water partition coefficient.

This equation was chosen because it is the best fit for important site-related compounds, such as semivolatile nonionizing organic compounds.

F_{oc} values for sediment have been set at 0.067, based on sediment samples collected from the West Area Road Red Water Pond (IT, 2000). To estimate inorganic partitioning from sediment to pore water, K_d values (Table 3-3; with units of L/kg) were used instead of F_{oc} and K_{oc}. It should be noted that estimates of COPEC concentrations in sediment pore water were set at the calculated value using the appropriate K_{oc} or K_d value, or were set at a specific COPEC's published solubility in water, whichever was lower. This approach was necessary as some of the estimated pore-water concentrations could exceed typical solubility values because partitioning may be inaccurate for COPECs with elevated sediment concentrations. For TNT Area C, the estimated pore water concentration for 2,4,6-TNT (242 milligrams per liter [mg/L]) was unusually elevated, and the literature solubility value was used (100 mg/L), as opposed to the estimated pore water concentration (Appendix G).

Adjustments were considered for potential biomagnification of contaminants through aquatic trophic levels. Food-chain multipliers (FCM), derived by EPA (1995), have been used to assess the possibility of contaminant magnification through site receptors, particularly fish. The FCMs are multiplied by chemical-specific BCFs to obtain BAFs. Assessments may use either

laboratory-measured BCF values obtained from the scientific literature or aquatic biota BCFs calculated for organic compounds using the following equation (EPA, 1995):

$$BCF = K_{ow} \qquad \text{Eq. 3.4}$$

where:

K_{ow} = chemical-specific octanol/water partition coefficient.

When possible, K_{ow} values for appropriate COPEC have been obtained from the literature or from databases, and are presented in Table 3-2.

The BCF is dependent upon a chemical-specific K_{ow} that relates to a chemical's tendency to partition to a polar versus nonpolar solution. EPA has established a relationship between the K_{ow} and the FCM such that as the K_{ow} increases, the FCM increases correspondingly. However, for trophic level 2, FCMs are set at 1.0 (EPA, 1995), and sediment-dwelling aquatic invertebrates are assumed to generally function as secondary trophic level feeders within the aquatic habitats at TNT Area C. The EPA guidance also notes that for chemicals for which no K_{ow} is available, and for which no BCF can be estimated, a default FCM of 1.0 should be used. Thus, for inorganics not thought to biomagnify and/or for which no literature value is available, this value of 1.0 has been used.

As an alternative to literature- or K_{ow}-related BCFs, site-specific BCFs were preferentially selected, where available, for sediment-to-invertebrate bioaccumulation estimates. Site-specific BCFs (Table 3-4) are from 28-day bioaccumulation studies performed using the invertebrate species *Lumbriculus variegatus* and sediment samples collected from PBOW Red Water Ponds (IT, 2001b). It should be noted that site-specific BCFs, derived by dividing COPEC tissue concentrations by COPEC sediment concentrations, were calculated and presented two different ways in IT (2001b). Both reasonable maximum exposure (RME) and central tendency (CT) site-specific BCFs were estimated in IT (2001b), with the RME BCFs based on all tissue concentration results, even if blank related, and the CT BCFs were based on blank-corrected tissue results. For this BERA the RME BCFs were conservatively selected over the CT BCFs, as they were numerically greater for some COPECs.

In addition to the aquatic food web, FCMs are also related to an organism's trophic status as predator/prey, producer/consumer, etc in the terrestrial food web. Although exposures of terrestrial floral and faunal receptors are significant considerations for many hazardous waste sites, well accepted models for predicting the fate of many contaminants in terrestrial systems are less developed. Trophic level compartments and transfer between compartments based on uptake, storage, and loss processes are not as well defined in terrestrial systems as in aquatic systems. In addition, the relationship between K_{ow} and bioconcentration is less well delineated by trophic level in terrestrial ecosystems. For the current BERA, soil-to-plant and food-to-muscle BAFs (or transfer factors [TF]) were estimated for organic constituents using the log K_{ow} relationships developed by Travis and Arms (1988), as presented below, with calculated transfer factors presented in the hazard calculation spreadsheets in Appendix G.

$$\log Tf_{soil\text{-}to\text{-}plant} = 1.588 - 0.578(\log K_{ow})$$
$$\log Tf_{food\text{-}to\text{-}muscle} = -7.735 + 1.033(\log K_{ow}).$$

Soil-to-insect BAFs were initially based on log K_{ow} relationships developed by Connell and Markwell (1990). For organic COPECs in soil invertebrates, the transfer factor was derived from the following equation developed by Connell and Markwell (1990) for bioaccumulation in earthworms:

$$BAF = \frac{y_L \cdot K_{ow}^{b-a}}{x \cdot f_{oc}} \qquad \text{Eq. 3.5}$$

where:

BAF = the bioaccumulation factor (unitless)
y_L = the fractional lipid content of the organism
K_{ow} = the octanol/water partition coefficient
(b-a) = a nonlinearity constant
x = a proportionality constant
f_{oc} = the fractional organic carbon content in the soil.

Although derived from earthworm data, the values for the nonlinearity constant (0.05) and proportionality constant (0.66) were applied to modeling uptake in soil invertebrates. Because of

differences in integument, it is expected that the uptake by earthworms will generally be greater than that of invertebrates such as insects. Therefore, these factors are expected to yield conservative estimates of invertebrate uptake. The lipid content in insects was estimated at 3.1 percent fresh weight (Taylor, 1975), which is 7.9 percent of dry weight, using a value of 61 percent water content in beetles (EPA, 1993), calculated as follows:

$$\frac{0.031}{(1 - 0.61)} = 0.079 \text{ or } 7.9 \text{ percent}$$

The fraction of organic carbon in the soil was estimated to be 0.01, or 1 percent, as site-specific soil f_{oc} data were not available. This default value was based on information related to fate and transport data for organic constituents, as presented in *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA, 1998). Except where literature-derived values are available, the soil-to-invertebrate transfer factors for inorganics were assumed to be 1. Table 3-3 presents the soil-to-plant and initial soil-to-invertebrate transfer factors estimated for the inorganic COPECs. The COPECs in this table are limited to those that were not dropped during the screening assessment (Section 2.2.6). Transfer factors estimated using the Connell and Markwell method for organic COPECs are presented as calculated/literature values in Table 3-5.

As an alternative to literature- or Connell and Markwell-calculated BAFs, site-specific BAFs were preferentially selected, where available, for soil-to-invertebrate bioaccumulation estimates. Site-specific BAFs (Table 3-5) are from 28-day bioaccumulation studies performed using the earthworm species *Eisenia foetida* and soil samples collected from PBOW Red Water Ponds (IT, 2001b). It should be noted that site-specific BAFs, derived by dividing COPEC tissue concentrations by COPEC soil concentrations, were calculated and presented two different ways in IT (2001b), as was done for aquatic uptake estimates. Both RME and CT site-specific BAFs were estimated in IT (2001b), with the RME BAFs based on all tissue concentration results, even if blank related, and the CT BAFs were based on blank-corrected tissue results. For this BERA the RME BAFs were conservatively selected over the CT BAFs, as they were numerically greater for some COPECs.

Tissue concentrations in vertebrate prey species were estimated from the daily intake of the COPECs through the use of transfer factors for beef. The regression equation developed by

Travis and Arms (1988) was used to derive food-to-beef transfer factors for the organic COPECs based on the log K_{ow} value of the chemical of concern. Transfer factors for the inorganic COPECs were taken from International Atomic Energy Agency (1994), National Council on Radiation Protection and Measurements (1989), Ma (1982), and Baes, et al. (1984), as shown in Table 3-3. A weighted total of the concentrations of COPEC intakes (including ingested soil and surface water) was then used in the calculation of tissue concentrations in prey species and the dietary exposure rate in all selected receptor assessment species, as follows:

$$\frac{\text{Total intake of soil, water, plants, and/or invertebrates (in mg COPEC/day)} \times \text{Food-to-Tissue TF}}{0.32 \times \text{Total food and soil intake (in kg mass/day)}}$$

A conversion factor of 0.32 was used to convert wet weight tissue concentrations to dry weight values, given that the water content of mammals and passerine birds is reported to be 68 percent (Table 4-1 in EPA, 1993).

Media-Specific Exposure Pathways. Exposure to four categories of environmental media are addressed in this BERA, as discussed in the following subsections.

Soil Exposure Pathway. Soil exposure pathways are potentially important for terrestrial plants and animals at the site. For non-burrowing animal exposure, soil samples obtained from a depth of 0 to 2 feet have been considered, as this would be the point of exposure. Although the OEPA-approved work plan (IT, 2001a) states surfaces soils will consist of the 0 to 1 foot depth interval, there were essentially no soil samples collected from this depth interval (Table 2-8), therefore, surface soil was redefined as 0 to 2 feet. For burrowing animals such as the shrew, soil samples obtained from a depth of 0 to 6 feet have been considered.

For deep-rooted plant exposure, soil samples taken from 0 to 6 feet have been considered because most feeder roots are located within this depth. Thus, the white-tailed deer is assumed to ingest leaves of trees translocating COPECs from subsoils (Figure 2-6). It should be noted that this assumes not only that trees translocate soil-borne contaminants, but also that tree leaves available to deer have contaminants in them as well.

Environmental conditions such as soil moisture, soil pH, and cation exchange capacities significantly influence whether potential soil contaminants remain chemically bound in the soil

matrix or whether they can be chemically mobilized (in a bioavailable form) and released for plant absorption. Generally, neutral to alkaline soils (soil pH of 6.5 or greater) restrict the absorption of toxic metals, making pathway completion to plants difficult. Literature values for soil-to-plant transfer rates for inorganic soil contaminants have been used (Table 3-3).

Sediment Exposure Pathway. Sediment consists of materials precipitated or settled out of suspension in surface water or native soils underlying flowing or standing surface water bodies. Potential contaminant sources for sediment include buried or stored waste, and contaminated surface water, groundwater, and soil. The release mechanisms include surface water runoff, groundwater discharge, and airborne deposition. Potential receptors of chemicals in contaminated sediment include aquatic flora and fauna. Direct exposure routes for contaminated sediment include contact by benthic-dwelling organisms such as amphipod invertebrates, uptake by aquatic flora and ingestion by aquatic fauna. Indirect exposure pathways from sediment include consumption of bioaccumulated contaminants by consumers in the food chain. Chemical bioavailability of many nonpolar organic compounds (e.g., polychlorinated biphenyls and pesticides) decreases with increasing concentrations of total organic carbon in the sediment; however, these compounds can still bioaccumulate up the food chain (Landrum and Robbins, 1990).

Surface Water Exposure Pathway. Surface water represents a potential transport medium for COPECs. Potential sources for contaminated surface water include: buried or stored waste, stored or spilled fuel, contaminated soil and groundwater, and deposition of airborne contaminants. The release mechanisms include surface runoff, leaching, and groundwater seepage. Potential receptors of contaminated surface water include terrestrial and aquatic fauna and aquatic flora. Exposure routes for contaminated surface water include ingestion by terrestrial fauna, and uptake and absorption by aquatic flora and fauna. Consumption of bioaccumulated contaminants constitutes a potential indirect exposure pathway for faunal receptors. Piscivorous receptor's exposure to fish has not been quantified due to the lack of fish habitat at the site. Chemical bioavailability of some metals and other chemicals is controlled by water hardness, pH, and total suspended solids.

Groundwater Exposure Pathway. Groundwater represents a potential transport medium for COPECs. Potential contaminant sources for groundwater include contaminated soil, and buried

or stored waste. The release mechanism for contaminants into groundwater is direct transfer of contaminants from waste materials to water as water passes through the materials.

Groundwater itself is not an exposure point. However, contaminant transport along the shallow groundwater pathway would be considered an exposure route to aquatic life, wetlands, and some wildlife where the groundwater discharges to surface water. This pathway is of importance to aquatic and wetland receptors if groundwater is found to be discharging to surface water. A groundwater assessment was not included in this BERA because no groundwater samples were collected, and even if they were, surface water samples collected at this potential point of exposure would be more appropriate to use. In addition, groundwater discharge to surface water at TNT Area C is not suspected, based on existing data.

3.2 Exposure Characterization Summary

The estimated chemical intakes for each exposed receptor group under each exposure pathway and scenario are presented in the risk characterization spreadsheets in Appendix G. These intake estimates are combined with the COPEC toxicity values, discussed in the following section, to derive estimates and characterize potential ecological risk. The uncertainties associated with the estimation of chemical intake are discussed in Section 5.4. The basis for each uncertainty has been identified, with the degree of uncertainty estimated qualitatively (low, medium, or high) or quantitatively, and the impact of the uncertainty estimated qualitatively (overestimate or underestimate, as appropriate).

4.0 Ecological Effects Characterization

The ecological effects characterization includes the selection of literature benchmark values and the development of reference toxicity values.

4.1 Selection of Literature Benchmark Values

IT has consulted appropriate sources for literature benchmark values, such as (1) *Toxicological Benchmarks for Wildlife* (Sample, et al., 1996); *Development of Toxicity Reference Values for Conducting Ecological Risk Assessments at Naval Facilities in California* (Engineering Field Activity, West, 1998); *Review of the Navy - EPA Region 9 BTAG Toxicity Reference Values for Wildlife* (CH2M-Hill, 2000); and (2) LD_{50} values from data bases such as the Registry of Toxic Effects Concentrations (RTEC) (extrapolated to chronic NOAEL or LOAEL values using recommended Tri-Service [Wentsel et al., 1996] uncertainty factors). The level of effort has been limited to documents that summarize the available ecotoxicological information and does not consist of a review of the primary toxicological literature (i.e., IT has not reviewed details of toxicity test conditions to determine validity of the tests performed).

4.2 Development of Reference Toxicity Values

IT has developed or determined reference toxicity values (RTV) for the site. These RTVs focus on the growth, survival, and reproduction of species and/or populations. Empirical data is available for the specific receptor-endpoint combinations in some instances. However, for some COPECs, data on surrogate species and/or on endpoints other than the NOAEL and LOAEL had to be used. The NOAEL is a dose of each COPEC that will produce no known adverse effects in the test species. The NOAEL was judged to be an appropriate toxicological endpoint since it would provide the greatest degree of protection to the receptor species. In addition, the LOAEL was used as a point of comparison for decision-making for risk management purposes. In addition, in instances where data are unavailable for a site-associated COPEC, toxicological information for surrogate chemicals had to be used. Safety factors are used to adjust for these differences and extrapolate risks to the site's receptors at the NOAEL and/or LOAEL endpoint. This process is described in the following paragraphs.

Toxicity information pertinent to identified receptors has been gathered for those analytes identified as COPECs. Because the measurement endpoint ranges from the NOAEL to the

LOAEL, preference has been given to chronic studies noting concentrations at which no adverse effects were observed and ones for which the lowest concentrations associated with adverse effects were observed. As previously noted, where data are unavailable for the exposure of a receptor to a COPEC, data for a surrogate chemical (e.g., benzo[a]pyrene for other PAHs have been gathered for use in the BERA.

Using the relevant toxicity information, RTVs have been calculated for each of the COPECs. RTVs represent NOAELs and LOAELs with safety factors incorporated for toxicity information derived from studies other than no-effects or lowest-effects studies.

RTVs have been calculated using safety factors specified in Ford et al. (1992) and reported in Wentsel, et al. (1996) and shown in Figure 4-1, and summarized in Tables 4-1 and 4-2 for NOAEL and LOAEL TRVs, respectively. Interclass toxicity extrapolations were not performed as physiological differences between classes are too great to be addressed with the use of simplistic safety factors. Separate factors are used to account for extrapolation to the no effects or lowest-effects endpoints, for study duration (Tables 4-1 and 4-2), and for extrapolation across taxonomic groups (e.g., species, genus, family, order), as shown in Table 4-3 for the receptors used in this BERA. Although additional safety factors may be employed for endangered species, no endangered species were selected as representative receptors and these additional safety factors were not required. Because NOAELs and LOAELs for the selected wildlife receptor species are based on NOAELs and LOAELs from test species, the latter are converted to NOAELs and LOAELs specific to the selected wildlife receptors using a power function of the ratio of body weights, as described by Sample, et al. (1996). A body weight scaling factor of 0.25 was used for mammals, whereas a body weight scaling factor of 0 was used for birds, making the $NOAEL_w$ or $LOAEL_w$ for birds the same as the $NOAEL_T$ or $LOAEL_T$, as shown below:

$$N/LOAEL_W = N/LOAEL_T \left(\frac{BW_T}{BW_W} \right)^s \qquad \text{Eq. 4.1}$$

where:

$N/LOAEL_W$ = the no observed adverse effect level or lowest observed adverse effect level for the wildlife indicator species (mg/kg-day)

$N/LOAEL_T$	=	the no observed adverse effect level or lowest observed adverse effect level for the test species (mg/kg-day)
BW_T	=	the body weight of the test species (kg)
BW_W	=	the body weight of the wildlife indicator species (kg)
s	=	a body weight scaling factor (s = 1/4 for mammals and s = 0 for birds).

Test species body weights (BW_T) used for COPEC RTVs are contained in the risk characterization spreadsheets presented in Appendix G.

These factors were used together to derive a final adjusted RTV, as shown in the risk characterization spreadsheets (Appendix G). Reference toxicity threshold value uncertainties are discussed in Section 5.4.

Exposure rate RTVs provide a reference point for the comparison of toxicological effects upon exposure to a contaminant. To complete this comparison, receptor exposures to site contaminants are calculated, or as in the case of plant receptors, exposure is estimated using the soil concentration (Section 5.1).

The potential toxicity of essential nutrients is assessed in detail in Appendix H, with maximum tolerance levels presented for several essential nutrients.

The equilibrium partitioning approach has been used by the EPA and OME in the preparation of sediment quality criteria for the protection of aquatic life. These criteria have been used, as available, to assess sediment risks to aquatic receptors.

5.0 Risk Characterization

The risk characterization phase integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is a determination of the likelihood, severity, and characteristics of adverse effects to environmental stressors present at a site. Qualitative and semiquantitative approaches have been taken to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to COPECs. Potential adverse affects to terrestrial plants have been qualitatively assessed by comparing plant toxicity benchmarks with COPEC concentrations. Potential adverse impacts to aquatic biota have been qualitatively assessed by comparing surface water and sediment quality criteria for the protection of aquatic life with surface water and sediment COPEC concentrations.

For the semiquantitative predictive assessment, RTVs and exposure rates have been calculated and are used to generate hazard quotients (HQ) (Wentsel, et al., 1996), by dividing the receptor exposure rate for each contaminant by the calculated RTV. HQs are a means of estimating the potential for adverse effects to organisms at a contaminated site, and for assessing the potential that toxicological effects will occur among site receptors.

5.1 Terrestrial Plant Impact Assessment

To assess the potential impact of COPEC concentrations in surface soil on terrestrial plant species, the source-term concentrations from TNT Area C were compared with available benchmark concentrations developed for the protection of terrestrial plants. As shown in Table 5-1, only four benchmarks were exceeded by the COPEC source-term concentrations (for 2,4,6-TNT, lead, manganese, and zinc). It should be noted, however, that benchmarks were not readily available for some of the COPECs retained for the predictive BERA. Based on site reconnaissances performed, no signs of vegetative stress were noted (Section 2.1.4).

5.2 Aquatic Biota Impact Assessment

To assess the potential impact of COPEC concentrations in surface water and sediment on aquatic biota, the source-term concentrations from the TNT Area C were compared with available benchmark concentrations developed for the protection of aquatic life. As shown in Table 5-2, surface water COPEC concentrations for carbon disulfide, aluminum, barium, cadmium, calcium, copper, iron, and manganese exceeded some or all of the available

benchmarks for the protection of aquatic life. As up to four different benchmarks are used for the surface water assessment, a weight-of-evidence approach may be taken, with more significant impacts being predicted as the number of surface water benchmarks that are exceeded increases. Thus, for TNT Area C, elevated concentrations of copper are less of a concern because only one surface water benchmark out of three was exceeded. The seven other COPECs had a source-term concentration that exceeded at least 50 percent of the available benchmarks. It is important to note that the limited number of surface water samples collected at TNT Area C resulted in the maximum measured concentration being used in many cases as the source-term concentration (Table 2-12). It is possible that additional sampling would result in different conclusions for the impact assessment. It is also important to note that surface water is limited at TNT Area C, and is not a major habitat type.

Potential nonchemical stressors in surface water were evaluated by reviewing the field parameter data presented in Table 5-3 for the ten monitored surface water sample locations. Eh ranged from 7.3 to 218 millivolts (mV) and is a measure of oxidation-reduction potential. As DO levels approach zero, Eh is expected to drop, with lower values representing reducing conditions. Surface water pH ranged from 7.23 to 8.84 standard units (SU), showing slightly alkaline waters. Specific conductance (conductivity), a measure of dissolved particles, ranged from about 0.01 to 1.17 microSiemens per centimeter (mS/cm). Turbidity readings ranged from 0 to 332 nephelometric turbidity units (NTU). DO ranged from 0.007 to 9.03 mg/L. It should be noted that DO levels below about 5 mg/L (a situation that occurred at 90 percent of the monitored locations; Table 5-3) are generally unacceptable for sensitive species of fish. Temperatures ranged from 14.6 to 29.5 degrees Celsius (°C). Overall, nonchemical data suggest poor surface water quality, particularly related to low DO, reducing conditions, and elevated dissolved and suspended solids, as represented by elevated conductivity and turbidity readings, respectively. This finding is not unexpected, given the intermittent flow and shallow characteristics of the small drainage ditches at TNT Area C. The one monitoring location with adequate concentrations of DO for aquatic biota (location SW-01) was recorded as having flowing water conditions, and was situated at the northwest corner of the site. Of the eight surface water COPECs identified to be above benchmarks (previous paragraph), only calcium was documented to be numerically highest at sample location SW-01.

As shown in Table 5-4, sediment COPEC concentrations for seven constituents detected in TNT Area C sediment exceeded at least one available benchmark developed for the protection of aquatic biota. Only four COPECs, however, (e.g., 1,3,5-trinitrobenzene, 2,4,6-TNT, Aroclor-1260, and lead), had a source-term concentration that exceeded at least 50 percent of the available benchmarks. It is important to note that the limited number of sediment samples collected at the TNT Area C resulted in the maximum measured concentration being used in many cases as the source-term concentration (Table 2-13). It is possible that additional sampling would result in different conclusions for the impact assessment. It is also important to note that aquatic habitat is limited at TNT Area C, and is not a major habitat type. It should also be noted that EPA Region 5 (1996a) BTAG recommends that National Oceanic and Atmospheric Administration (NOAA) effects range-low and effects range-medium benchmarks only be used when freshwater benchmarks are unavailable, as NOAA benchmarks are primarily for marine environments. Discounting of the NOAA benchmarks, however, would not significantly change the previous findings.

5.3 Predictive Risk Estimation for Terrestrial and Aquatic Wildlife

IT has estimated the risk associated with TNT Area C. The risk estimation has been performed through a series of quantitative HQ calculations that compare receptor-specific exposure values with RTVs. The HQs are compared to HQ guidelines for assessing the risk posed from contaminants. HQs less than or equal to 1 represent no probable risk; HQs from 1 up to, but less than 10, represent a low potential for environmental effects; HQs from 10 up to, but less than 100, represent a significant potential that effects could result from greater exposure; and HQs greater than 100 represent the highest potential for expected effects (Wentsel, et al., 1996). It should be noted that OEPA considers HQs greater than 1.0 to be potentially significant. It should also be noted that HQs are not measured of risk, are not population-based statistics, and are not linearly-scaled statistics, and therefore an HQ above 1, even exceedingly so, does not guarantee that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Tannenbaum, 2001; Bartell, 1996).

The simple HQ ratios have been summed to provide conservative hazard index estimates for all chemicals and exposure pathways for a given receptor. The following criterion may be used to determine if HQ summation is appropriate and scientifically defensible: for a given receptor, only HQs for those chemicals that have a similar mode of toxicological action should be

summed. While individual contaminants may affect distinct target organs or systems within an organism, classes of chemicals may act in similar ways, thus being additive in effect. The summation of HQs into a hazard index was performed, in part, to determine whether or not individual COPEC HQs should be segregated based on dissimilar modes of toxicological action. If a risk driver resulted in an HQ greater than approximately 10 to 100, segregation of other COPECs by mode of toxicological action would not be necessary.

Conservative NOAEL-based hazard indices (summed HQs) for terrestrial receptors at TNT Area C were estimated to be 31,559 for the deer mouse, 36,410 for the cottontail rabbit, 5,621 for the shrew, 25,077 for the marsh wren, 26,141 for the raccoon, 3,100 for the white-tailed deer, and 73 for the red-tailed hawk (Table 5-5). COPECs from soil, not surface water, were risk drivers for all of the evaluated terrestrial receptors (with the possible exception of aluminum concentrations in surface water impacts to the deer). Major soil risk drivers, listed in decreasing order of concern, included 2,4,6-TNT, Aroclor-1260, and lead. Important routes of exposure included invertebrate, soil, and plant intake and, for the hawk, predation of shrew and wren (Table 5-5).

Conservative LOAEL-based hazard indices (summed HQs) for terrestrial receptors at TNT Area C were estimated to be 6,190 for the deer mouse, 7,280 for the cottontail rabbit, 977 for the shrew, 1,150 for the marsh wren, 5,110 for the raccoon, 614 for the white-tailed deer, and 4 for the red-tailed hawk (Table 5-6). COPECs from soil, not surface water, were risk drivers for all of the evaluated terrestrial receptors. Major soil risk drivers, listed in decreasing order of concern, included 2,4,6-TNT, Aroclor-1260, and lead. Important routes of exposure included invertebrate, soil, and plant intake and, for the hawk, predation of shrew and wren (Table 5-6).

Conservative NOAEL-based hazard indices (summed HQs) for aquatic receptors at the TNT Area C were estimated to be 2,350 for the mallard and 1,130 for the raccoon (Table 5-7). It should be noted that both terrestrial and aquatic hazards have been estimated for the raccoon as it exhibits a combined terrestrial and aquatic lifestyle, and hazards may be summed for this receptor. COPECs from sediment, and not surface water, were risk drivers for both the raccoon and the mallard receptor. Major sediment risk drivers, listed in decreasing order of concern, included 2,4,6-TNT, selenium, aluminum, Aroclor-1260, 2-amino-4,6-DNT, and 4-amino-2,6-DNT. The most important route of exposure was aquatic invertebrate intake, with a minor contribution from direct sediment intake for aluminum (Table 5-7).

Conservative LOAEL-based hazard indices (summed HQs) for aquatic receptors at the TNT Area C were estimated to be 97 for the mallard and 265 for the raccoon (Table 5-8). It should again be noted that both terrestrial and aquatic hazards have been estimated for the raccoon and hazards may be summed for this receptor. COPECs from sediment, and not surface water, were risk drivers for both the raccoon and the mallard receptor. Major sediment risk drivers, listed in decreasing order of concern, included 2,4,6-TNT, selenium, aluminum, and Aroclor-1260. The most important route of exposure was aquatic invertebrate intake, with a minor contribution from direct sediment intake for aluminum (Table 5-8).

5.4 Uncertainty Analysis

The results of the BERA are influenced to some degree by variability and uncertainty. In theory, investigators might reduce variability by increasing sample size of the media or species sampled. Alternatively, uncertainty within the risk analysis can be reduced by using species-specific and site-specific data (i.e., to better quantify contamination of media, vegetation, and prey through: direct field measurements, toxicity testing of site-specific media, and field studies using site-specific receptor species). Detailed media, prey, and receptor field studies are costly; thus, the preliminary predictive analyses of risk has been conducted to limit the potential use of these resource-intensive techniques to only those COPECs that continue to show a relatively high potential for ecological risk. Since assessment criteria were developed based on conservative assumptions, the results of the screening and predictive assessments err on the side of conservatism. This has the effect of maximizing the likelihood of accepting a false positive (Type I error: the rejection of a true H_o) and simultaneously minimizing the likelihood of accepting a true negative (Type II error: the acceptance of a false H_o).

A number of factors contribute to the overall variability and uncertainty inherent in ecological risk assessments. Variability is due primarily to measurement error; laboratory media analyses and receptor study design are the major sources of this kind of error. Uncertainty, on the other hand, is associated primarily with deficiency or irrelevancy of effects, exposure, or habitat data to actual ecological conditions at the site. Species physiology, feeding patterns, and nesting behavior are poorly predictable; therefore, all toxicity information derived from toxicity testing, field studies, or observation will have uncertainties associated with them. Laboratory studies conducted to obtain site-specific, measured information often suffer from poor relevance to the actual exposure and uptake conditions on site (i.e., bioavailability, exposure, assimilation, etc.,

are generally greater under laboratory conditions as compared to field conditions). Calculating an estimated value based on a large number of assumptions is often the only alternative to the accurate (but costly) method of direct field or laboratory observation, measurement, or testing. Finally, habitat- or site-specific species may be misidentified if, for example, the observational assessment results are based on only one brief site reconnaissance.

The uncertainty analysis is presented in Table 5-9 and lists some of the major assumptions made for the BERA; the direction of bias caused by each assumption (i.e., if the uncertainty results in an overestimate or underestimate of risk); the likely magnitude of impact (quantitative [percent difference], or qualitative [high, medium, low, or unknown]); and, if possible, a description of recommendations for minimizing the identified uncertainties if the BERA progresses to higher level assessment phases (EPA, 1997). The uncertainty analysis identifies and, if possible, quantifies the uncertainty in the individual preliminary scoping assessment, problem formulation, exposure and effects assessment, and risk characterization phases of this BERA. Based on this uncertainty analysis, the most important biases, that may result in an overestimation of risk, include the following:

- Assuming that COPECs are 100 percent bioavailable
- Using some laboratory-derived or empirically-estimated partitioning and transfer factors to predict COPEC concentrations in plants, invertebrates, prey species, and sediment pore water
- Inclusion of sample outliers in the estimation of exposure point concentrations for risk drivers
- Use of the hazard quotient method to estimate risks to populations or communities.

It should be noted that some of the maximum concentrations of COPECs measured in surface water and sediment were used as source-term concentrations due to the limited number of samples, and an additional sampling effort could potentially reduce the hazard estimate. It should also be mentioned that there are significant uncertainties associated with estimating COPEC concentrations in macroinvertebrates.

5.5 Risk Description

As part of the risk description, IT has completed the following: (1) summarized the ecological risk associated with the site; and (2) interpreted the ecological significance, which describes the magnitude of the identified risks and the accompanying uncertainty. The effect of additional data or analyses on uncertainty has also been discussed. A weight-of-evidence approach has been used to interpret the ecological significance of the findings.

Soil COPEC impacts to terrestrial plants are estimated to be generally insignificant, except for perhaps elevated levels of 2,4,6-TNT, lead, manganese, and zinc (Section 5.1). No vegetative stress was observed on site. Potential surface water COPEC impacts to aquatic biota are of most concern for carbon disulfide, aluminum, barium, cadmium, calcium, iron, and manganese (Section 5.2). Potential sediment COPEC impacts on aquatic biota are of most concern for 1,3,5-trinitrobenzene, 2,4,6-TNT, Aroclor-1260, and lead (Section 5.2). Considerations of small sample size suggest these findings should be confirmed based on additional sampling before any remedial actions are considered. In addition, limited aquatic habitat at the site reduces the concern for impact to aquatic biota, and generally low DO, elevated turbidity, and other nonchemical stressors measured in surface water suggests overall water quality is poor. Terrestrial receptors (especially mice, rabbits, shrews, raccoons, and wrens) are predicted to incur elevated hazards from exposure to 2,4,6-TNT, Aroclor-1260, and lead in soil, based on both NOAEL- and LOAEL-based HQ approaches (Section 5.3). Based on uncertainties of toxicity, and on the fact that no wildlife RTE species have been confirmed at the site, remedial actions solely to address ecological concerns are not warranted at this time for soil. However, as estimated hazards are above 30,000 for some receptors using the NOAEL-based approach, and above 5,000 for some receptors using the LOAEL-based approach, additional study is recommended. Alternatively, if human health risks or hazards are unacceptable and chemical-specific human health preliminary remediation goals (PRG) are being developed for the site, these PRGs may be evaluated to (1) determine if they are also protective of the environment; or (2) determine if they will reduce the estimated baseline ecological hazards by a significant amount.

Aquatic receptors are predicted to have elevated hazards from exposure to 2,4,6-TNT, selenium, aluminum, Aroclor-1260 in sediment, based on both NOAEL- and LOAEL-based hazard quotient approaches, plus 2-amino-4,6-DNT, and 4-amino-2,6-DNT for the NOAEL-based

hazard approach (Section 5.3). Although hazards are estimated to be 2,350 and 1,130 for the mallard and raccoon using the NOAEL-based approach, when the LOAEL-based approach is used, estimated hazards drop to 97 and 265 respectively. Based on uncertainties associated with estimating COPEC concentrations in aquatic insects, and the limited amount and low quality of aquatic habitat at the site, remedial action is not recommended for surface water and sediment at the site at this time. However, given the elevated hazard estimates, additional study is recommended. Alternatively, if human health risks or hazards are unacceptable and chemical-specific human health PRGs are being developed for the site, these PRGs may be evaluated to (1) determine if they are also protective of the environment; or (2) determine if they will reduce the estimated baseline ecological hazards by a significant amount.

6.0 Risk Summary and Identification of Preliminary Remedial Action Objectives

IT has summarized ecological risk associated with releases from the site (Section 5.5). This summary is supported by tasks performed during the previous sections. Additionally, IT has made recommendations for further risk investigation for impacted soils and sediment at the site. IT has not developed site-specific remedial action objectives for the site at this time due to previously discussed uncertainties associated with the BERA (Section 5.4).

7.0 Conclusions and Recommendations

Only the data, results, and conclusions of the various preliminary scoping and predictive assessment phases are described in this section. No recommendations concerning types of remedial actions to be conducted are given other than to present the specific remedial action objectives, if any. Conclusion and recommendations are derived from the risk assessment and are based on the responses to the assessment hypotheses. The predictive assessment results are summarized and presented in Tables 5-1 through 5-8. The predictive assessment suggests potential adverse impacts to terrestrial wildlife, especially mice, rabbits, shrews, raccoons, and birds like the march wren, for modeled contact with the hazard drivers (2,4,6-TNT, Aroclor-1260, and lead) in surface soil. The predictive assessment also suggests potential adverse impacts to aquatic wildlife, for modeled contact with the hazard drivers (2,4,6-TNT, selenium, aluminum, Aroclor-1260, 2-amino-4,6-DNT, and 4-amino-2,6-DNT) in sediment. However, as aquatic habitat at the site is quite limited in areal extent, and is generally of poor intrinsic quality, these adverse impact findings may be less of a concern than for the potential adverse impact findings hazard drivers in soil.

The predictive assessment results may serve as the foci of discussions with risk managers and regulatory agencies concerning the potential need for additional assessment at PBOW TNT Area C to reduce the uncertainty in the estimate of ecological risk, as summarized in Table 5-9. It is very important to note that many conservative assumptions and modeling approaches were used in the predictive assessment, and actual hazards to wildlife may be orders of magnitude lower than predicted herein.

8.0 References

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TABLES

Table 2-1

Vegetative Community Types
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Community Type	Definition
AGRI	Agricultural areas including crop fields, pastures, and fallow fields
DIST	Disturbed or developed areas
MOW	Mowed areas
OFE	Early old field (herbaceous vegetation only)
OFM	Moderate old field (some shrubs/saplings)
OFL	Late old field (up to 50 percent shrub/sapling cover)
ESU	Early successional/shrub thicket (mostly shrubs, few saplings)
MSU	Moderate successional/shrub thicket (shrubs and saplings dominant)
LSU	Late successional/shrub thicket (saplings most abundant with some trees)
FRE	Early forest (young trees with early successional species, red maple, ashes, elms, etc., most dominant)
FRM	Moderate forest (larger trees regardless of species or younger trees with late successional species)
FRL	Late forest (mature forest with climax species such as sugar maple, beech, oaks, etc., with established subcanopy and understory)
OW	Open water
PEM	Palustrine, emergent wetlands (marshes and wet meadows)
PSS	Palustrine, scrub/shrub wetlands (wetlands dominated by shrubs and saplings)
PFO	Palustrine, forested wetlands (all wooded wetlands)

Table 2-2

Common and/or Frequent Vascular Plant Species Observed at TNT Area C Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 3)

Plant Species	TNT Area C
American stinging nettle	common
Black raspberry	common
Black willow	common
Blackberry	common
Bluegrass	frequent
Boneset	frequent
Box elder maple	frequent
Broad-leaved cattail	frequent
Broom sedge	frequent
Calico aster	frequent
Canada goldenrod	common
Canada thistle	common
Cinquefoil	frequent
Common milkweed	frequent
Common teasel	frequent
Cottonwood	common
Cudweed	frequent
Dewberry	common
Dotted St. John's wort	frequent
Downy hawthorn	frequent
Evening primrose	frequent
Fescue	frequent
Garlic mustard	frequent
Grass-leaved goldenrod	common
Gray dogwood	frequent
Great lobelia	frequent

Table 2-2

Common and/or Frequent Vascular Plant Species Observed at TNT Area C Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 3)

Plant Species	TNT Area C
Green ash	common
Green foxtail grass	common
Ground ivy	frequent
Hairy panic-grass	frequent
Horse nettle	common
Horsetail	frequent
Marsh fern	frequent
Muhly grass	frequent
Nodding foxtail-grass	common
Pennsylvania sedge	common
Poison ivy	frequent
Red maple	common
Redtop	common
Riddell's goldenrod	frequent
Riverbank grape	frequent
Rough-leaved dogwood	frequent
Sandbar willow	frequent
Self-heal	frequent
Sensitive fern	frequent
Slender gerardia	frequent
Sorrel	common
Southern agrimony	frequent
Tall white beard-tongue	frequent
Timothy	frequent
Umbrella sedge	frequent
Virginia creeper	frequent

Table 2-2

Common and/or Frequent Vascular Plant Species Observed at TNT Area C Plum Brook Ordnance Works, Sandusky, Ohio

(Page 3 of 3)

Plant Species	TNT Area C
Virginia knotweed	common
White heath aster	frequent
White snake root	common
White vervain	frequent
Wild black cherry	common
Wild strawberry	common
Yarrow	frequent
Yellow sweet clover	frequent
Total Species Documented (common, frequent, occasional, and/or rare)	144
Total Common or Frequent Species Documented	60

For scientific names and habitat, as well as occasional and/or rare species, see Appendix A.

Table 2-3

Mammals Observed On Site and Likely to be Found in Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site [a]
Didelphidae	*Didelphis virginiana*	Virginia opossum	
Talpidae	*Condylura cristata*	star-nosed mole	
	Parascalops breweri	hairy-tailed mole	
	Scalopus aquaticus	Eastern mole	
Verspertilionidae	*Myotis keenii*	Keen's bat	
	M. lucifugus	little brown bat	
	M. sodalis	Indiana bat **(E)**	
	Eptesicus fuscus	big brown bat	
	Lasionycteris noctivagans	silver-haired bat	
	Lasiurus borealis	red bat	
	L. cinereus	hoary bat	
	Nycticeius humeralis	evening bat	
	Pipistrellus subflavus	Eastern pipistrelle	
Leporidae	*Sylvilagus floridanus*	cottontail rabbit	
Sciuridae	*Glaucomys volans*	Southern flying squirrel	
	Marmota monax	woodchuck	
	Sciurus carolinensis	gray squirrel	
	S. niger	fox squirrel	
	Spermophilus tridecemlineatus	thirteen-lined ground squirrel	
	Tamias striatus	Eastern chipmunk	
	Tamiasciurus hudsonicus	red squirrel	
	Blarina brevicauda	short-tailed shrew	
	Cryptotis parva	least shrew	
	Sorex cinereus	masked shrew	
Castoridae	*Castor canadensis*	beaver	
Cricetidae	*Microtus pennsylvanicus*	meadow vole	
	Mus musculus	house mouse	
	Ondatra zibethicus	muskrat	
	Peromyscus leucopus	white-footed mouse	
	P. maniculatus	deer mouse	
	Rattus norvegicus	Norway rat	
	Synaptomys cooperi	Southern bog lemming	
	Zapus hudsonius	meadow jumping mouse	
Procyonidae	*Procyon lotor*	raccoon	
Mustelidae	*Mephitis mephitis*	striped skunk	
	Mustela frenata	long-tailed weasel	
	M. nivalis	least weasel	
	M. vison	mink	
	Taxidea taxus	badger	
Canidae	*Canis latrans*	coyote	
	Urocyon cinereoargenteus	gray fox	
	Vulpes vulpes	red fox	
Cervidae	*Odocoileus virginianus*	white-tailed deer	X

Mammals likely to be found in Erie County based on information presented in:
Gottschang, J. L., 1981, A Guide to the Mammals of Ohio, Ohio State University Press, 176 pages.
E = Ohio Endangered species.
[a] IT Site Reconnaissance, September 11, 12, 2000 and May 21, 2001.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Ardeidae	*Ardea herodias*	great blue heron	(1) Regular visitor at ponds, streams, and ditches.
	Bublucus ibis	cattle egret **(T)**	(1) Rare visitor in short grass areas
	Butorides striatus	green-backed heron	(1) Confirmed breeder, rare at ponds, streams.
	Casmerodius albus	great egret	(1) Regular visitor at ponds, streams, and ditches.
	Nycticorax nycticorax	black-crowned night heron **(T)**	(1) Regular visitor at ponds, streams, and ditches.
Anserinae	*Branta canadensis*	Canada goose	(1) Confirmed breeder; uncommon around ponds.
Anatinae	*Aix sponsa*	Wood duck	(1) Confirmed breeder, uncommon around ponds.
	Anas discors	blue-winged teal	Confirmed and/or probable breeder in county.
	A. platyrhynchos	mallard	(1) Confirmed breeder, uncommon at ponds, streams.
	A. rubripes	American black duck	(1) Possible breeder, rare at ponds, streams, ditches.
Merginae	*Lophodytes cucullatus*	hooded merganser	Confirmed and/or probable breeder in county.
Accipitrinae	*Accipiter striatus*	sharp-shinned hawk	Confirmed and/or probable breeder in county.
Buteoninae	*Buteo jamaicensis*	red-tailed hawk	(2) Confirmed and/or probable breeder in county.
	B. lineatus	red-shouldered hawk	Confirmed and/or probable breeder in county.
	B. platypterus	broad-winged hawk	Confirmed and/or probable breeder in county.
	Haliaeetus leucocephalus	bald eagle **(E)**	Confirmed and/or probable breeder in county.
Anatidae	*Cygnus buccinator*	Trumpeter swan **(E)**	(1) Rare migrant seen flying toward lake.
Falconinae	*Falco sparverius*	American kestrel	Confirmed and/or probable breeder in county.
Phasianidae	*Colinus virginianus*	Northern bobwhite quail	Confirmed and/or probable breeder in county.
	Phasianus colchicus	ring-necked pheasant	Confirmed and/or probable breeder in county.
Rallidae	*Gallinula chloropus*	common moorhen	Confirmed and/or probable breeder in county.
	Porzana carolina	Sora	Confirmed and/or probable breeder in county.
Cathartidae	*Cathartes aura*	turkey vulture	(2) Possible breeder in county.
Charadriidae	*Charadrius vociferus*	killdeer	Confirmed and/or probable breeder in county.
Scolopacidae	*Actitis macularia*	spotted sandpiper	Confirmed and/or probable breeder in county.
	Bartramia longicauda	upland sandpiper **(T)**	(1) Confirmed breeder, rare in grassy areas.
	Gallinago gallinago	common snipe	Confirmed and/or probable breeder in county.
Scolopacidae	*Scolopax minor*	American woodcock	(1) Confirmed breeder, uncommon in moist woodlots.
Larinae	*Larus argentatus*	herring gull	(1) Regular visitor.
	L. delawarensis	ring-billed gull	(1) Regular visitor.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 6)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Columbidae	*Columba livia*	rock dove	(1) Confirmed breeder, very common.
	Zenaida macroura	mourning dove	(1) Confirmed breeder, very common.
Cuculidae	*Coccyzus americanus*	yellow-billed cuckoo	(1) Confirmed breeder, uncommon in woodlots, shrubs.
	C. erythropthalmus	black-billed cuckoo	(1) Probable breeder, rare in woodlots & shruby areas.
Tytonidae	*Bubo virginianus*	great horned owl	(1) Confirmed breeder, uncommon in woodlots.
	Otus asio	Eastern screech-owl	(1) Confirmed breeder, common in woodlots, shrubs.
	Strix varia	barred owl	Confirmed and/or probable breeder in county.
Caprimulgidae	*Chordeiles minor*	common nighthawk	(1) Possible breeder, rare.
Apodidae	*Chaetura pelagica*	chimney swift	(1) Confirmed breeder, uncommon.
Trochilidae	*Archilochus colubris*	ruby-throated hummingbird	(1) Confirmed breeder, uncommon in woodlots, shrubs.
Alcedinidae	*Ceryle alcyon*	belted kingfisher	(1) Confirmed breeder, rare around ponds, streams.
Picidae	*Colaptes auratus*	Northern flicker	(1) Confirmed breeder, common in woodlots.
	Dryocopus pileatus	pileated woodpecker	Confirmed and/or probable breeder in county.
	Melanerpes carolinus	red-bellied woodpecker	(1) Confirmed breeder, common in mature woods.
	M. erythrocephalus	red-headed woodpecker	(1) Confirmed breeder, uncommon in mature woods.
	Picoides pubescens	downy woodpecker	(1) Confirmed breeder, common in woodlots.
	P. villosus	hairy woodpecker	(1) Confirmed breeder, uncommon in large woodlots.
Tyrannidae	*Contopus virens*	Eastern wood-pewee	(1) Confirmed breeder, very common in large woodlots.
	Empidonax alnorum	alder flycatcher	(1) Possible breeder, rare in shrubby wet areas.
	E. minimus	least flycatcher	(1) Probable breeder, rare in shrubby areas.
	E. traillii	willow flycatcher	(1) Confirmed breeder, very common in shrubby areas.
	E. virescens	Acadian flycatcher	(1) Confirmed breeder, uncommon in mature woodlots.
	Myiarchus crinitus	great crested flycatcher	(1) Confirmed breeder, common in large woodlots.
	Sayornis phoebe	Eastern phoebe	(1) Confirmed breeder, common near stream bridges.
	Tyrannus tyrannus	Eastern kingbird	(1) Confirmed breeder, very common - open shrub area.
Alaudidae	*Eremophila alpestris*	horned lark	(1) Probable breeder, rare in grassland, cultiv. fields.
Hirundinidae	*Hirundo pyrrhonota*	cliff swallow	Confirmed and/or probable breeder in county.
	H. rustica	barn swallow	(1) Confirmed breeder, very common near vacant bldgs.
	Progne subis	purple martin	(1) Probable breeder, rare.
	Riparia riparia	bank swallow	(1) Rare migrant or visitor.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Hirundinidae	*Stelgidopteryx seripennis*	Northern rough-winged swallow	(1) Confirmed breeder, rare along streams, ditches.
	Tachycineta bicolor	tree swallow	(1) Confirmed breeder, rare around ponds.
Corvidae	*Corvus brachyrhynchos*	American crow	(1) Confirmed breeder, very common in woodlots.
	Cyanocitta cristata	blue jay	(1)(2) Confirmed breeder, abundant in woods.
Paridae	*Parus atricapillus*	black-capped chickadee	(1)(2) Confirmed breeder, common in woodlots.
	P. bicolor	tufted titmouse	(1) Confirmed breeder, common in woodlots.
Sittidae	*Sitta carolinensis*	white-breasted nuthatch	(1) Confirmed breeder, uncommon in woodlots.
Troglodytidae	*Cistothorus palustris*	marsh wren	(1) Possible breeder, rare in wetlands with cattails.
	C. platensis	sedge wren **(E)**	(1) Confirmed breeder, common in old grassy fields.
	Thryothorus ludovicianus	Carolina wren	(1) Probable breeder, rare in shrubby areas & woodlots.
	Troglodytes aedon	house wren	(1) Confirmed breeder, abundant in shrubby areas.
	T. troglodytes	winter wren **(E)**	(1) Rare migrant.
Mimidae	*Dumetella carolinensis*	gray catbird	(1)(2) Confirmed breeder, abundant in shrubby areas.
	Mimus polyglottos	Northern mockingbird	(1) Confirmed breeder, rare in shrubby areas.
	Toxostoma rufum	brown thrasher	(1) Confirmed breeder, common in shrubby areas.
Turdidae	*Catharus fuscescens*	veery	(1) Confirmed breeder, uncommon in large woodlots.
	Hylocichla mustelina	wood thrush	(1) Confirmed breeder, very common in large woodlots.
	Sialia sialis	Eastern bluebird	(1) Confirmed breeder, common in openfields & edges.
	Turdus migratorius	American robin	(1) Confirmed breeder, abundant everywhere.
Sylviidae	*Polioptila caerulea*	blue-gray gnatcatcher	(1) Confirmed breeder, uncommon in woodlots.
	Regulus calendula	ruby-crowned kinglet	(1) Rare migrant.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

(Page 4 of 6)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Bombycillidae	*Bombycilla cedrorum*	cedar waxwing	(1)(2) Confirmed breeder, very common everywhere.
Sturnidae	*Sturnus vulgaris*	European starling	(1) Confirmed breeder, abundant everywhere.
Vireonidae	*Vireo bellii*	Bell's vireo	Confirmed and/or probable breeder in county.
	V. flavifrons	yellow-throated vireo	(1) Confirmed breeder, uncommon in mature woodlots.
	V. gilvus	warbling vireo	(1) Confirmed breeder, common in large woodlots.
	V. griseus	white-eyed vireo	(1) Confirmed breeder, uncommon in shrubby areas.
	V. olivaceus	red-eyed vireo	(1) Confirmed breeder, very common in woodlots.
Parulidae	*Dendroica cerulea*	cerulean warbler	(1) Possible breeder, rare in mature woodlots.
	D. dominica	yellow-throated warbler	(1) Confirmed and/or probable breeder in county.
	D. pensylvanica	chestnut-sided warbler	(1) Probable breeder, uncommon in shrubby areas.
	D. petechia	yellow warbler	(1) Confirmed breeder, abundant in shrubby areas.
	D. virens	black-throated green warbler	(1) Possible breeder, rare in mature woodlots.
	Geothylpis trichas	common yellowthroat	(1) Confirmed breeder, abundant in shrub areas, fields.
	Icteria virens	yellow-breasted chat	(1) Confirmed breeder, uncommon in shrubby areas.
	Mniotilta varia	black and white warbler	(1) Possible breeder, rare in mature woodlots.
	Oporomis formosus	Kentucky warbler	(1) Possible breeder, rare in mature woodlots.
	Protonotaria citrea	prothonotary warbler	Confirmed and/or probable breeder in county.
	Seiurus aurocapillus	overbird	(1) Probable breeder, rare in mature woodlots.
	S. motacilla	Louisiana waterthrush	Confirmed and/or probable breeder in county.
	Setophaga ruticilla	American redstart	(1) Probable breeder, rare in shrubby areas & woodlots.
	Vermivora leucobronchialis	Brewster's warbler	(1) Possible breeder, rare in shrubby areas and edges.
	V. pinus	blue-winged warbler	(1) Confirmed breeder, common in shrubby areas.
	Wilsonia citrina	hooded warbler	Confirmed and/or probable breeder in county.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

(Page 5 of 6)

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Icteridae	*Agelaius phoeniceus*	red-winged blackbird	(1) Confirmed breeder, abund. in grasslands, streams.
	Dolichonyx oryzivorus	bobolink	(1) Confirmed breeder, uncommon in grasslands.
	Icterus galbula	Northern oriole	(1) Confirmed breeder, uncommon in open woods.
	I. spurius	orchard oriole	(1) Confirmed breeder, common in open woods & edges.
	Molothrus ater	brown-headed cowbird	(1) Confirmed breeder, abundant everywhere.
	Quiscalus quiscula	common grackle	(1) Confirmed breeder, abundant everywhere.
	Sturnella magna	Eastern meadowlark	(1) Confirmed breeder, common in grasslands.
Ploceidae	*Passer domesticus*	house sparrow	(1) Confirmed breeder, uncommon near buildings.
Thraupidae	*Piranga olivacea*	scarlet tanager	(1) Possible breeder, rare on open woods.
	P. ruba ruba	summer tanager	(1) Confirmed breeder, common in mature woodlots.
Fringillidae	*Ammodramus henslowii*	Henslow's sparrow	(1) Probable breeder, rare in old fields.
	A. savannarum	grasshopper sparrow	(1) Confirmed breeder, common in grasslands.
	Cardinalis cardinalis	Northern cardinal	(1)(2) Confirmed breeder, abundant everywhere.
	Carduelis tristis	American goldfinch	(1) Confirmed breeder, abundant in shrubby areas.
	Carpodacus mexicanus	house finch	(1) Confirmed breeder, uncommon around buildings.
	Melospiza georgiana	swamp sparrow	(1) Confirmed breeder, rare in wet fields and ditches.
	M. melodia	song sparrow	(1) Confirmed breeder, abundant everywhere.
	Passerculus sandwichensis	Savannah sparrow	(1) Confirmed breeder, common in grasslands.
	Passerina cyanea	indigo bunting	(1) Confirmed breeder, abundant everywhere.
	Pheucticus ludovicianus	rose-breasted grosbeak	(1) Confirmed breeder, common in woodlots & edges.
	Pipilo erythrophthalmus	rufous-sided towhee	(1) Confirmed breeder, very common in woodlots, edges.
	Pooecetes gramineus	vesper sparrow	(1) Confirmed breeder, uncommon in grassland & fields.
	Spiza amercana	dickcissel	Confirmed and/or probable breeder in county.
	Spizella passerina	chipping sparrow	(1) Confirmed breeder, common in open woods & lawns.
	S. pusilla	field sparrow	(1) Confirmed breeder, abundant in grasslands, shrubs.
	Zonotrichia albicollis	white-throated sparrow	(1) Late migrant, rare.

Table 2-4

Birds Observed On Site and/or Likely to be Breeding In Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

[a] Family names from: Peterson, R. T., 1947, *A Field Guide to the Birds*, Sponsored by the National Audubon Society, Houghton Mifflin Company, Boston, Massachusetts.

[b] Peterjohn, B. G. and D. L. Rice, 1991, *The Ohio Breeding Bird Atlas*, The Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio, 416 pages.

[c] E = Ohio Endangered species; T = Ohio Threatened species.

Observation References:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).
(2) IT site reconnaisance at TNT Area C, September 11, 12, 2000 and May 21, 2001.

Table 2-5

Reptiles Observed On Site and Likely to be Found[a] at Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site
Chelydridae	*Chelydra serpentina*	snapping turtle	(1)
Kinosternidae	*Sternotherus odoratus*	musk turtle	
Emydidae	*Chrysemys picta*	painted turtle	(1)
	Emys blandingii	Blanding's turtle	(1)
	Terrapene carolina	box turtle	(1)
Colubridae	*Elaphe vulpina*	fox snake	(1)
	Heterodon platyrhinos	hog-nosed snake	
	Nerodia septemvittata	queen snake	
	N. sipedon sipedon	water snake	(1)
	Opheodrys vernalis	green snake	(1)
	Storeria dekayi	Dekay's brown snake	(1)
	Thamnophis butleri	Butler's garter snake	(1)
	T. sauritus	ribbon snake	
	T. sirtalis	common garter snake	(1)

[a] Pfingsten, R.A. (ODNR, 1994).

References:

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America*, Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

Wright, A. H. and A. A. Wright, 1957, *Handbook of Snakes of the United States and Canada*, Volumes I and II, Comstock Publishing Associates, Ithaca and London, 1105 pages.

Reference for on-site observation:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).
(2) IT Site Reconnaissance, September 11, 12, 2000 and May 21, 2001.

Table 2-6

Amphibians Observed On Site and Likely to be Found[a] at Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site
Ambystomatidae	*Ambystoma texanum*	smallmouth salamander	(1)
	Plethodon cinereus	redback salamander	(1)
Bufonidae	*Bufo americanus*	American toad	(1)
Hylidae	*Acris gryllus*	cricket frog	
	Hyla versicolor	gray treefrog	(1)
	Pseudacris crucifer	spring peeper	(1)
	P. triseriata	chorus frog	(1)
Ranidae	*Rana catesbeiana*	bullfrog	(1)
	R. clamitans	green frog	(1)
	R. pipiens	Northern leopard frog	(1)

[a] Pfingsten, R.A. (ODNR, 1994).

References:

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America*, Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

Pfingsten, R. A. and F. L. Downs (eds.), 1989, *Salamanders of Ohio*, Ohio Biological Survey Bulletin, New Series, Vol. 7, No. 2, 315 pages, 29 pls.

Reference for on-site observation:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).
(2) IT Site Reconnaissance, September 11, 12, 2000 and May 21, 2001.

Table 2-7

Fish Observed On Site at Plum Brook Ordnance Works Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site	Habitat[a]
Catostomidae	*Catostomus commersoni*	white sucker	(1)	lotic
Centrarchidae	*Lepomis cyanellus*	green sunfish	(1)	lentic, lotic
	Lepomis species	green sunfish hybrid	(1)	lentic
	L. gibbosus	pumpkinseed sunfish	(1)	lentic
	L. macrochirus	bluegill	(1)	lentic
	Micropterus salmoides	largemouth bass	(1)	lentic
Cyprinidae	*Campostoma anomalum*	central stoneroller	(1)	lotic
	Carassius auratus	goldfish	(1)	lentic
	Luxilus chrysocephalus	striped shiner	(1)	lotic
	Pimephales notatus	bluntnose minnow	(1)	lotic
	P. promelas	fathead minnow	(1)	lotic
	Semotilus atromaculatus	creek chub	(1)	lotic
Gasterosteidae	*Culaea inconstans*	brook stickleback	(1)	lotic
Ichtaluridae	*Ameiurus melas*	black bullhead	(1)	lentic

[a] lotic = flowing water such as brooks, ditches, and creeks.
lentic = still waters such as ponds and lakes.

Reference for on-site observation:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).

Table 2-8

Sample List
TNT Area C, PBOW, Sandusky, Ohio

(Page 1 of 2)

Sample Type	Sample Identification	Depth of Sample (feet)
Surface Soil (0 - 2 feet)	AB0426	0 - 1
	AB0429	0 - 1
	AB0427 (duplicate of AB0429)	0 - 1
	AB0432	0 - 1
	AB0437	0.33 - 1
	AB0438	0 - 1
	AB0439	1.3 - 2.3
	AB0442	1.5 - 2.5
	AB0443	1 - 2
	AB0444	1 - 2
	AB0445	0 - 1
	AB0447	1 - 2
	AB0448	1 - 2
	AB0451	0.5 - 1.5
	AB0449 (duplicate of AB0451)	0.5 - 1.5
	AB0454	0.25 - 1.25
	AB0452 (duplicate of AB0454)	0.25 - 1.25
	AB0455	0.5 - 1.5
	AB0477	1.5 - 2.5
	AB0478	1 - 2
Total Soil (0 to 6 feet)	AB0426	0 - 1
	AB0429	0 - 1
	AB0427 (duplicate of AB0429)	0 - 1
	AB0430	2.5 - 3.5
	AB0431	2.5 - 3.5
	AB0432	0 - 1
	AB0433	3 - 4
	AB0436	2.5 - 3.5
	AB0434 (duplicate of AB0436)	2.5 - 3.5
	AB0437	0.33 - 1
	AB0438	0 - 1
	AB0439	1.3 - 2.3
	AB0442	1.5 - 2.5
	AB0443	1 - 2
	AB0444	1 - 2
	AB0445	0 - 1
	AB0446	2 - 2.5
	AB0447	1 - 2
	AB0448	1 - 2
	AB0451	0.5 - 1.5
	AB0449 (duplicate of AB0451)	0.5 - 1.5
	AB0454	0.25 - 1.25
	AB0452 (duplicate of AB0454)	0.25 - 1.25

Table 2-8

Sample List
TNT Area C, PBOW, Sandusky, Ohio

(Page 2 of 2)

Sample Type	Sample Identification	Depth of Sample (feet)
Total Soil (continued) (0 to 6 feet)	AB0455	0.5 - 1.5
	AB0460	4 - 6
	AB0466	4 - 6
	AB0468	3 - 5
	AB0469	4 - 6
	AB0470	4 - 6
	AB0471	4 - 6
	AB0474	4 - 6
	AB0473 (duplicate of AB0474)	4 - 6
	AB0476	2 - 3
	AB0477	1.5 - 2.5
	AB0478	1 - 2
	AB0479	2 - 3
Sediment	AB1001	NA
	AB1016 (duplicate of AB1001)	NA
	AB1002	NA
	AB1003	NA
	AB1004	NA
	AB1005	NA
	AB1006	NA
	AB1007	NA
	AB1008	NA
	AB1018 (duplicate of AB1008)	NA
	AB1009	NA
	AB1010	NA
	AB1011	NA
	AB1012	NA
	AB1013	NA
	AB1014	NA
	AB1015	NA
Surface Water	AB2001	NA
	AB2016 (duplicate of AB2001)	NA
	AB2002	NA
	AB2003	NA
	AB2004	NA
	AB2005	NA
	AB2006	NA
	AB2007	NA
	AB2008	NA
	AB2018 (duplicate of AB2008)	NA
	AB2010	NA
	AB2011	NA

Table 2-9

Background Concentrations of Metals in Soil[a]
TNT Manufacturing Area C, Plum Brook Ordnance Works, Sandusky, Ohio

Chemical Name (mg/kg)	Frequency of Detection	Range of Detected Concentrations	Range of Reporting Limits	Statistical Distribution	Arithmetic Mean	95% UTL [b]	Background Screening Criterion [c]
Aluminum	12 / 12	3520 - 15500	NA	L	8.43E+03	2.69E+04	1.55E+04
Antimony	9 / 25	5.9 - 9.3	5.4 - 74	NP	4.68E+00	NA	9.30E+00
Arsenic	23 / 26	2.1 - 36.5	1.2 - 3.7	L	1.08E+01	7.10E+01	3.65E+01
Barium	9 / 12	35.6 - 826	23.2 - 24.7	L	1.16E+02	1.30E+03	8.26E+02
Beryllium	6 / 25	0.57 - 1	0.57 - 1.2	L	5.65E-01	1.17E+00	1.00E+00
Cadmium	0 / 25	NA	0.57 1.2	L	4.49E-01	NA	NA
Calcium	12 / 12	735 - 52300	NA	L	1.13E+04	2.18E+05	5.23E+04
Chromium	25 / 26	4.4 - 29	12.3 - 12.3	NP	1.34E+01	NA	2.90E+01
Cobalt	9 / 12	9.6 - 116	5.8 - 6.2	L	2.26E+01	2.48E+02	1.16E+02
Copper	23 / 26	2.3 - 56.2	2.2 - 2.9	L	1.70E+01	1.47E+02	5.62E+01
Iron	12 / 12	5880 - 234000	NA	L	4.01E+04	3.58E+05	2.34E+05
Lead	26 / 26	1.9 - 48.6	NA	L	1.28E+01	5.13E+01	4.86E+01
Magnesium	12 / 12	629 - 10400	NA	L	3.26E+03	3.08E+04	1.04E+04
Manganese	26 / 26	21 - 13300	NA	L	7.29E+02	3.51E+03	3.51E+03
Mercury	2 / 26	0.085 - 0.085	0.037 - 0.3	L	9.06E-02	5.60E-01	8.50E-02
Nickel	26 / 26	5.4 - 55.1	NA	L	2.28E+01	7.79E+01	5.51E+01
Potassium	11 / 12	579 - 3390	617 - 617	L	1.24E+03	6.08E+03	3.39E+03
Selenium	5 / 25	0.61 - 2	0.57 - 4.9	NP	1.55E+00	NA	2.00E+00
Silver	2 / 26	1.1 - 11.1	1.1 - 1.3	NP	1.00E+00	NA	1.11E+01
Sodium	0 / 12	NA	566 - 663	L	3.03E+02	NA	NA
Thallium	2 / 25	1.2 - 1.3	1.1 - 6.1	NP	1.91E+00	NA	1.30E+00
Vanadium	11 / 12	9 - 40.9	61.7 - 61.7	L	2.48E+01	8.31E+01	4.09E+01
Zinc	26 / 26	6.6 - 655	NA	L	7.30E+01	3.22E+02	3.22E+02

NA = Not applicable; not available.

[a] Data used to determine soil background are based on sampling from IT, 1998, ***Site Investigation of Acid Areas, Plum Brook Ordnance Works, Sandusky, Ohio.***

[b] 95% UTL = 95% upper tolerance limit calculated as described in Section 2.6.4 and rounded to 3 significant figures.

[c] The maximum detected concentration is used as the background screening criterion for nonparametric data sets; for lognormally distributed data sets, the 95% UTL or the maximum detected concentration, whichever is less, is used.

Note: Detection limits from sample 6990 were deleted when calculating results for antimony, beryllium, cadmium, selenium and thallium. The detection limits were elevated by dilution factors which greatly exceed any detected concentration and would bias results unrealistically high.

Table 2-10

Statistical Summary and COPEC Selection of Surface Soil Sample Analyses
TNT Area C, PBOW, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution	Arithmetic Mean	95% UCL[b]	Background Screening Criterion[c]	Ecological Screening Criterion[d]	COPEC?[e,f]	Source Term Concentration[g]
Inorganics										
Aluminum	17 - 17	2210 - 7340	NA	L	4.56E+03	5.36E+03	1.55E+04	6.00E+02	N(b)	--
Antimony	7 - 17	0.68 - 4.496	1.22 - 1.55	U	9.90E-01	4.50E+00	9.30E+00	5.00E+00	N(a)(b)	--
Arsenic	17 - 17	2.14 - 10.5	NA	L	5.48E+00	7.06E+00	3.65E+01	9.90E+00	N(b)	--
Barium	17 - 17	14.1 - 251	NA	L	5.87E+01	8.79E+01	8.26E+02	2.83E+02	N(a)(b)	--
Beryllium	17 - 17	0.156 - 0.823	NA	L	3.71E-01	4.56E-01	1.00E+00	1.00E+01	N(a)(b)	--
Cadmium	15 - 17	0.159 - 2.19	0.608 - 0.697	L	5.65E-01	8.27E-01	NA	4.00E+00	N(a)	--
Calcium	17 - 17	2590 - 55100	NA	L	2.33E+04	4.28E+04	5.23E+04	NA	Y(b)	4.28E+04
Chromium	17 - 17	3.77 - 24.55	NA	L	1.01E+01	1.30E+01	2.90E+01	4.00E-01	N(b)	--
Cobalt	17 - 17	1.39 - 7.495	NA	L	3.72E+00	4.82E+00	1.16E+02	2.00E+01	N(a)(b)	--
Copper	17 - 17	3.73 - 99.8	NA	L	2.40E+01	4.34E+01	5.62E+01	6.00E+01	Y(a)(b)	4.34E+01
Iron	17 - 17	6570 - 32150	NA	L	1.55E+04	2.04E+04	2.34E+05	2.00E+02	N(b)	--
Lead	17 - 17	8.07 - 934	NA	L	2.42E+02	1.35E+03	4.86E+01	4.05E+01	Y(a)(b)	9.34E+02
Magnesium	17 - 17	1040 - 13200	NA	L	4.38E+03	7.10E+03	1.04E+04	NA	Y(a)(b)	7.10E+03
Manganese	17 - 17	63.7 - 3800	NA	L	6.24E+02	1.37E+03	3.51E+03	1.00E+02	Y(a)(b)	1.37E+03
Mercury (Inorganic)	15 - 17	0.021 - 0.39	0.037 - 0.037	L	1.00E-01	1.98E-01	8.50E-02	5.10E-04	Y(a)(b)	1.98E-01
Nickel	17 - 17	4.43 - 22.1	NA	N	1.26E+01	1.50E+01	5.51E+01	3.00E+01	N(a)(b)	--
Potassium	17 - 17	308 - 1140	NA	L	6.57E+02	8.23E+02	3.39E+03	NA	N(b)	--
Selenium	2 - 17	0.948 - 1.11	1.01 - 2.07	U	6.54E-01	1.11E+00	2.00E+00	2.10E-01	N(b)	--
Silver	2 - 17	0.455 - 0.677	0.608 - 0.779	U	3.72E-01	6.77E-01	1.11E+01	2.00E+00	N(a)(b)	--
Sodium	17 - 17	151 - 403	NA	L	2.13E+02	2.36E+02	NA	NA	Y(a)(b)	2.36E+02
Vanadium	17 - 17	7.185 - 28.8	NA	L	1.46E+01	1.73E+01	4.09E+01	2.00E+00	N(b)	--
Zinc	17 - 17	19.2 - 708	NA	L	1.67E+02	3.21E+02	3.21E+02	8.50E+00	Y(a)(b)	3.21E+02
Nitroaromatics										
1,3,5-Trinitrobenzene	11 - 17	0.153 - 7.93	0.08 - 0.1	L	1.77E+00	2.74E+01		3.76E-01	Y(a)	7.93E+00
1,3-Dinitrobenzene	6 - 17	0.0778 - 0.751	0.08 - 0.1	U	1.29E-01	7.51E-01		6.56E-01	Y(a)	7.51E-01
2,4,6-Trinitrotoluene	17 - 17	0.1975 - 41261	NA	L	3.12E+03	5.15E+07		NA	Y(a)	4.13E+04
2,4-Dinitrotoluene	12 - 17	0.06 - 10.6	0.377 - 3.91	L	2.23E+00	1.23E+01		1.28E+00	Y(a)	1.06E+01
2,6-Dinitrotoluene	7 - 17	0.0616 - 10.7	0.372 - 4.37	L	1.82E+00	6.95E+00		3.30E-02	Y(a)	6.95E+00
2-Amino-4,6-Dinitrotoluene	15 - 17	0.0712 - 38	0.0917 - 0.0952	L	7.19E+00	1.92E+02		NA	Y(a)	3.80E+01
3-Nitrotoluene	4 - 17	0.271 - 1.71	0.16 - 0.2	U	2.84E-01	1.71E+00		NA	Y(a)	1.71E+00
4-Amino-2,6-Dinitrotoluene	14 - 17	0.0876 - 14.6	0.0917 - 0.1	N	4.42E+00	6.34E+00		NA	Y(a)	6.34E+00
Dinitrotoluene[h]	10 - 17	0.288 - 16.7	0.0909 - 0.1	L	2.43E+00	4.91E+01		6.50E-01	Y(a)	1.67E+01
Nitrobenzene	3 - 17	0.0966 - 0.309	0.08 - 0.1	U	7.41E-02	3.09E-01		4.00E+01	N(a)	--
Tetryl	1 - 17	0.626 - 0.626	0.16 - 0.2	U	1.27E-01	6.26E-01		NA	Y(a)	6.26E-01
PCBs										
Aroclor 1260	16 - 17	0.0237 - 4.875	0.0807 - 0.0807	L	8.33E-01	4.71E+00		3.71E-01	Y(a)	4.71E+00
Semivolatile Organics										
Acenaphthylene	1 - 17	0.545 - 0.545	0.368 - 4.37	U	9.54E-01	5.45E-01		6.82E+02	N(a)	--
Anthracene	2 - 17	0.351 - 1.34	0.368 - 4.105	U	8.93E-01	1.34E+00		1.48E+03	N(a)	--
Benzo(a)anthracene	7 - 17	0.0498 - 6.94	0.368 - 4.105	L	1.32E+00	6.64E+00		5.21E+00	Y(a)	6.64E+00
Benzo(a)pyrene	7 - 17	0.0449 - 6.33	0.368 - 4.105	L	1.28E+00	6.52E+00		1.52E+00	Y(a)	6.33E+00
Benzo(b)fluoranthene	7 - 17	0.0826 - 9.05	0.368 - 4.105	L	1.54E+00	6.01E+00		5.98E+01	N(a)	--

Table 2-10

Statistical Summary and COPEC Selection of Surface Soil Sample Analyses
TNT Area C, PBOW, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution	Arithmetic Mean	95% UCL[b]	Background Screening Criterion[c]	Ecological Screening Criterion[d]	COPEC?[e,f]	Source Term Concentration[g]
Benzo(g,h,i)perylene	3 - 17	0.222 - 2.78	0.368 - 4.105	U	1.06E+00	2.78E+00		1.19E+02	N(a)	--
Benzo(k)fluoranthene	3 - 17	0.178 - 3.02	0.368 - 4.105	U	1.07E+00	3.02E+00		1.48E+02	N(a)	--
bis(2-Ethylhexyl) phthalate	6 - 17	0.0302 - 0.0493	0.368 - 4.37	U	8.91E-01	4.93E-02		9.26E-01	N(a)	--
Chrysene	6 - 17	0.0656 - 6.28	0.368 - 4.105	L	1.26E+00	4.60E+00		4.73E+00	Y(a)	4.60E+00
Dibenz(a,h)anthracene	3 - 17	0.0817 - 1.03	0.368 - 4.105	U	8.82E-01	1.03E+00		1.84E+01	N(a)	--
Diethyl phthalate	3 - 17	0.425 - 0.672	0.368 - 4.37	U	1.01E+00	6.72E-01		1.00E+02	N(a)	--
Di-n-butyl phthalate	2 - 17	0.0494 - 0.169	0.368 - 4.37	U	9.38E-01	1.69E-01		2.00E+02	N(a)	--
Fluoranthene	7 - 17	0.086 - 12.9	0.368 - 4.105	L	1.83E+00	7.63E+00		1.22E+02	N(a)	--
Indeno(1,2,3-cd)pyrene	3 - 17	0.21 - 2.91	0.368 - 4.105	U	1.08E+00	2.91E+00		1.09E+02	N(a)	--
Phenanthrene	4 - 17	0.0543 - 4.13	0.368 - 4.105	L	9.81E-01	3.12E+00		4.57E+01	N(a)	--
Pyrene	6 - 17	0.0873 - 10.1	0.368 - 4.105	L	1.63E+00	6.30E+00		7.85E+01	N(a)	--
Volatile Organics										
2-Butanone	2 - 16	0.0104 - 0.0617	0.0097 - 0.0135	U	9.34E-03	6.17E-02		8.96E+01	N(a)	--
Acetone	15 - 15	0.0114 - 0.456	NA	L	1.23E-01	2.45E-01		2.50E+00	N(a)	--
Benzene	4 - 17	0.0016 - 0.006	0.0048 - 0.0067	L	2.79E-03	3.17E-03		2.50E-01	N(a)	--
Carbon disulfide	7 - 17	0.0022 - 0.01	0.0048 - 0.0067	U	3.78E-03	1.00E-02		9.40E-02	N(a)	--
Ethylbenzene	2 - 17	0.0016 - 0.0021	0.0048 - 0.0067	N	2.67E-03	2.84E-03		5.16E+00	N(a)	--
m,p-Xylene	4 - 17	0.0039 - 0.0075	0.0049 - 0.0067	U	3.41E-03	7.50E-03		1.00E+01	N(a)	--
Methylene chloride	16 - 17	0.0051 - 0.0514	0.005 - 0.005	L	1.42E-02	2.27E-02		1.04E+01	N(a)	--
o-Xylene	3 - 17	0.0017 - 0.0031	0.0048 - 0.0067	N	2.73E-03	2.89E-03		1.00E+01	N(a)	--
Styrene	1 - 17	0.002 - 0.002	0.0048 - 0.0067	N	2.74E-03	2.87E-03		3.00E+02	N(a)	--
Toluene	9 - 17	0.0018 - 0.0264	0.0052 - 0.0067	U	5.82E-03	2.64E-02		2.00E+02	N(a)	--

COPEC - Chemical of Potential Ecological Concern; UCL - Upper Confidence Limit.
mg/kg - milligram per kilogram.
Surface soil is defined by samples taken from 0-2 feet below ground surface. These include two samples from 1.5 - 2.5 and one sample from 1.3 to 2.3 feet below ground surface.

[a] L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; U - Data are found to be nonparametric distribution.
[b] Calculated based on statistical distribution indicated (Section 2.2.2).
[c] Background data for constituents in soil as presented in Table 2-9.
[d] Ecological screening criteria for constituents in soil as presented in Appendix C.
[e] N = Chemical is not chosen as a COPEC:
(a) = Maximum detection is less than the Ecological Screening Criterion.
(b) = Maximum detection is less than the Background Screening Criterion.
[f] Y = Chemical is chosen as a COPEC:
(a) = Maximum detection is greater than the Ecological Screening Criterion or no screening criteria is available.
(b) = Maximum detection is greater than the Background Screening Criterion.
[g] Source term concentration represents the minimum of the MDC or the 95% UCL.
[h] Data for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene utilized for assessment since the total of the source term concentrations is greater than the source term concentration of total dinitrotoluene.

Table 2-11

Statistical Summary and COPEC Selection of Total Soil Sample Analyses
TNT Area C, PBOW, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution[a]	Arithmetic Mean	95% UCL[b]	Background Screening Criterion[c]	Ecological Screening Criterion[d]	COPEC?[e,f]	Source Term Concentration[g]
Inorganics										
Aluminum	31 - 31	1420 - 10900	NA	L	4.86E+03	5.68E+03	1.55E+04	6.00E+02	N(b)	--
Antimony	11 - 31	0.633 - 4.496	1.22 - 1.55	U	8.58E-01	1.44E+00	9.30E+00	5.00E+00	N(a)(b)	--
Arsenic	31 - 31	1.77 - 15.85	NA	L	5.45E+00	6.58E+00	3.65E+01	9.90E+00	N(b)	--
Barium	31 - 31	14.1 - 427	NA	L	7.58E+01	9.80E+01	8.26E+02	2.83E+02	N(b)	--
Beryllium	31 - 31	0.156 - 0.823	NA	L	3.65E-01	4.19E-01	1.00E+00	1.00E+01	N(a)(b)	--
Cadmium	21 - 31	0.159 - 2.19	0.608 - 0.753	L	4.83E-01	5.73E-01	NA	4.00E+00	N(a)	--
Calcium	31 - 31	1410 - 252000	NA	L	3.05E+04	5.79E+04	5.23E+04	NA	Y(b)	5.79E+04
Chromium	31 - 31	3.71 - 202	NA	U	1.58E+01	1.00E+01	2.90E+01	4.00E-01	Y(a)(b)	1.00E+01
Cobalt	31 - 31	0.297 - 11.45	NA	L	3.83E+00	5.22E+00	1.16E+02	2.00E+01	N(a)(b)	--
Copper	31 - 31	1.36 - 99.8	NA	L	1.91E+01	3.00E+01	5.62E+01	6.00E+01	Y(a)(b)	3.00E+01
Iron	31 - 31	4010 - 32150	NA	L	1.42E+04	1.75E+04	2.34E+05	2.00E+02	N(b)	--
Lead	31 - 31	6.03 - 934	NA	L	1.84E+02	5.78E+02	4.86E+01	4.05E+01	Y(a)(b)	5.78E+02
Magnesium	31 - 31	422 - 18700	NA	L	4.53E+03	7.07E+03	1.04E+04	NA	Y(b)	7.07E+03
Manganese	31 - 31	33.7 - 3800	NA	L	5.27E+02	8.51E+02	3.51E+03	1.00E+02	Y(a)(b)	8.51E+02
Mercury (Inorganic)	27 - 31	0.019 - 0.39	0.036 - 0.038	L	7.69E-02	1.08E-01	8.50E-02	5.10E-04	Y(a)(b)	1.08E-01
Nickel	31 - 31	3.72 - 90.8	NA	L	1.49E+01	1.88E+01	5.51E+01	3.00E+01	Y(a)(b)	1.88E+01
Potassium	31 - 31	242 - 2760	NA	L	7.59E+02	9.32E+02	3.39E+03	NA	N(b)	--
Selenium	2 - 31	0.948 - 1.11	1.01 - 2.07	U	6.15E-01	1.17E+00	2.00E+00	2.10E-01	N(b)	--
Silver	2 - 31	0.455 - 0.677	0.608 - 0.779	U	3.58E-01	7.00E-01	1.11E+01	2.00E+00	N(a)(b)	--
Sodium	31 - 31	78.2 - 403	NA	L	1.93E+02	2.16E+02	NA	NA	Y(a)(b)	2.16E+02
Vanadium	31 - 31	5.87 - 28.8	NA	L	1.41E+01	1.61E+01	4.09E+01	2.00E+00	N(b)	--
Zinc	31 - 31	5.8 - 708	NA	L	1.22E+02	1.99E+02	3.22E+02	8.50E+00	Y(a)(b)	1.99E+02
Nitroaromatics										
1,3,5-Trinitrobenzene	16 - 31	0.0616 - 7.93	0.08 - 0.1	U	1.04E+00	4.08E-01		3.76E-01	Y(a)	4.08E-01
1,3-Dinitrobenzene	6 - 31	0.0778 - 0.751	0.08 - 0.1	U	9.28E-02	1.00E-01		6.56E-01	Y(a)	1.00E-01
2,4,6-Trinitrotoluene	31 - 31	0.0622 - 41261	NA	L	1.81E+03	1.58E+06		NA	Y(a)	4.13E+04
2,4-Dinitrotoluene	21 - 31	0.0493 - 275	0.374 - 3.91	L	1.16E+01	2.02E+01		1.28E+00	Y(a)	2.02E+01
2,6-Dinitrotoluene	11 - 31	0.0616 - 23.8	0.372 - 4.37	U	2.12E+00	4.45E-01		3.30E-02	Y(a)	4.45E-01
2-Amino-4,6-dinitrotoluene	25 - 31	0.0712 - 38	0.087 - 0.1	L	4.51E+00	4.71E+01		NA	Y(a)	3.80E+01
2-Nitrotoluene	4 - 31	0.921 - 3.27	0.16 - 0.2	U	3.48E-01	2.00E-01		NA	Y(a)	2.00E-01
3-Nitrotoluene	8 - 31	0.263 - 4.82	0.16 - 0.2	U	3.76E-01	2.00E-01		NA	Y(a)	2.00E-01
4-Amino-2,6-dinitrotoluene	24 - 31	0.0876 - 14.6	0.092 - 0.1	L	2.77E+00	1.94E+01		NA	Y(a)	1.46E+01
4-Nitrotoluene	3 - 31	1.18 - 2.86	0.16 - 0.2	U	2.82E-01	2.00E-01		NA	Y(a)	2.00E-01
Dinitrotoluene, total[h]	20 - 31	0.0855 - 236	0.087 - 0.1	U	1.45E+01	7.77E-01		6.50E-01	Y(a)	7.77E-01
Nitrobenzene	6 - 31	0.0963 - 0.309	0.08 - 0.1	U	7.40E-02	1.00E-01		4.00E+01	N(a)	--
Tetryl	1 - 31	0.626 - 0.626	0.16 - 0.2	U	1.14E-01	2.00E-01		NA	Y(a)	2.00E-01
PCBs										
Aroclor 1254	1 - 31	0.2661 - 0.26605	0.036 - 0.419	U	4.56E-02	4.11E-02		3.71E-01	N(c)	--
Aroclor 1260	28 - 31	0.0095 - 4.875	0.075 - 0.081	L	5.65E-01	1.71E+00		3.71E-01	Y(a)	1.71E+00
Semivolatile Organics										
2-Methylnaphthalene	1 - 31	0.0381 - 0.0381	0.368 - 7.66	U	8.31E-01	6.73E-01		3.24E+00	N(a)	--
Acenaphthylene	1 - 31	0.545 - 0.545	0.368 - 7.66	U	8.39E-01	5.00E-01		6.82E+02	N(a)	--
Anthracene	5 - 31	0.113 - 4.14	0.368 - 7.66	U	8.75E-01	3.87E-01		1.48E+03	N(a)	--
Benzo(a)anthracene	12 - 31	0.0384 - 11.1	0.368 - 7.66	L	1.33E+00	3.35E+00		5.21E+00	Y(a)	3.35E+00
Benzo(a)pyrene	12 - 31	0.0361 - 8.2	0.368 - 7.66	L	1.21E+00	3.32E+00		1.52E+00	Y(a)	3.32E+00
Benzo(b)fluoranthene	10 - 31	0.0826 - 10.2	0.368 - 7.66	U	1.44E+00	7.45E-01		5.98E+01	N(a)	--

Table 2-11

Statistical Summary and COPEC Selection of Total Soil Sample Analyses
TNT Area C, PBOW, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution[a]	Arithmetic Mean	95% UCL[b]	Background Screening Criterion[c]	Ecological Screening Criterion[d]	COPEC?[e,f]	Source Term Concentration[g]
Benzo(g,h,i)perylene	5 - 31	0.222 - 3.4	0.368 - 7.66	U	9.53E-01	1.18E+00		1.19E+02	N(a)	--
Benzo(k)fluoranthene	5 - 31	0.155 - 4.38	0.368 - 7.66	U	9.80E-01	1.14E+00		1.48E+02	N(a)	--
bis(2-Ethylhexyl) phthalate	11 - 31	0.0302 - 0.202	0.368 - 7.66	U	7.88E-01	6.65E-01		9.26E-01	N(a)	--
Carbazole	1 - 31	0.109 - 0.109	0.368 - 7.66	U	8.33E-01	6.73E-01		NA	N(c)	--
Chrysene	10 - 31	0.0535 - 8.74	0.368 - 7.66	U	1.23E+00	6.32E-01		4.73E+00	Y(a)	6.32E-01
Dibenz(a,h)anthracene	5 - 31	0.0817 - 1.4	0.368 - 7.66	U	7.82E-01	5.31E-01		1.84E+01	N(a)	--
Diethyl phthalate	6 - 31	0.307 - 0.672	0.368 - 7.66	U	9.00E-01	6.52E-01		1.00E+02	N(a)	--
Di-n-butyl phthalate	2 - 31	0.0494 - 0.169	0.368 - 7.66	U	8.30E-01	6.73E-01		2.00E+02	N(a)	--
Fluoranthene	10 - 31	0.086 - 20.3	0.368 - 7.66	U	1.94E+00	1.32E+00		1.22E+02	N(a)	--
Indeno(1,2,3-cd)pyrene	5 - 31	0.21 - 3.64	0.368 - 7.66	U	9.65E-01	1.16E+00		1.09E+02	N(a)	--
Phenanthrene	7 - 31	0.0543 - 5.21	0.368 - 7.66	U	9.74E-01	6.25E-01		4.57E+01	N(a)	--
Pyrene	9 - 31	0.0873 - 17.1	0.368 - 7.66	U	1.71E+00	1.15E+00		7.85E+01	N(a)	--
Volatile Organics										
2-Butanone	3 - 30	0.0104 - 0.06165	0.009 - 0.014	U	7.83E-03	1.15E-02		8.96E+01	N(a)	--
Acetone	26 - 27	0.0114 - 0.456	0.01 - 0.01	L	9.10E-02	1.52E-01		2.50E+00	N(a)	--
Benzene	8 - 31	0.0016 - 0.00601	0.005 - 0.007	U	2.72E-03	5.69E-03		2.50E-01	N(a)	--
Carbon disulfide	17 - 31	0.0018 - 0.0272	0.005 - 0.007	U	4.65E-03	3.56E-03		9.40E-02	N(a)	--
Ethylbenzene	3 - 31	0.0012 - 0.00207	0.005 - 0.007	N	2.64E-03	2.77E-03		5.16E+00	N(a)	--
Methylene chloride	30 - 31	0.002 - 0.0514	0.005 - 0.005	L	1.06E-02	1.40E-02		1.04E+01	N(a)	--
Styrene	1 - 31	0.002 - 0.00197	0.004 - 0.007	N	2.71E-03	2.80E-03		3.00E+02	N(a)	--
Toluene	15 - 31	0.0018 - 0.0264	0.005 - 0.007	U	4.53E-03	3.05E-03		2.00E+02	N(a)	--
Xylene, o-	3 - 31	0.0017 - 0.00307	0.004 - 0.007	N	2.70E-03	2.81E-03		1.00E+01	N(a)	--
Xylenes, m,p-	5 - 31	0.0011 - 0.0075	0.005 - 0.007	U	3.04E-03	5.86E-03		1.00E+01	N(a)	--

COPEC - Chemical of Potential Ecological Concern; UCL - Upper Confidence Limit.
mg/kg - milligram per kilogram.
Total soil is defined by samples taken from 0-6 feet below ground surface.

[a] L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; U - Data are found to be nonparametric distribution.
[b] Calculated based on statistical distribution indicated (Section 2.2.2).
[c] Background data for constituents in soil as presented in Table 2-9.
[d] Ecological screening criteria for constituents in soil as presented in Appendix C.
[e] N = Chemical is not chosen as a COPEC:
(a) = Maximum detection is less than the Ecological Screening Criterion.
(b) = Maximum detection is less than the Background Screening Criterion.
(c) = Frequency of detection is less than 5%.
[f] Y = Chemical is chosen as a COPEC:
(a) = Maximum detection is greater than the Ecological Screening Criterion or no screening criteria is available.
(b) = Maximum detection is greater than the Background Screening Criterion.
[g] Source term concentration represents the minimum of the MDC or the 95% UCL
[h] Data for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene utilized for assessment since the total of the source term concentrations is greater than the source term concentration of total dinitrotoluene.

Table 2-12

Statistical Summary and COPEC Selection of Surface Water Sample Analyses
TNT Area C, Plum Brook Ordnance Works, Sandusky, Ohio

Chemical Name (mg/L)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution	Arithmetic Mean	95% UCL[a]	Ecological Screening Criterion[b]	COPEC?[c,d]	Source Term Concentration[e]
Inorganics									
Aluminum	10 - 10	0.152 - 3.83	NA	L	9.59E-01	3.22E+00	8.70E-02	Y	3.22E+00
Barium	10 - 10	0.028 - 0.125	NA	L	5.66E-02	8.27E-02	4.00E-03	Y	8.27E-02
Beryllium	10 - 10	0.0001 - 0.00032	NA	L	1.75E-04	2.33E-04	6.60E-04	N	--
Cadmium	2 - 10	0.00212 - 0.00519	0.003 - 0.003	U	1.93E-03	5.19E-03	6.60E-04	Y	5.19E-03
Calcium	10 - 10	99.7 - 235	NA	N	1.68E+02	1.93E+02	NA	Y	1.93E+02
Chromium	8 - 10	0.00101 - 0.00445	0.005 - 0.005	L	2.14E-03	2.89E-03	4.20E-02	N	--
Cobalt	4 - 10	0.00123 - 0.0044	0.005 - 0.005	U	2.58E-03	4.40E-03	5.00E-03	N	--
Copper	7 - 10	0.00129 - 0.00581	0.005 - 0.005	L	2.67E-03	3.68E-03	5.00E-03	Y	3.68E-03
Iron	10 - 10	0.2315 - 15.3	NA	L	3.40E+00	2.40E+01	1.00E+00	Y	1.53E+01
Lead	5 - 10	0.00162 - 0.00689	0.003 - 0.003	U	2.66E-03	6.89E-03	1.30E-03	Y	6.89E-03
Magnesium	10 - 10	25.6 - 51.7	NA	N	3.61E+01	4.12E+01	NA	Y	4.12E+01
Manganese	10 - 10	0.06095 - 3.01	NA	L	7.80E-01	4.73E+00	1.20E-01	Y	3.01E+00
Nickel	6 - 10	0.00286 - 0.00869	0.005 - 0.005	L	4.39E-03	6.45E-03	2.90E-02	N	--
Potassium	10 - 10	0.967 - 3.1	NA	L	1.99E+00	2.55E+00	NA	Y	2.55E+00
Selenium	3 - 10	0.00278 - 0.00311	0.005 - 0.005	U	2.65E-03	3.11E-03	3.90E-04	Y	3.11E-03
Sodium	10 - 10	1.35 - 5.48	NA	N	3.94E+00	4.86E+00	NA	Y	4.86E+00
Vanadium	7 - 10	0.00116 - 0.00712	0.005 - 0.005	L	2.59E-03	3.73E-03	1.90E-02	N	--
Zinc	10 - 10	0.00542 - 0.0279	NA	N	1.60E-02	2.08E-02	5.89E-02	N	--
Nitroaromatics									
2,4,6-Trinitrotoluene	1 - 10	0.00034 - 0.00034	0.00026 - 0.00026	U	1.51E-04	3.44E-04	NA	Y	3.44E-04
2,4-Dinitrotoluene	1 - 10	0.00257 - 0.00257	0.01025 - 0.012	U	5.20E-03	2.57E-03	2.30E-01	N	--
2,6-Dinitrotoluene	1 - 10	0.00295 - 0.00295	0.01025 - 0.012	U	5.24E-03	2.95E-03	4.20E-02	N	--
2-Amino-4,6-Dinitrotoluene	1 - 10	0.00098 - 0.00098	0.00026 - 0.00026	U	2.15E-04	9.84E-04	NA	Y	9.84E-04
2-Nitrotoluene	1 - 10	0.0104 - 0.0104	0.00052 - 0.00052	U	1.27E-03	1.04E-02	NA	Y	1.04E-02
3-Nitrotoluene	1 - 10	0.00147 - 0.00147	0.00052 - 0.00052	U	3.81E-04	1.47E-03	NA	Y	1.47E-03
4-Nitrotoluene	1 - 10	0.0043 - 0.0043	0.00052 - 0.00052	U	6.64E-04	4.30E-03	NA	Y	4.30E-03
4-Amino-2,6-Dinitrotoluene	2 - 10	0.00033 - 0.00055	0.00026 - 0.00026	U	1.92E-04	5.49E-04	NA	Y	5.49E-04
Dinitrotoluene	2 - 10	0.00097 - 0.00792	0.00026 - 0.00026	U	9.93E-04	7.92E-03	NA	Y	7.92E-03
Semivolatile Organics									
Di-n-butyl phthalate	1 - 10	0.00525 - 0.00525	0.01025 - 0.012	L	5.45E-03	5.64E-03	1.00E-03	Y	5.25E-03
Volatile Organics									
Acetone	1 - 1	0.0108 - 0.0108	NA	NA	NA	NA	1.50E+00	N	--
Carbon disulfide	10 - 10	0.0011 - 0.0231	NA	L	8.11E-03	2.51E-02	9.20E-04	Y	2.31E-02
Methylene chloride	10 - 10	0.0006 - 0.00093	NA	L	7.22E-04	7.76E-04	4.30E-01	N	--

COPEC - Chemical of Potential Ecological Concern; UCL - Upper Confidence Limit.
L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; U - Data are found to be nonparametric distribution.
mg/kg - milligram per kilogram.

[a] Calculated based on statistical distribution indicated (Section 2.2.2).
[b] Ecological screening criteria for surface water as presented in Appendix C.
[c] N = Chemical is not chosen as a COPEC: Maximum detected concentration does not exceed screening criterion.
[d] Y = Chemical is chosen as a COPEC: Maximum detected concentration exceeds screening criterion or no screening criteria is available.
[e] Source term concentration represents the minimum of the MDC or the 95% UCL.

Table 2-13

Statistical Summary and COPEC Selection of Sediment Sample Analyses
TNT Area C, Plum Brook Ordnance, Sandusky, Ohio

(Page 1 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution	Arithmetic Mean	95% UCL[a]	Background Screening Criterion[b]	Ecological Screening Criterion[c]	COPEC?[d,e]	Source Term Concentration[f]
Inorganics										
Aluminum	15 - 15	1200 - 15600	NA	L	6.52E+03	1.10E+04	1.55E+04	NA	Y(a)(b)	1.10E+04
Arsenic	13 - 15	1.14 - 25.3	1.26 - 1.63	L	8.22E+00	2.49E+01	3.65E+01	5.90E+00	N(b)	--
Barium	15 - 15	15.3 - 324	NA	L	7.20E+01	1.15E+02	8.26E+02	NA	N(b)	--
Beryllium	14 - 15	0.101 - 0.8475	0.24 - 0.24	N	4.40E-01	5.60E-01	1.00E+00	NA	N(b)	--
Cadmium	15 - 15	0.144 - 1.24	NA	N	5.88E-01	7.25E-01	NA	5.96E-01	Y(a)	7.25E-01
Calcium	15 - 15	1320 - 182000	NA	L	2.75E+04	1.06E+05	5.23E+04	NA	Y(a)(b)	1.06E+05
Chromium	15 - 15	4.05 - 22.35	NA	N	1.17E+01	1.43E+01	2.90E+01	2.60E+01	N(a)(b)	--
Cobalt	15 - 15	0.871 - 18.4	NA	N	7.97E+00	1.05E+01	1.16E+02	5.00E+01	N(a)(b)	--
Copper	15 - 15	2.49 - 38.8	NA	L	1.77E+01	3.35E+01	5.62E+01	1.60E+01	N(b)	--
Iron	15 - 15	5320 - 64600	NA	L	2.26E+04	3.68E+04	2.34E+05	2.00E+04	N(b)	--
Lead	15 - 15	2.83 - 86.3	NA	L	2.62E+01	4.88E+01	4.86E+01	3.10E+01	Y(a)(b)	4.88E+01
Magnesium	15 - 15	297 - 8230	NA	L	2.70E+03	5.83E+03	1.04E+04	NA	N(b)	--
Manganese	15 - 15	37.3 - 1230	NA	N	5.01E+02	6.85E+02	3.51E+03	4.60E+02	N(b)	--
Mercury (Inorganic)	10 - 15	0.0215 - 0.156	0.029 - 0.042	U	4.48E-02	1.56E-01	8.50E-02	1.74E-01	N(a)	--
Nickel	15 - 15	2.23 - 47.3	NA	L	2.19E+01	4.67E+01	5.51E+01	1.60E+01	N(b)	--
Potassium	15 - 15	155 - 3310	NA	L	1.51E+03	3.41E+03	3.39E+03	NA	N(b)	--
Selenium	11 - 15	0.904 - 2.47	1.19 - 1.31	L	1.32E+00	1.77E+00	2.00E+00	NA	Y(a)(b)	1.77E+00
Sodium	15 - 15	164 - 272	NA	L	2.07E+02	2.23E+02	NA	NA	Y(a)	2.23E+02
Vanadium	15 - 15	6.93 - 31.15	NA	N	1.77E+01	2.06E+01	4.09E+01	NA	N(b)	--
Zinc	15 - 15	11.1 - 131	NA	L	5.49E+01	9.57E+01	3.22E+02	1.20E+02	N(b)	--
Nitroaromatics										
1,3,5-Trinitrobenzene	1 - 15	0.832 - 0.832	0.0833 - 0.1	U	1.00E-01	8.32E-01		1.21E-04	Y(a)	8.32E-01
2,4,6-Trinitrotoluene	8 - 15	0.0715 - 1496	0.0833 - 0.1	U	1.00E+02	1.50E+03		NA	Y(a)	1.50E+03
2,4-Dinitrotoluene	3 - 15	0.0884 - 0.276	0.42 - 0.568	N	2.19E-01	2.42E-01		7.51E-02	Y(a)	2.42E-01
2,6-Dinitrotoluene	1 - 15	0.183 - 0.183	0.385 - 0.568	L	2.25E-01	2.38E-01		2.06E-02	Y(a)	1.83E-01
2-Amino-4,6-Dinitrotoluene	4 - 15	0.214 - 12.8	0.0833 - 0.1	U	1.14E+00	1.28E+01		NA	Y(a)	1.28E+01
4-Amino-2,6-Dinitrotoluene	4 - 15	0.126 - 11.2	0.0833 - 0.1	U	9.97E-01	1.12E+01		NA	Y(a)	1.12E+01
RDX (Cyclonite)	1 - 15	0.521 - 0.521	0.167 - 0.2	U	1.25E-01	5.21E-01		NA	Y(a)	5.21E-01
Dinitrotoluene[g]	7 - 15	0.102 - 0.414	0.0833 - 0.1	U	1.23E-01	4.14E-01		NA	Y(a)	4.14E-01
Nitrobenzene	1 - 15	0.051 - 0.051	0.0833 - 0.1	U	4.85E-02	5.10E-02		4.88E-01	N(a)	--
PCBs										
Aroclor 1260	8 - 15	0.0292 - 0.769	0.084 - 0.115	U	1.88E-01	7.69E-01		3.41E-02	Y(a)	7.69E-01

Table 2-13

Statistical Summary and COPEC Selection of Sediment Sample Analyses
TNT Area C, Plum Brook Ordnance, Sandusky, Ohio

(Page 2 of 2)

Chemical Name (mg/kg)	Frequency of Detection	Range of Detections	Range of Detection Limits	Statistical Distribution	Arithmetic Mean	95% UCL[a]	Background Screening Criterion[b]	Ecological Screening Criterion[c]	COPEC?[d,e]	Source Term Concentration[f]
Semivolatile Organics										
Benzo(a)anthracene	2 - 15	0.0693 - 0.0947	0.385 - 0.548	U	2.05E-01	9.47E-02		3.17E-02	Y(a)	9.47E-02
Benzo(a)pyrene	3 - 15	0.0324 - 0.0699	0.42 - 0.548	U	1.92E-01	6.99E-02		3.19E-02	Y(a)	6.99E-02
Benzo(b)fluoranthene	1 - 15	0.12 - 0.12	0.385 - 0.568	N	2.21E-01	2.38E-01		1.04E+01	N(a)	--
bis(2-Ethylhexyl) phthalate	2 - 15	0.0299 - 0.0553	0.385 - 0.568	U	2.03E-01	5.53E-02		1.82E-01	N(a)	--
Chrysene	1 - 15	0.0737 - 0.0737	0.385 - 0.568	U	2.18E-01	7.37E-02		5.71E-02	Y(a)	7.37E-02
Di-n-butyl phthalate	1 - 15	0.0702 - 0.0702	0.385 - 0.568	U	2.16E-01	7.02E-02		1.00E-03	Y(a)	7.02E-02
Fluoranthene	1 - 15	0.147 - 0.147	0.385 - 0.548	N	2.18E-01	2.30E-01		1.11E-01	Y(a)	1.47E-01
Pyrene	1 - 15	0.11 - 0.11	0.385 - 0.568	N	2.20E-01	2.38E-01		5.30E-02	Y(a)	1.10E-01
Volatile Organics										
2-Butanone	1 - 15	0.0086 - 0.0086	0.0116 - 0.0172	L	6.74E-03	7.35E-03		1.37E-01	N(a)	--
Acetone	8 - 15	0.0035 - 0.0379	0.0116 - 0.0145	L	1.18E-02	1.81E-02		4.53E-01	N(a)	--
Benzene	1 - 15	0.0035 - 0.0035	0.00578 - 0.00861	L	3.42E-03	3.59E-03		1.42E-01	N(a)	--
Methylene chloride	14 - 15	0.0037 - 0.074	0.00578 - 0.00578	U	1.81E-02	7.40E-02		1.26E+00	N(a)	--
Toluene	3 - 15	0.0034 - 0.0063	0.00578 - 0.00861	U	3.71E-03	6.33E-03		5.25E+01	N(a)	--

COPEC - Chemical of Potential Ecological Concern; UCL - Upper Confidence Limit.

L - Data are found to have lognormal distribution; N - Data are found to have normal distribution; U - Data are found to be nonparametric distribution.

mg/kg - milligram per kilogram.

[a] Calculated based on statistical distribution indicated (Section 2.2.2).

[b] Background data for constituents in soil as presented in Table 2-9.

[c] Ecological screening criteria for sediment as presented in Appendix C.

[d] N = Chemical is not chosen as a COPEC: Maximum detected concentration does not exceed screening criterion.

(a) = Maximum detection is less than the Ecological Screening Criterion.

(b) = Maximum detection is less than the Background Screening Criterion.

[e] Y = Chemical is chosen as a COPEC: Maximum detected concentration exceeds screening criterion or no screening criteria is available.

(a) = Maximum detection is greater than the Ecological Screening Criterion or no screening criteria is available.

(b) = Maximum detection is greater than the Background Screening Criterion.

[f] Source term concentration represents the minimum of the MDC or the 95% UCL.

[g] Data for 2,4-Dinitrotoluene and 2,6-Dinitrotoluene utilized for assessment since the total of the source term concentrations is greater than the source term concentration of total dinitrotoluene.

Table 2-14

Assessment and Measurement Endpoints and Exposure Delineation
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of terrestrial ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for soil invertebrates.	The presence of site contaminants within surficial soils will have no adverse effect on survival and reproductive capabilities of terrestrial invertebrates.	Terrestrial invertebrates Ingestion of soil and direct exposure to soil	Comparison of soil concentration to soil critical effect values (CEV).
	Protection of long-term survival and reproductive capabilities for herbivorous mammals.	The presence of site contaminants within surface and subsurface soils, surface water, and vegetation will have no adverse effect on survival and reproductive capabilities of herbivorous mammals.	Eastern cottontail (*Sylvilagus floridanus*) white-tailed deer (*Odocoileus virginianus*) ingestion of plants, water, and incidental soil	Comparison of total daily dose to species-specific toxicity endpoint values (TEV).
	Protection of long-term survival and reproductive capabilities for omnivorous mammals.9	The presence of site contaminants within surface soils, surface water, terrestrial invertebrates and vegetation will have no adverse effect on survival and reproductive capabilities of omnivorous mammals.	raccoon (*Procyon lotor*) ingestion of terrestrial plants, and invertebrates, small mammals, water and incidental soil	Comparison of total daily dose to species-specific toxicity endpoint values (TEV).

Table 2-14

Assessment and Measurement Endpoints and Exposure Delineation
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 4)

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of terrestrial ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for omnivorous mammals.	The presence of site contaminants within surficial soils, surface water, terrestrial invertebrates, and vegetation will have no adverse effect on survival and reproductive capabilities of omnivorous mammals.	deer mouse (*Peromyscus maniculatus*) ingestion of terrestrial invertebrates, plants, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.
	Protection of long-term survival and reproductive capabilities for carnivorous birds.	The presence of site contaminants within surficial soils, surface water, small mammals, and birds will have no adverse effect on survival and reproductive capabilities of carnivorous birds.	red-tailed hawk (*Buteo jamacencis*) ingestion of small mammals, birds, water, incidental soil	Comparison of total daily dose to species-specific TEVs.
	Protection of long-term survival and reproductive capabilities for small insectivorous mammals.	The presence of site contaminants within surficial soils, surface water, and terrestrial invertebrates will have no adverse effect on survival and reproductive capabilities of insectivorous mammals.	short-tailed shrew (*Blarnia brevicauda*) ingestion of terrestrial invertebrates, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.

Table 2-14

Assessment and Measurement Endpoints and Exposure Delineation
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of terrestrial ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for insectivorous birds.	The presence of site contaminants within surficial soils, surface water, and terrestrial invertebrates will have no adverse effect on survival and reproductive capabilities of insectivorous birds.	march wren (*Cistorthorus palustris*) ingestion of terrestrial invertebrates, water, and incidental soil	Comparison of total daily dose to species-specific TEVs.
Protection of aquatic ecosystem structure and function.	Protection of long-term survival and reproductive capabilities for benthic invertebrates.	The presence of site contaminants within sediments and surface water will have no adverse effect on survival and reproductive capabilities of benthic invertebrates.	benthic invertebrates ingestion of sediment and direct exposure to surface water	Comparison of sediment concentration to sediment CEVs.
	Protection of long-term survival and reproductive capabilities for aquatic invertebrates (crustaceans).	The presence of site contaminants within surface water will have no adverse effect on survival and reproductive capabilities of aquatic invertebrates.	aquatic invertebrates direct exposure to water	Comparison of surface water concentration to aquatic CEVs.
	Protection of long-term survival and reproductive capabilities for semi-aquatic omnivorous mammals (also considered in the terrestrial assessment).	The presence of site contaminants within surface water, sediments, and aquatic invertebrates have no adverse effect on survival and reproductive capabilities of aquatic mammals.	raccoon (*Procyon lotor*) ingestion of aquatic invertebrates, water and incidental sediment	Comparison of total daily dose to species-specific TEVs.

Table 2-14

Assessment and Measurement Endpoints and Exposure Delineation
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 4 of 4)

Assessment Goal	Assessment Endpoint	Null Hypothesis (H_o)	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of aquatic ecosystem structure and function. (continued)	Protection of long-term survival and reproductive capabilities for aquatic birds.	The presence of site contaminants within aquatic and benthic invertebrates will have no adverse effect on survival and reproductive capabilities of aquatic birds.	mallard (*Anas platyrhynchos*) ingestion of aquatic and benthic invertebrates, water, and incidental sediment	Comparison of total daily dose to species-specific TEVs.

Table 3-1

Data Used to Model Exposure in the Indicator Wildlife Species
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Indicator Species	Class/ Order	Average Body Weight[a] (kg)	Average Home Range[a] (ha)	Dietary Intake[a] (kg[dw]/day)	Soil/Sed. Intake (kg[dw]/day)	Water Intake (L/day)[b]	Trophic Level	Dietary Composition[a] (percent)
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	0.0148	0.062	0.0028[d]	0.000057 (2.0%)	0.0022	Omnivore	Terr. Inverts. : 39 Plants: 61
Eastern cottontail (*Sylvilagus floridanus*)	Mammalia/ Lagomorpha	1.132	3.1	0.096[d]	0.006 (6.3%)	0.11	Herbivore	Plants: 100
Short-tailed shrew (*Blarina brevicauda*)	Mammalia/ Insectivora	0.015	0.39	0.0022[d]	0.00083 (10.4%)	0.0023	Insectivore	Terr. Inverts.: 100
White-tailed deer (*Odocoileus virginianus*)	Mammalia/ Artiodactyla	61[c]	518[c]	2.0[d]	0.04 (2.0%)	4.0	Herbivore	Plants: 100
Marsh wren (*Cistothorus palustris*)	Aves/ Passeriformes	0.010	0.054	0.0029[d]	0.00019 (2.0%)	0.0027	Insectivore	Terr. Inverts.: 100
Red-tailed hawk (*Buteo jamaicensis*)	Aves/ Falconiformes	0.957	842	0.057[d]	0.002 (2.0%)	0.057	Carnivore	Rabbits: 25.3 Shrews: 25.3 Mice: 25.3 Birds: 24
Mallard duck (*Anas platyrhynchos*)	Aves/ Anseriformes	1.13	580	0.063[d]	0.0013 (2.0%)	0.064	Omnivore	Plants: 62.5 Aq. Inverts. 37.5

Table 3-1

Data Used to Model Exposure in the Indicator Wildlife Species
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Indicator Species	Class/ Order	Average Body Weight[a] (kg)	Average Home Range[a] (ha)	Dietary Intake[a] (kg[dw]/day)	Soil/Sed. Intake (kg[dw]/day)	Water Intake (L/day)[b]	Trophic Level	Dietary Composition[a] (percent)
Raccoon (*Procyon lotor*)	Mammalia/ Carnivora	5.1	156	0.26[d]	0.024 (9.4%)	0.43	Omnivore	Aq. Inverts.: 21 Terr. Inverts.: 30 Mice: 5.0 Plants: 42 (Fish: 2.0 not included, as no fish on site).

[a] From EPA (1993), except as noted.
[b] Allometric equations for mammals and birds from EPA (1993), as follows:
Mammals: WI (water ingestion; L/day) = 0.099 $Wt^{0.90}$ (kg), where Wt = body weight.
Birds: WI (L/day) = 0.059 $Wt^{0.67}$ (kg).
[c] Information is from *A Guide to the Mammals of Ohio* (Gottschang, 1981).
[d] Allometric equation for mammals: FI (kg/day) = 0.0687 $Wt^{0.822}$ for shrew, deer, and raccoon; FI (g/day) = 0.621 $Wt^{0.564}$ for rodents (deer mouse); and FI (g/day) = 0.577 $Wt^{0.727}$ for small herbivores (cottontail). Allometric equation for birds: FI (kg/day) = 0.0582 $Wt^{0.651}$ (EPA, 1993), where FI = food ingestion (dry weight) and Wt = body weight. Allometric equations from EPA (1993).

Table 3-2

Octanol-Water Partition Coefficients (Kow) for Organic Chemicals of Potential Ecological Concern - TNT Area C Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	K_{ow} (unitless)[a]
1,3-Dinitrobenzene	30.9[b]
1,3,5-Trinitrobenzene	15.1[b]
2,4,6-Trinitrotoluene	100[b]
2,4-Dinitrotoluene	95
2,6-Dinitrotoluene	190
2-Amino-4,6-dinitrotoluene	100[d]
2-Nitrotoluene	200[c]
3-Nitrotoluene	282[c]
4-Nitrotoluene	263[c]
4-Amino-2,6-dinitrotoluene	100[d]
Aroclor 1260	14,000,000
Benzo(a)anthracene	410,000
Benzo(a)pyrene	1,150,000
Carbon disulfide	69.2[e]
Chrysene	410,000
Di-n-butyl phthalate	360,000
Dinitrotoluene	190[f]
Fluoranthene	79,000
Pyrene	80,000
RDX	7.4[b]
Tetryl	44.7[b]

[a] Octanol-water partition coefficients (K_{ow}) values are from EPA-440/4-81-014, 1982, Aquatic Fate Process Data for Organic Priority Pollutants,
[b] K_{ow} values are from Rosenblatt, D. H., et. al., 1991, Organic Explosives and Related Compounds.
[c] K_{ow} values are from Leo, A., Hansch, C., and Elkins, D., 1971, Partition Coefficients and Their Uses.
[d] The K_{ow} for 2,4,6-Trinitrotoluene was used as a surrogate.
[e] The K_{ow} values are from Montgomery, 1996.
[f] The K_{ow} for 2,6-Dinitrotoluene was used as a surrogate.

Table 3-3

Fate and Transport Factors for Inorganic Chemicals of Potential Ecological Concern, TNT Area C Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Soil/Sediment-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor	Water-to-Fish/Invertebrate Bio-Concentration Factor	Distribution Coefficient K_d (L/kg)
Aluminum	2.3×10^{-3} [b]	1.0×10^{0} [a]	1.5×10^{-3} [b]	1.0×10^{2} [a]	1.5×10^{3} [b]
Barium	--	--	2.0×10^{-4} [c]	--	--
Cadmium	3.5×10^{-1} [b]	4.2×10^{1} [d]	4.0×10^{-4} [c]	1.0×10^{2} [a]	6.4×10^{0} [b]
Calcium	1.9×10^{0} [b]	1.0×10^{0} [a]	2.0×10^{-3} [c]	1.0×10^{2} [a]	4.0×10^{0} [b]
Chromium	1.0×10^{-3} [c]	7.0×10^{-2} [d]	9.0×10^{-3} [c]	--	--
Copper	8.0×10^{-1} [c]	2.5×10^{-1} [e]	9.0×10^{-3} [c]	2.0×10^{2} [c]	3.5×10^{1} [b]
Iron	--	--	2.0×10^{-2} [c]	--	--
Lead	1.1×10^{-3} [c]	9.3×10^{-1} [d]	4.0×10^{-4} [c]	3.0×10^{2} [c]	9.0×10^{2} [b]
Magnesium	7.8×10^{-1} [b]	1.0×10^{0} [a]	2.0×10^{-2} [c]	1.0×10^{2} [a]	4.5×10^{0} [b]
Manganese	6.8×10^{-1} [c]	3.2×10^{-1} [d]	5.0×10^{-4} [c]	4.0×10^{2} [c]	1.0×10^{3} [c]
Mercury	5.5×10^{-1} [b]	1.0×10^{0} [a]	2.5×10^{-1} [b]	--	--
Nickel	3.6×10^{-1} [f]	3.8×10^{-1} [d]	5.0×10^{-3} [c]	--	--
Potassium	--	--	1.0×10^{-2} [c]	--	--
Selenium	2.5×10^{-2} [b]	1.0×10^{0} [a]	1.5×10^{-2} [b]	1.0×10^{2} [a]	3.0×10^{2} [b]
Sodium	6.5×10^{-2} [b]	1.0×10^{0} [a]	8.0×10^{-2} [c]	2.0×10^{1} [c]	1.0×10^{2} [b]
Zinc	4.3×10^{-1} [f]	3.0×10^{-1} [e]	1.0×10^{-1} [c]	--	--

[a] Consevative default values: 1.0×10^{0} for soil-to-insect TF, based on data in Stafford et al. (1991), Ma (1982), and NCRP (1989); 1.0×10^{2} for water-to-invertebrate BCF, based on 95% UCL for non-parametric distribution of 54 BCF values presented in IAEA (1994).
[b] From Baes et. al., (1984); for soil-to-plant transfer factors, average of vegetative and nonvegetative values was used.
[c] From IAEA (1994). For food-to-muscle TFs, transfer coefficients for beef were used. For water-to-invertebrate BCF, values for freshwater fish were utilized.
[d] From Ma (1982).
[e] Stafford et al. (1991).
[f] Based on data in Arthur and Gates (1998).
" – " symbol indicates factor was not required as the inorganic was not selected as a COPEC for the particular pathway of concern.

Table 3-4

BCF Selection
Sediment to Invertebrate BCF
TNT Area C, PBOW, Sandusky, Ohio

Chemical Name	Literature Value	Site-Specific RME	Selected BCF	Comments
Organics				
Aroclor 1260	14,000,000	NA	14,000,000	Literature
2-Amino-4,6-DNT	100	ND	100	Literature
4-Amino-2,6-DNT	100	ND	100	Literature
Benzo(a)anthracene	410,000	NA	410,000	Literature
Benzo(a)pyrene	1,150,000	NA	1,150,000	Literature
Chrysene	410,000	NA	410,000	Literature
Di-n-butyl phthalate	360,000	NA	360,000	Literature
2,4-DNT	95	ND	95	Literature
2,6-DNT	190	ND	190	Literature
Fluoranthene	79,000	NA	79,000	Literature
Pyrene	80,000	NA	80,000	Literature
RDX	7.4	ND	7.4	Literature
1,3,5-TNB	15.1	ND	15.1	Literature
2,4,6-TNT	100	ND	100	Literature
Inorganics				
Aluminum	100	0.0035	0.0035	Site-Specific (Red Water Ponds)
Cadmium	100	ND	100	Literature
Calcium	100	0.033	0.033	Site-Specific (Red Water Ponds)
Lead	300	0.025	0.025	Site-Specific (Red Water Ponds)
Selenium	100	NA	100	Literature
Sodium	20	0.77	0.77	Site-Specific (Red Water Ponds)

NA - Not Available.
ND - Constituent not detected in RWP site-specific biota or sediment samples.

Notes:
Literature value is porewater to tissue biotransfer factor.
Site-specific BCF is from RWP laboratory bioaccumulation study, with conservative selection of RME over CT value.
Site-specific BCF selected if available.

Table 3-5

BAF Selection
Soil to Invertebrate BAF
TNT Area C, PBOW, Sandusky, Ohio

Chemical Name	Calculated/Literature Value	Site-Specific RME	Selected BAF	Comments
Organics				
Aroclor-1260	27.3	NA	27.3	Calculated
Benzo(a)anthracene	22.8	0.58	0.58	Site-Specific (Red Water Ponds)
Benzo(a)pyrene	24.1	0.46	0.46	Site-Specific (Red Water Ponds)
Chrysene	22.8	0.55	0.55	Site-Specific (Red Water Ponds)
2-Amino-4,6-DNT	15.1	0.1	0.1	2,4-DNT as Surrogate
4-Amino-2,6-DNT	15.1	0.1	0.1	2,4-DNT as Surrogate
1,3-DNB	14.2	0.1	0.1	2,4-DNT as Surrogate
2,4-DNT	15.0	0.1	0.1	Site-Specific (Red Water Ponds)
2,6-DNT	15.6	0.1	0.1	2,4-DNT as Surrogate
2-Nitrotoluene	15.6	0.1	0.1	2,4-DNT as Surrogate
3-Nitrotoluene	15.9	0.1	0.1	2,4-DNT as Surrogate
4-Nitrotoluene	15.8	0.1	0.1	2,4-DNT as Surrogate
Tetryl	14.5	0.1	0.1	2,4-DNT as Surrogate
1,3,5-TNB	13.7	0.1	0.1	2,4-DNT as Surrogate
2,4,6-TNT	15.1	0.1	0.1	2,4-DNT as Surrogate
Inorganics				
Calcium	1	NA	1	Literature
Chromium	0.07	NA	0.07	Literature
Copper	0.25	NA	0.25	Literature
Lead	0.93	NA	0.93	Literature
Magnesium	1	NA	1	Literature
Manganese	0.32	NA	0.32	Literature
Mercury	1	NA	1	Literature
Nickel	0.38	NA	0.38	Literature
Sodium	1	NA	1	Literature
Zinc	8	NA	8	Literature

NA - Not Available.

Notes:

Site-specific BAF is from RWP laboratory bioaccumulation study, with conservative selection of RME over CT value.
Site-specific BAF selected if available.

Table 4-1

NOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for COPEC - PBOW, Sandusky, Ohio

(Page 1 of 2)

COPEC	Mammalian Data					Avian Data				
	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)
Organics										
1,3,5-Trinitrobenzene	--	2.68	rat	IRIS on-line (2001)	0.35	42 (LD_{50})	0.42	red-winged black bird	1,3-DNB as surrogate	0.077
1,3-Dinitrobenzene (1,3-DNB)	--	0.113	rat	Talmage et. al (1999)	0.35	42 (LD_{50})	0.42	red-winged black bird	Talmage et. al. (1999)	0.077
2,4-Dinitrotoluene (2,4-DNT)	--	0.2	beagle dog	IRIS on-line (2001)	11	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2,6-Dinitrotoluene	--	0.2	beagle dog	2,4-DNT as surrogate	11	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2,4,6-Trinitrotoluene (2,4,6-TNT)	--	1.6	rat	Talmage et. al (1999)	0.35	7	0.7	Bobwhite quail	USACHPPM (2000)	0.19
2-Nitrotoluene (2-NT)	--	45	rat	Dunnick et al., 1994 as summarized by Johnson (2000)	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
3-Nitrotoluene	--	45	rat	2-NT as surrogate	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
4-Nitrotoluene	--	45	rat	2-NT as surrogate	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2-Amino-4,6-dinitrotoluene	1394 (LD_{50})	13.9	rat	TOMES database	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
4-Amino-2,6-dinitrotoluene	959 (LD_{50})	9.59	rat	TOMES database	0.35	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
Aroclor-1260 (Aroclor-1254)	--	0.068	mouse	Sample, et al. (1996)	0.014	--	0.18	ring neck pheasant	Sample, et al. (1996)	1
Benzo(a)anthracene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Benzo(a)pyrene [B(a)P]	--	1.0	mouse	Sample, et al. (1996)	0.03	NA	NA	NA	NA	NA
Carbon disulfide	3,188 (LD_{50})	31.9	rat	Montgomery (1996)	0.35	NA	NA	NA	NA	NA
Chrysene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Di-n-butyl phthalate	--	550	mouse	Sample, et al. (1996)	0.03	--	0.11	ringed dove	Sample, et al. (1996)	0.155
Dinitrotoluene	--	0.2	beagle dog	2,4-DNT as surrogate	11	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate	0.19
Fluoranthene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Pyrene	--	1.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
RDX	--	7.0	mouse	Talmage et. al (1999)	0.03	NA	NA	NA	NA	NA
Tetryl	--	1.3	rat	Talmage et. al (1999)	0.35	NA	NA	NA	NA	NA

Table 4-1

NOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for COPEC - PBOW, Sandusky, Ohio

(Page 2 of 2)

COPEC	Mammalian Data					Avian Data				
	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)
Inorganics										
Aluminum	--	1.93	mouse	Sample, et al. (1996)	0.03	--	110	ringed dove	Sample, et al. (1996)	0.155
Barium	--	5.1	rat	Sample, et al. (1996)	0.435	--	20.8	chicks	Sample, et al. (1996)	0.121
Cadmium	--	1.0	rat	Sample, et al. (1996)	0.303	--	1.45	mallard duck	Sample, et al. (1996)	1.153
Calcium	--	1053	rabbit	(See Appendix)	3.8	--	2833	Japanese quail	(See Appendix)	0.072
Chromium	--	2737	rat	Sample, et al. (1996)	0.35	--	1.0	black duck	Sample, et al. (1996)	1.25
Copper	--	11.7	mink	Sample, et al. (1996)	1.0	--	47	chicks	Sample, et al. (1996)	0.534
Iron	--	26	rabbit	(See Appendix)	3.8	--	50	poultry	(See Appendix)	1.6
Lead	--	8.0	rat	Sample, et al. (1996)	0.35	--	3.85	Am. Kestrel	Sample, et al. (1996)	0.13
Magnesium	--	158	rabbit	(See Appendix)	3.8	--	150	poultry	(See Appendix)	1.6
Manganese	--	88	rat	Sample, et al. (1996)	0.35	--	977	Japanese quail	Sample, et al. (1996)	0.072
Mercury	--	1.0	mink	Sample, et al. (1996)	1.0	--	0.45	Japanese quail	Sample, et al. (1996)	0.15
Nickel	--	40	rat	Sample, et al. (1996)	0.35	--	77.4	mallard duck	Sample, et al. (1996)	0.782
Potassium	--	1,597	rabbit	(See Appendix)	3.8	--	1,000	poultry	(See Appendix)	1.6
Selenium	--	0.2	rat	Sample, et al. (1996)	0.35	--	0.5	mallard duck	Sample, et al. (1996)	1.0
Sodium	--	1,597	rabbit	(See Appendix)	3.8	--	1,000	poultry	(See Appendix)	1.6
Zinc	--	160	rat	Sample, et al. (1996)	0.35	--	14.5	hens	Sample, et al. (1996)	1.935

Notes:

NA indicates that the information is not available.
NOAELs for selected nutrients are based on mineral dietary requirements (Appendix H).

The following surrogate values were used:
Benzo(a)pyrene for benzo(a)anthracene, fluoranthene, chrysene, and pyrene.
2,4,6-TNT for 2-Amino-4,6-dinitrotoluene, 4-Amino-2,6-dinitrotoluene, 2-4-DNT, 2,6-DNT, 2-NT, 3-NT, 4-NT, and DNT, unless otherwise noted..

LD50 values are from RTECS (1998) as summarized in the TOMES CPC™ System Data Base (1/1/99) or from Montgomery (1996).
LD50 values were converted to chronic NOAELs by dividing by a factor of 100 and subchronic LOAELs were converted to chronic NOAELs by dividing by a factor of 20, as recommended by Wentsel, et. al. (1996), Tri-Service Procedural Guidelines for Ecological Risk Assessments.
For Nutrients, NOAELs were set at maximum tolerated dose levels (see Appendix H).

Red-wing blackbird body weight assumed to be equal to American robin.
2,4,6-TNT RTV values from USACHPPM, 2000.

Table 4-2

LOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for COPEC - PBOW, Sandusky, Ohio

(Page 1 of 2)

COPEC	Mammalian Data					Avian Data				
	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)
Organics										
1,3,5-Trinitrobenzene	--	13.31	rat	IRIS on-line (2001)	0.35	42 (LD_{50})	2.10	red-winged black bird	1,3-DNB as surrogate	0.077
1,3-Dinitrobenzene (1,3-DNB)	--	1.130	rat	Talmage et. al (1999)	0.35	42 (LD_{50})	2.10	red-winged black bird	Talmage et. al. (1999)	0.077
2,4-Dinitrotoluene (2,4-DNT)	--	1.5	beagle dog	IRIS on-line (2001)	11	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2,6-Dinitrotoluene	--	1.5	beagle dog	2,4-DNT as surrogate	11	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2,4,6-Trinitrotoluene (2,4,6-TNT)	1.6 (NOAEL)	8.0	rat	Talmage et. al (1999)	0.35	178	17.8	Bobwhite quail	USACHPPM (2000)	0.19
2-Nitrotoluene (2-NT)	--	87	rat	Dunnick et al., 1994 as summarized by Johnson (2000)	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
3-Nitrotoluene	--	87	rat	2-NT as surrogate	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
4-Nitrotoluene	--	87	rat	2-NT as surrogate	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
2-Amino-4,6-dinitrotoluene	1394 (LD_{50})	69.5	rat	TOMES database	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
4-Amino-2,6-dinitrotoluene	959 (LD_{50})	48.0	rat	TOMES database	0.35	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
Aroclor-1260 (Aroclor-1254)	--	0.680	mouse	Sample, et al. (1996)	0.014	--	1.80	ring neck pheasant	Sample, et al. (1996)	1
Benzo(a)anthracene	--	10.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Benzo(a)pyrene [B(a)P]	--	10.0	mouse	Sample, et al. (1996)	0.03	NA	NA	NA	NA	NA
Carbon disulfide	3,188 (LD_{50})	159.4	rat	Montgomery (1996)	0.35	NA	NA	NA	NA	NA
Chrysene	--	10.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Di-n-butyl phthalate	--	1833	mouse	Sample, et al. (1996)	0.03	--	1.10	ringed dove	Sample, et al. (1996)	0.155
Dinitrotoluene	--	1.5	beagle dog	2,4-DNT as surrogate	11	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate	0.19
Fluoranthene	--	10.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
Pyrene	--	10.0	mouse	B(a)P as surrogate	0.03	NA	NA	NA	NA	NA
RDX	7 (NOAEL)	35.0	mouse	Talmage et. al (1999)	0.03	NA	NA	NA	NA	NA
Tetryl	1.3 (NOAEL)	6.5	rat	Talmage et. al (1999)	0.35	NA	NA	NA	NA	NA
Inorganics										
Aluminum	--	19.30	mouse	Sample, et al. (1996)	0.03	--	1100	ringed dove	Sample, et al. (1996)	0.155
Barium	--	19.8	rat	Sample, et al. (1996)	0.35	--	41.7	chicks	Sample, et al. (1996)	0.121
Cadmium	--	10.0	rat	Sample, et al. (1996)	0.303	--	20.00	mallard duck	Sample, et al. (1996)	1.153

Table 4-2

LOAEL Reference Toxicity Values Used to Derive Wildlife Toxicity Benchmarks for COPEC - PBOW, Sandusky, Ohio

(Page 2 of 2)

COPEC	Mammalian Data					Avian Data				
	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference	Body Wt. (kg)
Calcium	--	5265	rabbit	(See Appendix)	3.8	--	14165	Japanese quail	(See Appendix)	0.072
Chromium	2737 (NOAEL)	13690	rat	Sample, et al. (1996)	0.35	--	5.0	black duck	Sample, et al. (1996)	1.25
Copper	--	15.1	mink	Sample, et al. (1996)	1.0	--	62	chicks	Sample, et al. (1996)	0.534
Iron	--	130	rabbit	(See Appendix)	3.8	--	250	poultry	(See Appendix)	1.6
Lead	--	80.0	rat	Sample, et al. (1996)	0.35	--	38.50	Am. Kestrel	Sample, et al. (1996)	0.13
Magnesium	--	790	rabbit	(See Appendix)	3.8	--	750	poultry	(See Appendix)	1.6
Manganese	--	284	rat	Sample, et al. (1996)	0.35	--	9770	Japanese quail	Sample, et al. (1996)	0.072
Mercury	1.0 (NOAEL)	5.0	mink	Sample, et al. (1996)	1.0	--	0.90	Japanese quail	Sample, et al. (1996)	0.15
Nickel	--	80	rat	Sample, et al. (1996)	0.35	--	107.0	mallard duck	Sample, et al. (1996)	0.782
Potassium	--	7,895	rabbit	(See Appendix)	3.8	--	5,000	poultry	(See Appendix)	1.6
Selenium	--	0.3	rat	Sample, et al. (1996)	0.35	--	1.0	mallard duck	Sample, et al. (1996)	1.0
Sodium	--	7,895	rabbit	(See Appendix)	3.8	--	5,000	poultry	(See Appendix)	1.6
Zinc	--	320	rat	Sample, et al. (1996)	0.35	--	131.0	hens	Sample, et al. (1996)	1.935

Notes:

NA indicates that the information is not available.
NOAELs for selected nutrients are based on mineral dietary requirements (Appendix H).

The following surrogate values were used:
Benzo(a)pyrene for benzo(a)anthracene, fluoranthene, chrysene, and pyrene.
2,4,6-TNT for 2-Amino-4,6-dinitrotoluene, 4-Amino-2,6-dinitrotoluene, 2,4-DNT, 2,6-DNT, 2-NT, 3-NT, 4-NT, and DNT, unless otherwise noted.

LD50 values are from RTECS (1998) as summarized in the TOMES CPC™ System Data Base (1/1/99) or from Montgomery (1996).
LD50 values were converted to chronic NOAELs by dividing by a factor of 100 and subchronic LOAELs were converted to chronic NOAELs by dividing by a factor of 20, and chronic NOAELs were converted to chronic LOAELs by multiplying by a factor of 5.0, as recommended by Wentsel, et. al. (1996), Tri-Service Procedural Guidelines for Ecological Risk Assessments.

For Nutrients, NOAELs were set at maximum tolerated dose levels (see Appendix H) and multiplied by an uncertainty factor of 5 to estimate LOAELs.

Red-wing blackbird body weight assumed to be equal to American robin.
2,4,6-TNT Avian RTV values from USACHPPM, 2000.

Table 4-3

Uncertainty Factors [a] for Ecological RTV [b] Extrapolations [c]
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Laboratory Animals (toxicity data base)		Selected Site Receptor Species	
Rat	G: Rattus F: Muridae O: Rodentia	Deer mouse	G: Peromyscus F: Cricetidae O: Rodentia
Mouse	G: Mus F: Muridae O: Rodentia	Eastern cottontail	G: Sylvilagus F: Leporidae O: Lagomorpha
Mink	G: Mustela F: Mustelidae O: Carnivora	Raccoon	G: Procyon F: Procyonidae O: Carnivora
Rabbit: (N. Zealand White)	G: Oryctolagus F: Leporidae O:Lagomorpha	Short-tailed shrew	G: Blarina F: Soricidae O: Insectivora
Ringed dove	G: Streptopelia F: Columbidae O: Columbiformes	White-tailed deer	G: Odocoileus F: Cervidae O: Artiodactyla
Ring-necked pheasant	G: Phasianus F: Phasianidae O: Galliformes	Mallard duck	G: Anas F: Anatidae O: Anseriformes
Beagle dog	G: Canis F: Canidae O: Carnivora	Marsh wren	G: Cistothorus F: Troglodytidae O: Passeriformes
Black duck	G: Anas F: Anatidae O: Anseriformes	Red-tailed hawk	G: Buteo F: Accipitridae O: Falconiformes
Red-wing blackbird	G: Agelaius F: Fringillidae O: Passeriformes		
Bobwhite quail	G: Colinus F: Phasianidae O: Galliformes		
Chick, Poultry	G: Gallus F: Phasianidae O: Galliformes		

Table 4-3

Uncertainty Factors [a] for Ecological RTV [b] Extrapolations [c]
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Laboratory Animals (toxicity data base)		Selected Site Receptor Species
Mallard duck	G: Anas F: Anatidae O: Anseriformes	
Japanese quail	G: Coturnix F: Phasianidae O: Galliformes	
American kestrel	G: Falco F: Falconidae O: Falconiformes	

[a] From ***Tri-Service Procedural Guidelines for Ecological Risk Assessment*** (Wentsel et al. 1996).
[b] RTV = Reference Toxicity Value.
[c] Interclass extrapolations not performed; only within bird class or within mammal class.

Extrapolation between two different species = uncertainty factor of 2.
Extrapolation between two different genera (G) = uncertainty factor of 4.
Extrapolation between two different families (F) or orders (O) = uncertainty factor of 8.
Thus, for all extrapolations used in the current Eco RA (except for the New Zealand White extrapolated to the cottontail, for the mallard duck to the mallard duck, and for the black duck to the mallard duck), an uncertainty factor of 8 was used. For the latter three, an uncertainty factor of 4 was used for extrapolating the New Zealand White to the cottontail, an uncertainty factor of 1 was used for the mallard duck, and an uncertainty factor of 2 was used for extrapolating the black duck to the mallard duck. It should be noted that the laboratory animals listed in this table are based on all COPECs selected for all exposure media, and it is possible some extrapolations are not needed due to some COPECs not being selected for a particular medium.

Table 5-1

Terrestrial Plant Impact Assessment
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Constituent	Source-Term Surface Soil Concentration[a] (mg/kg)	Benchmark Concentration for Plants (mg/kg)	Benchmark Exceeded?
Organics			
2-Amino-4,6-dinitrotoluene	38	80[b]	No
4-Amino-2,6-dinitrotoluene	6.34	80[b]	No
Aroclor-1260	4.71	40[c]	No
Benzo(a)anthracene	6.64	NA[d]	cnba[e]
Benzo(a)pyrene	6.33	NA	cnba
Chrysene	4.6	NA	cnba
1,3-Dinitrobenzene	0.751	NA	cnba
2,4-Dinitrotoluene	10.6	NA	cnba
2,6-Dinitrotoluene	6.95	NA	cnba
3-Nitrotoluene	1.71	NA	cnba
Tetryl	0.626	25[b]	No
1,3,5-Trinitrobenzene	7.93	NA	cnba
2,4,6-Trinitrotoluene	41,300	30[b]	Yes

Table 5-1

Terrestrial Plant Impact Assessment
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Constituent	Source-Term Surface Soil Concentration[a] (mg/kg)	Benchmark Concentration for Plants (mg/kg)	Benchmark Exceeded?
Inorganics			
Calcium	42,800	NA	cnba
Copper	43.4	100[c]	No
Lead	934	50[c]	Yes
Magnesium	7,100	NA	cnba
Manganese	1,370	500[c]	Yes
Mercury	0.198	0.3[c]	No
Sodium	236	NA	cnba
Zinc	321	50[c]	Yes

[a] 95 percent upper confidence limit concentrations presented for COPECs in Table 2-10.
[b] Talmage, et. al. (1999).
[c] Efroymson, et. al. (1997c).
[d] NA = not available.
[e] cnba = could not be assessed.

Table 5-2

Aquatic Biota Surface Water Impact Assessment
TNT Area C PBOW, Sandusky, Ohio

(Page 1 of 2)

Constituent	Source -Term Concentration (µg/L) [a]	NAWQ [b] (µg/L)	Tier II [c] (µg/L)	State of Ohio [d] (µg/L)	Other [e] (µg/L)	Benchmark Exceeded?
Organics						
2,4,6-Trinitrotoluene	0.344	NA	NA	NA	90 **	No
2-Amino-4,6-Dinitrotoluene	0.984	NA	NA	NA	20 **	No
2-Nitrotoluene	10.4	NA	NA	NA	NA	cnba
3-Nitrotoluene	1.47	NA	NA	NA	NA	cnba
4-Nitrotoluene	4.3	NA	NA	NA	NA	cnba
4-Amino-2,6-Dinitrotoluene	0.549	NA	NA	NA	20 **	No
Dinitrotoluene	7.92	NA	NA	NA	NA	cnba
Carbon disulfide	23.1	NA	8.89	NA	244 *	Yes (1/2)
Di-n-butyl phthalate	5.25	NA	32.7	NA	697 *	No
Inorganics						
Aluminum	3,220	87	NA	NA	1,900 *	Yes
Barium	82.7	NA	3.8	NA	5,800 *	Yes (1/2)
Cadmium (hardness dependent)	5.19	3.4	NA	7.3	0.15 *	Yes (2/3)
Calcium	193,000	NA	NA	NA	116,000 *	Yes
Copper (hardness dependent)	3.68	38	NA	30	0.23 *	Yes (1/3)
Iron	15,300	1,000	NA	NA	158 *	Yes
Lead (hardness dependent)	6.89	19	NA	37	12.3 *	No
Magnesium	41,200	NA	NA	NA	82,000 *	No
Manganese	3,010	1,500 #	80.3	NA	< 1,100 *	Yes

Table 5-2

Aquatic Biota Surface Water Impact Assessment
TNT Area C PBOW, Sandusky, Ohio

(Page 2 of 2)

Constituent	Source -Term Concentration (µg/L) [a]	NAWQ [b] (µg/L)	Tier II [c] (µg/L)	State of Ohio [d] (µg/L)	Other [e] (µg/L)	Benchmark Exceeded?
Potassium	2,550	NA	NA	NA	53,000 *	No
Selenium	3.11	35	NA	5.0	91.7 *	No
Sodium	4,860	15,000,000 #	NA	NA	680,000 *	No

[a] COPECs and UCL concentrations from Table 2-12.
[b] National Ambient Water Quality (NAWQ) criteria for chronic exposure (federal) from 40 CFR 131.36, Quality Criteria for Water (Red Book) (EPA, 1976), and EPA Health and Ecological Criteria Division recommendations (1997). Hardness of 400 mg/L assumed. Lowest effect concentration (LEC) values (that are not criteria) are indicated with "#."
[c] Values calculated using Great Lakes Water Quality Initiative Tier II methodology, as summarized in Eco Update (EPA, 1996b) and Suter and Mabrey (1994).
[d] Ohio Water Quality Criteria for the protection of aquatic life (Lake Erie Basin; Title 3745-1-33, assuming a hardness of 400 mg/L $CaCO_3$).
[e] Other references include the following:
- * indicates that the value is chronic LEC, or estimated lowest chronic value for daphnids and fish from Suter and Mabrey (1994).
- ** indicates that the value is a LOEC from Talmage, et. al. (1999).

Notes:
1) Water hardness measurements ranged from 372 to 592 mg/L at West Area Red Water Ponds and from 284 to 488 mg/L at Pentolite Road Red Water Ponds (IT, 1999). These values were assumed to be representative of TNT Area C.
2) NA = Not Available.
3) Hardness dependent criteria calculated for total water body concentration, not dissolved fraction, using average hardness of approximately 400 mg/L $CaCO_3$.
4) cnba = could not be assessed.

Table 5-3

Summary of Surface Water Field Parameters [(a)]
TNT Area C, PBOW, Sandusky, Ohio

Location Code	Eh (mV)	pH (su)	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)	Comments
SW-01	90	8.33	0.97	118	9.03	15.8	Flowing Water
SW-02	82	7.85	0.621	304	0.007	18.8	Stagnant Water
SW-03	24.4	7.77	0.257	2	0.10	16.9	Flowing Water
SW-04	7.3	8.08	0.913	332	0.09	16.4	Flowing Water
SW-05	33.1	7.52	0.097	63	0.04	15.9	----
SW-06	218.0	8.84	0.863	112	0.02	17.5	Stagnant Water
SW-07	N/A	7.23	1.17	0	0.03	14.6	----
SW-08	20.2	8.22	1.14	129	0.14	19.5	Flowing Water
SW-10	14.7	7.95	0.92	230	0.24	19.2	Flowing Water
SW-11	14.8	7.95	1.06	302	0.23	19.0	Flowing Water

[a]If sample location was dry, no field parameters were recorded and the location is not presented; data collected September 2000.

Notes:
- If more than one field reading was recorded, the average value of those readings is presented.
- Data are from the Field Collection Logs.
- N/A – Not Available.

Table 5-4

Aquatic Biota Sediment Impact Assessment
TNT Area C, PBOW, Sandusky, Ohio

(Page 1 of 2)

COPEC	Source-Term Concentration[a] (mg/kg)	NOAA ER-L[b] (mg/kg)	NOAA ER-M[c] (mg/kg)	FDEP TEL[d] (mg/kg)	FDEP PEL[e] (mg/kg)	OMOE Low[f] (mg/kg)	OMOE Severe[g] (mg/kg)	Talmage et. al. SQC[h] (mg/kg)	Benchmark Exceeded?
Organics									
1,3,5-Trinitrobenzene	0.832	NA[i]	NA	NA	NA	NA	NA	0.24	Yes
2,4,6-Trinitrotoluene	1,500	NA	NA	NA	NA	NA	NA	9.2	Yes
2,4-Dinitrotoluene	0.242	NA	NA	NA	NA	NA	NA	NA	cnba[j]
2,6-Dinitrotoluene	0.183	NA	NA	NA	NA	NA	NA	NA	cnba
2-Amino-4,6-dinitrotoluene	12.8	NA	NA	NA	NA	NA	NA	NA	cnba
4-Amino-2,6-dinitrotoluene	11.2	NA	NA	NA	NA	NA	NA	NA	cnba
RDX (Cyclonite)	0.521	NA	NA	NA	NA	NA	NA	1.3	No
Aroclor 1260	0.769	NA	NA	NA	NA	0.005	0.24	NA	Yes
Benzo(a)anthracene	0.095	0.261	1.6	0.075	0.693	0.32	1,480	NA	Yes (1/6)
Benzo(a)pyrene	0.07	0.43	1.6	0.089	0.763	0.37	1,440	NA	No
Chrysene	0.074	0.384	2.8	0.108	0.846	0.34	460	NA	No
Di-n-butyl phthalate	0.07	NA	NA	NA	NA	NA	NA	NA	cnba
Fluoranthene	0.147	0.6	5.1	0.113	1.49	0.75	1,020	NA	Yes (1/6)
Pyrene	0.11	0.665	2.6	0.153	1.398	0.49	850	NA	No

Table 5-4

Aquatic Biota Sediment Impact Assessment
TNT Area C, PBOW, Sandusky, Ohio

(Page 2 of 2)

COPEC	Source-Term Concentration[a] (mg/kg)	NOAA ER-L[b] (mg/kg)	NOAA ER-M[c] (mg/kg)	FDEP TEL[d] (mg/kg)	FDEP PEL[e] (mg/kg)	OMOE Low[f] (mg/kg)	OMOE Severe[g] (mg/kg)	Talmage et. al. SQC[h] (mg/kg)	Benchmark Exceeded?
Inorganics									
Aluminum	11,000	NA	NA	NA	NA	NA	NA	NA	cnba
Cadmium	0.725	1.2	9.6	0.68	4.21	0.6	10	NA	Yes (2/6)
Calcium	106,000	NA	NA	NA	NA	NA	NA	NA	cnba
Lead	48.8	46.7	218	30.2	112	31	250	NA	Yes (3/6)
Selenium	1.77	NA	NA	NA	NA	NA	NA	NA	cnba
Sodium	223	NA	NA	NA	NA	NA	NA	NA	cnba

[a] COPECs and 95% UCL concentrations are from Table 2-13.
[b] Effects Range - Low, developed by NOAA published by Long and Morgan (1990), updated by Long (1995, and summarized in Jones, et al. (1996). Should be used only if no freshwater benchmarks available (e.g., OMOE, 1993).
[c] Effects Range - Medium, developed by NOAA published by Long and Morgan (1990), updated by Long (1995), and summarized in Jones, et al. (1996). Should be used only if no freshwater benchmarks available (e.g., OMOE, 1993).
[d] Florida Department of Environmental Protection, threshold effects level, summarized in Jones, et al. (1996).
[e] Florida Department of Environmental Protection, probable effects level, summarized in Jones, et al. (1996).
[f] Ontario Ministry of the Environment (OMOE), Low = lowest effect level and is the 5th percentile of the screening level concentration.
[g] Ontario Ministry of the Environment (OMOE), Severe = severe effect level and is the 95th percentile of the screening level concentration.
[h] Talmage, et al. (1999), Sediment Quality Criteria/Screening Benchmarks.
[i] NA = Not available.
[j] cbna = could not be assessed.

Table 5-5

Terrestrial Receptors NOAEL-based Hazard Index (HI) Summary for TNT Area C[a]
Plum Brook Ordnance Works, Sandusky, Ohio

Media	Terrestrial Receptor						
	Deer Mouse	Cottontail	Shrew	Marsh Wren	Raccoon	Deer	Hawk
Soil [b] HI	31,557	36,408	5,620	25,075	26,138	3,080	73
Risk Drivers:	96% 2,4,6-TNT (plant intake) 4% Aroclor-1260 (invertebrate intake)	99.7% 2,4,6-TNT (plant intake)	73% 2,4,6-TNT (soil intake) 25% Aroclor-1260 (invertebrate intake)	90% 2,4,6-TNT (invertebrate intake) 7% Aroclor-1260 (invertebrate intake) 2% Lead (invertebrate intake)	95% 2,4,6-TNT (plant intake) 4% Aroclor-1260 (invertebrate intake)	99.6% 2,4,6-TNT (plant intake)	81% 2,4,6-TNT (soil intake) 19% Aroclor-1260 (shrew intake) (bird intake)
Surface Water HI	2.0	2.0	1.3	1.7	2.5	20	0.02
Risk Drivers:	82% Aluminum (water intake)	82% Aluminum (water intake)	82% Aluminum (water intake)	39% Iron (water intake)	81% Aluminum (water intake)	82% Aluminum (water intake)	39% Iron (water intake)
Total Receptor HI	31,559	36,410	5,621	25,077	26,141	3,100	73

[a] Details presented in eco risk assessment spreadsheets in Appendix (G).
[b] All receptors exposed to surface soil, except burrowing shrew exposed to surface and subsurface soil via ingestion of soil, and deer exposed to surface and subsurface soil via ingestion of plants (e.g., tree leaves) that have translocated COPECs via deep feeder roots.

Table 5-6

Terrestrial Receptors LOAEL-based Hazard Index (HI) Summary for TNT Area C[a]
Plum Brook Ordnance Works, Sandusky, Ohio

Media	Terrestrial Receptor						
	Deer Mouse	Cottontail	Shrew	Marsh Wren	Raccoon	Deer	Hawk
Soil [b] HI	6,190	7,274	977	1,150	5,110	612	4
Risk Drivers:	98% 2,4,6-TNT (plant intake) 2% Aroclor-1260 (invert. intake)	99.6% 2,4,6-TNT (plant intake)	84% 2,4,6-TNT (soil intake) 15% Aroclor-1260 (invert. intake)	77% 2,4,6-TNT (invert. intake) 14% Aroclor-1260 (invert. intake) 5% Lead (invert. intake)	98% 2,4,6-TNT (plant intake) 2% Aroclor-1260 (invert. intake)	99.7% 2,4,6-TNT (plant intake)	61% 2,4,6-TNT (soil intake) 36% Aroclor-1260 (shrew intake) (bird intake)
Surface Water HI	0.2	0.2	0.2	0.3	0.3	2	0.004
Risk Drivers:	68% Aluminum (water intake)	78% Aluminum (water intake)	68% Aluminum (water intake)	42% Iron (water intake)	68% Aluminum (water intake)	68% Aluminum (water intake)	42% Iron (water intake)
Total Receptor HI	6,190	7,274	977	1,150	5,110	614	4

[a] Details presented in ecological risk assessment spreadsheets in Appendix G.
[b] All receptors exposed to surface soil, except burrowing shrew exposed to surface and subsurface soil via ingestion of soil, and deer exposed to surface and subsurface soil via ingestion of plants (e.g., tree leaves) that have translocated COPECs via deep feeder roots.

Table 5-7

Aquatic NOAEL-based Hazard Index (HI) Summary for TNT Area C[a]
Plum Brook Ordnance Works, Sandusky, Ohio

Media	Aquatic Receptor	
	Mallard Duck	**Raccoon**
Sediment HI	2,350	1,130
Risk Drivers:	95% 2,4,6-TNT (invertebrate intake)	75% 2,4,6-TNT (invertebrate intake)
	2% 2-Amino-4,6-DNT (invertebrate intake)	11% Selenium (invertebrate intake)
	2% 4-Amino-2,6-DNT (invertebrate intake)	7% Aluminum (sediment intake)
		6% Aroclor-1260 (invertebrate intake)
Surface Water HI	0.07	0.5
Risk Drivers:	39% Iron (water intake)	82% Aluminum (water intake)
Total Receptor HI	2,350	1,130

[a] Details presented in ecological risk assessment spreadsheets (Appendix G).

Table 5-8

Aquatic LOAEL-based Hazard Index (HI) Summary for TNT Area C[a]
Plum Brook Ordnance Works, Sandusky, Ohio

Media	Aquatic Receptor	
	Mallard Duck	**Raccoon**
Sediment HI	97	265
Risk Drivers:	90% 2,4,6-TNT (invertebrate intake)	64% 2,4,6-TNT (invertebrate intake)
	3% Selenium (invertebrate intake)	30% Selenium (invertebrate intake)
		3% Aluminum (sediment intake)
		3% Aroclor-1260 (invertebrate intake)
Surface Water HI	0.01	0.06
Risk Drivers:	43% Iron (water intake)	68% Aluminum (water intake)
Total Receptor HI	97	265

[a] Details presented in ecological risk assessment spreadsheets (Appendix G).

Table 5-9

Uncertainty Analysis
TNT C Area
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Component	Bias	Magnitude	Ways to Minimize Uncertainty
Use of 95% UCL as source-term concentration	Overestimates Risk	Medium	Use central tendency
Assumption that soil depth interval of 0-2 ft is representative of surface soil	Overestimates Risk	Low to Medium	Resample to obtain additional samples 0-1 ft. for surface soil characterization
Assumption that MDC for some COPECs in surface water or sediment is representative	Overestimates Risk	Medium	Collect additional surface water or sediment samples
Use of representative receptor species for site ecological community	Underestimates Risk	Low	Select additional receptor species
Use of average intake values and average body weights	Underestimates Risk	Low	Measure site-specific intake values and species' body weights
Use of conservative foraging factors (i.e., 100%) for some species	Overestimates Risk	Medium	Use more site-specific foraging factors, i.e., less than 100%
Assumption that all COPECs are 100% bioavailable	Overestimates Risk	Medium to High	Obtain medium- and COPEC-specific bioavailability factors
Discounting of dermal and inhalation exposure routes	Underestimates Risk	Low	Include dermal and inhalation routes of exposure
Use of partitioning and transfer factors to estimate some COPEC concentrations in plants, invertebrates, other prey items, and sediment pore water	Overestimates Risk	Medium to High	Measure COPEC concentrations in site plants, invertebrates, other prey species, and/or sediment pore water
Inclusion of sample outliers in estimation of exposure point concentration for risk drivers	Overestimates Risk	Medium to High	Isolate sample data for "hot spot" analysis and estimate hazards separately for "hot spot" vs. "non-hot spot"
Assumption that soil F_{oc} = 1%; assumption that sediment F_{oc} = 6.7% (i.e., similar to West Area Red Water Pond)	Overestimates or Underestimates Risk	Unknown	Measure site-specific soil and sediment F_{oc}

Table 5-9

Uncertainty Analysis
TNT C Area
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Component	Bias	Magnitude	Ways to Minimize Uncertainty
Use of K_{ow} to estimate aquatic BCFs for some organic COPECs	Overestimates Risk	Medium to High	Use alternative BCF estimation method (e.g., Bintein and Devillers, 1993)
Assumption that sediment-pore-water-to-benthic-macro-invertebrate BCFs, are linear	Overestimates Risk	Medium to High	Measure concentrations in site benthic macroinvertebrates, or perform literature search for alternative BCF values
Use of Eq. 2.2 to estimate lognormal UCL exposure point concentration for risk drivers	Overestimates Risk	Medium to High	Use alternative UCL statistic such as Boot Strap (Singh et al., 1997)
Use of safety factors to convert LOAEL and LD_{50} toxicity data to NOAELs	Overestimates Risk	Medium	Obtain COPEC-specific NOAEL data
Use of safety factors to convert subchronic LOAEL and LD_{50} toxicity data to LOAELs	Overestimates Risk	Medium	Obtain COPEC-specific LOAEL data
Use of uncertainty factor of 8 to extrapolate RTVs between most species within the same class	Overestimates Risk	Medium	1) Assume RTVs similar for all species in the same genus, family, or order; or 2) obtain species-specific toxicity data
Assumption that body weight scaling factor = 0 for all bird species' toxicity data	Overestimates or Underestimates Risk	Low	Obtain species-specific NOAEL toxicity data
Use of surrogate constituents to estimate toxicity for those COPECs without available toxicity data	Overestimates or Underestimates Risk	Low to Medium	Obtain COPEC-specific toxicity data
Use of hazard quotient method to estimate risks to populations or communities may be biased	Overestimates Risk	High	Perform population or community studies

FIGURES

Figure 2-1

Photo No. 1 - Field vegetative community habitat typical at TNT Area A (9/13/00).

Photo No. 2 - Open forest vegetative community habitat typical at TNT Area A (5/21/01).

Figure 2-2

Photo No. 3 - Forest with understory vegetative community habitat typical at TNT Area A (9/13/00).

Photo No. 4 - Cattails along Maintenance Road, TNT Area A (5/21/001).

Figure 2-3

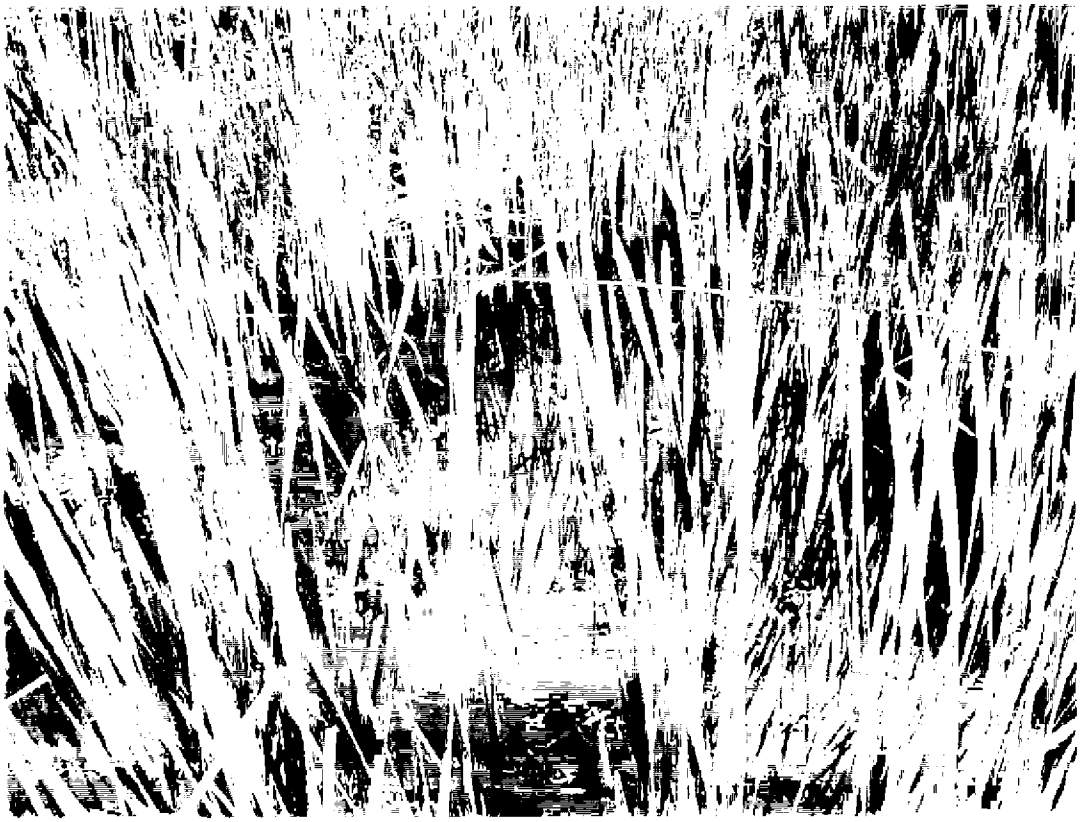
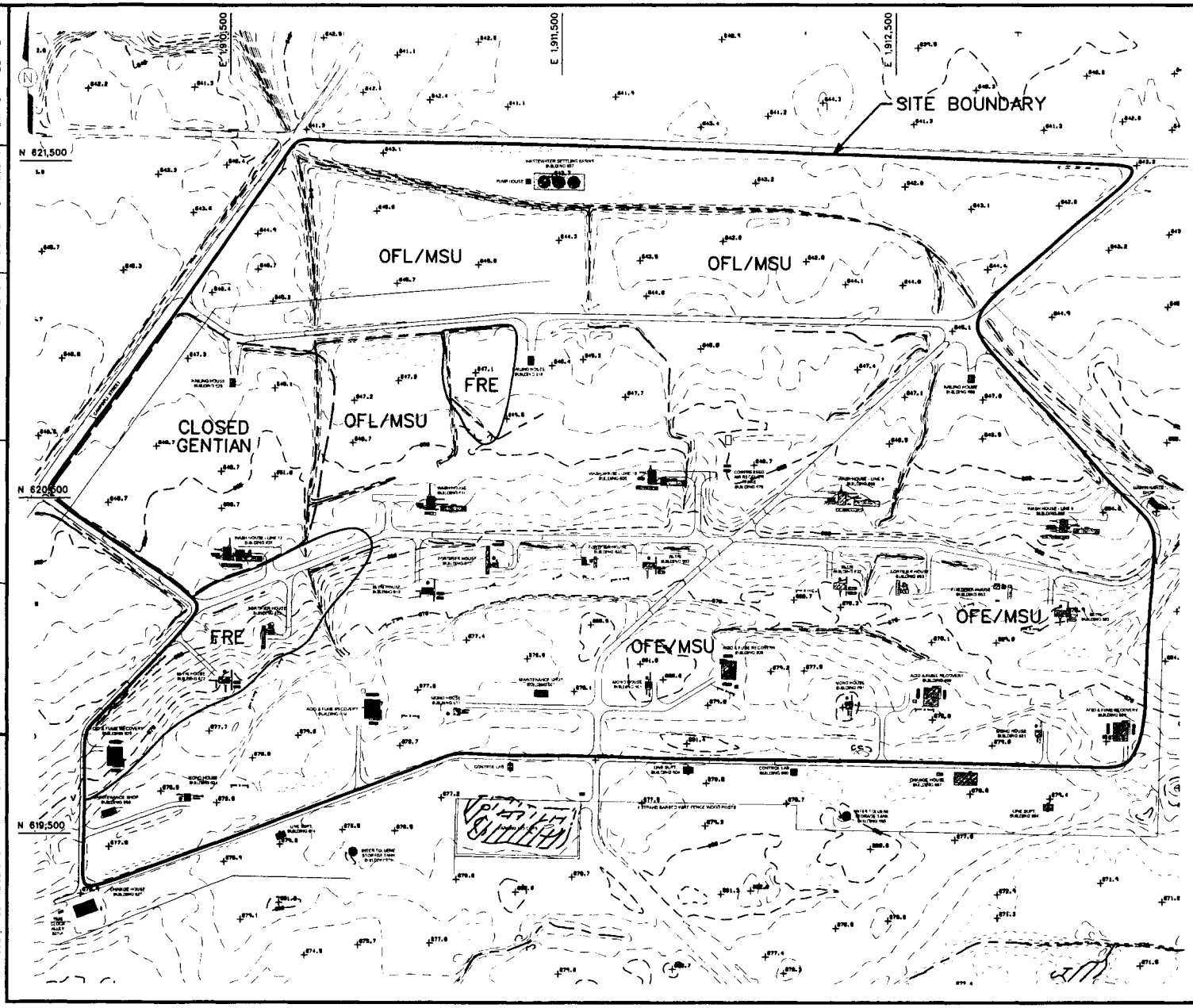


Photo No. 5 - Cattails in unnamed stream near Bldg. 128, TNT Area A (5/21/01).

Photo No. 6 - TNT hot spot near Bldg. 112, TNT Area A; bare soil from trenching/backfilling (5/21/01).

Photo No. 7 - TNT hot spot at Bldg. 146, TNT Area A; bare soil from trenching/backfill (5/21/01).

Photo No. 8 - Close up of TNT hot spot at Bldg. 146, TNT Area A (5/21/01).



LEGEND:

- TANK
- DRAINAGE
- PONDS
- LOCATION OF FORMER PROCESS BUILDING
- VEGETATIVE COMMUNITY
- LIMITS OF RARE, THREATENED, OR ENDANGERED SPECIES POPULATION
- OFL LATE OLD FIELD
- OFE EARLY OLD FIELD
- MSU MODERATE SHRUB THICKET
- FRE EARLY FOREST

NOTE:

LIMITED WETLAND PLANTS OCCUR ALONG SOME DRAINAGE DITCHES, BUT POPULATIONS CONSIDERED TOO SMALL TO BE CHARACTERIZED AS A VEGETATIVE COMMUNITY.

SCALE

0 300 600 FEET

FIGURE 2-5
VEGETATIVE COMMUNITIES
TNT AREA C

FORMER PLAN BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

IT CORPORATION
A Member of The IT Group

STARTING DATE 06/01/01 | DATE LAST REV | DRAFT CHCK BY C TUMLIN | INITIAT GR M WEISBERG | DWG NO 807112es.045
DRAWN BY B VANDERGRIFF | DRAWN BY | ENGR CHCK BY M WEISBERG | PROJ MGR SPANGERBERG | PROJ NO 807112
06/04/01 10:43:20
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Figure 2-6

Simplified Terrestrial Food Web Conceptual Site Model (CSM)
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

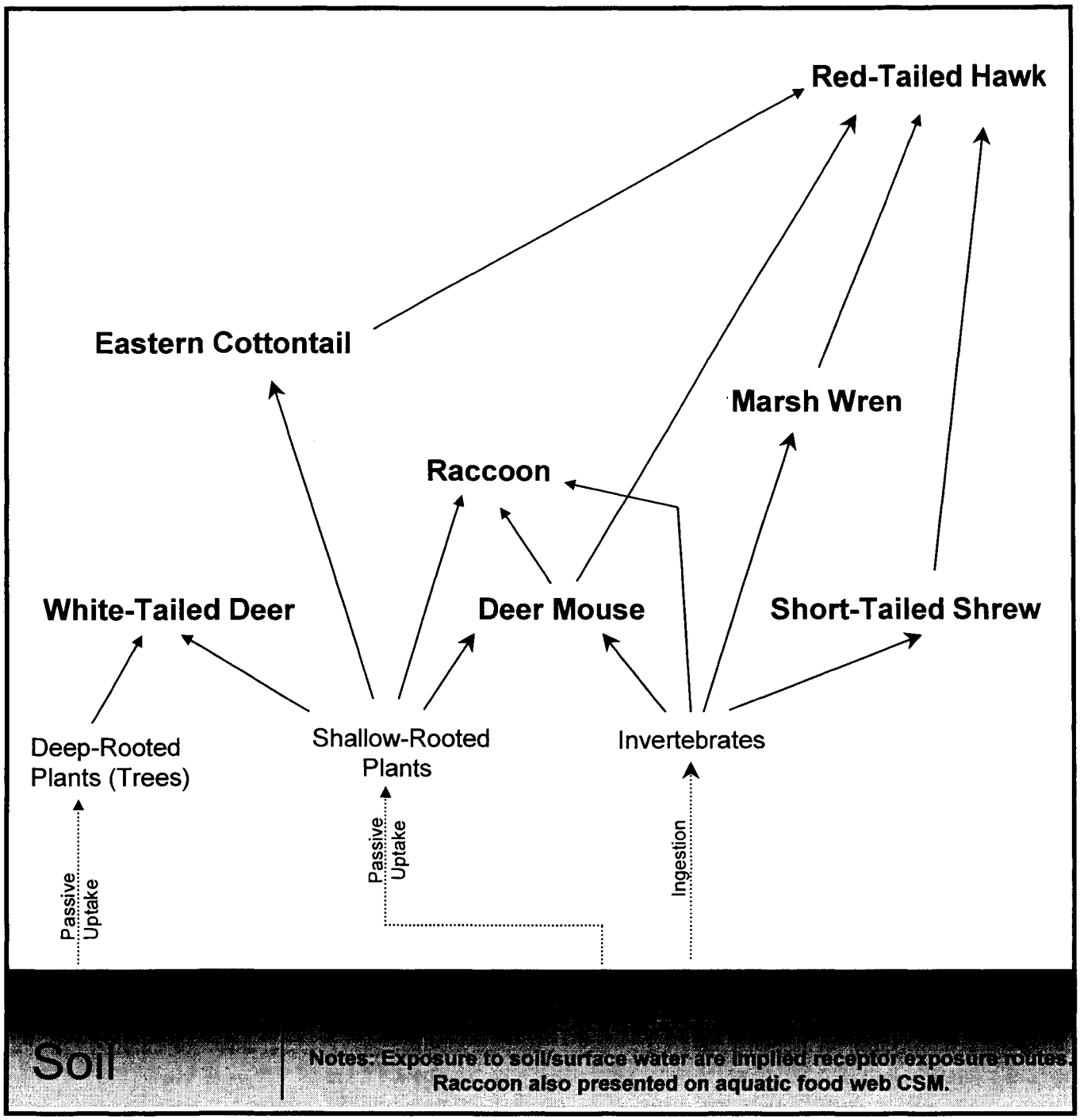
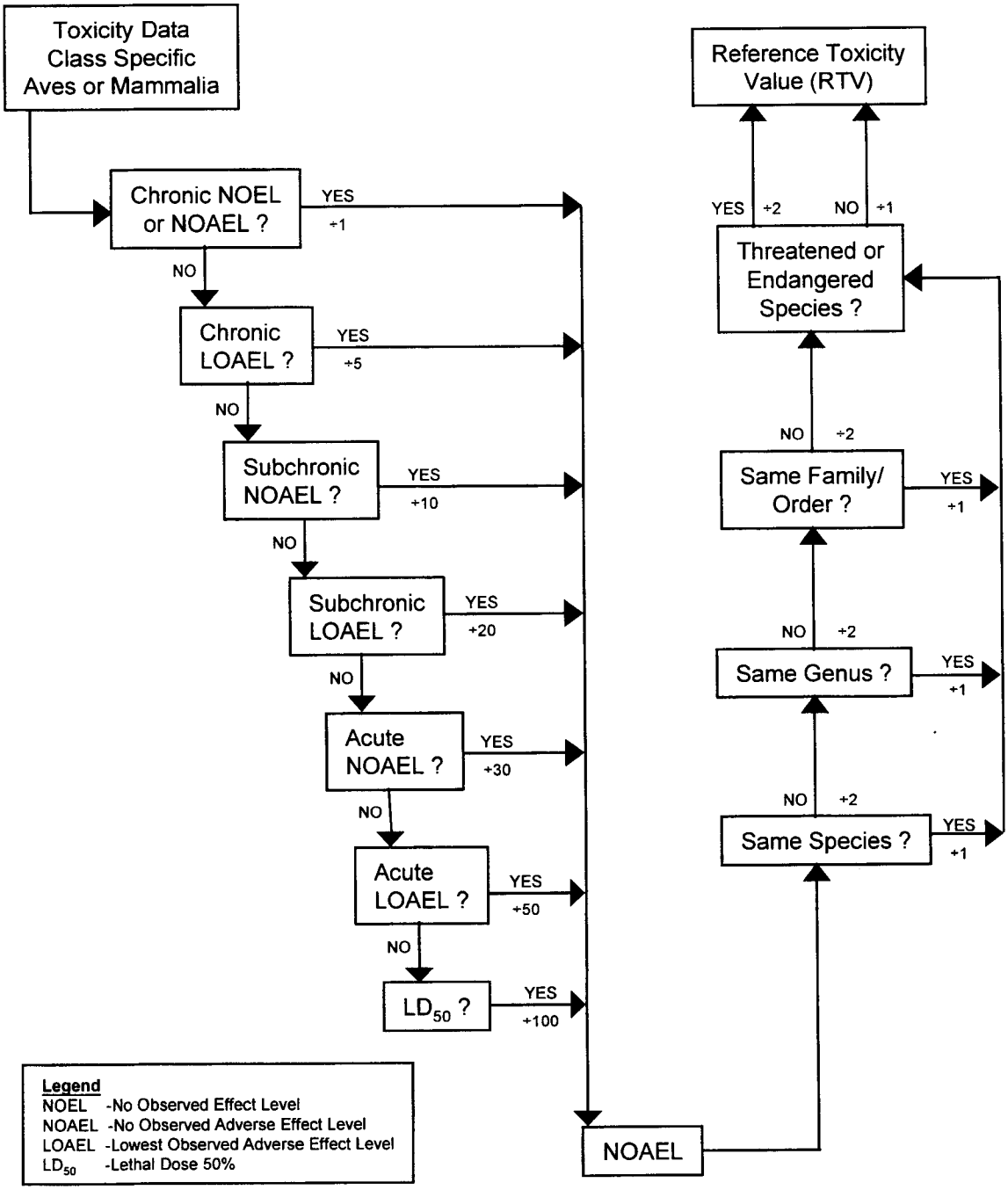


Figure 4-1

Procedural Flow Chart for Deriving Reference Toxicity Values (RTV) from Class-Specific Toxicity Data Plum Brook Ordnance Works, Sandusky, Ohio



Credit: Adapted from Ford et al. (1992) in *Tri-Service Procedural Guidelines for Ecological Risk Assessments*, 1996

APPENDIX A

VASCULAR PLANT SPECIES OBSERVED ON SITE

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Acer negundo	box-elder maple	Frequent		Stream banks, ditches, and moist woods	1, 2
*Acer platanoides	Norway maple	Occasional		Disturbed woods	1
Acer rubrum	red maple	Common		Dry to moist woods	1, 2
Acer saccharum	Sugar maple	Occasional		Dry to moist woods	2
*Achillea millefolium	Yarrow	Frequent		Dry fields, roadsides, and about buildings	1, 2
Agalinis purpurea	purple false-foxglove	Frequent		Moist openings and ditches	1
Agrimonia parviflora	southern agrimony	Frequent		Moist fields and ditches	1, 2
*Agropyron repens	Quack grass	Occasional		Old fields and roadsides	2
Agrostis hyemalis	Ticklegrass	Occasional		Dry, grassy fields and shaley openings	1
*Agrostis gigantea	Redtop	Common		Moist fields, ditches, and roadsides	1, 2
Agrostis perennans	autumn bent-grass	Frequent		Dry woods and borders on shale	1
Ailanthus altissima	Tree of heaven	Occasional		Woods	2
Alisma subcordatum	water-plantain	Occasional		Ponds and ditches	1
*Alliaria petiolata	garlic mustard	Frequent		Dry to moist wood lots	1, 2
Ambrosia artemisiifolia	common ragweed	Frequent, occasional 2		Dry fields and roadsides	1, 2
Ambrosia trifida	giant ragweed	Occasional		Dry fields and roadsides	1
Andropogon gerardii	big bluestem	Frequent, occasional 2		Dry to moist fields and roadsides	1, 2
*Andropogon virginicus	broom-sedge	Occasional, frequent 2		Dry fields and roadsides	1, 2
Anemone virginianum	Thimble weed	Occasional		Fields	2
Antennaria parlinii	pussy-toes	Occasional		Dry fields and openings, especially on shale	1

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Anthoxanthum odoratum	vernal-grass	Occasional		Dry fields and openings, especially on shale	1
Apocynum cannabinum	Dogbane	Frequent		Dry to moist fields and roadsides	1
*Arabidopsis thaliana	mouse-ear cress	Occasional		Road berms and about buildings	1
Arabis glabra	Tower mustard	Occasional		Roadsides and waste places	2
*Arctium minus	Burdock	Occasional		Disturbed fields and about buildings	1
Arenaria lateriflora	grove sandwort	Rare	T	Woods along Ransom Brook north of reactor	1
Aristida dichotoma	Churchmouse grass	Occasional		Dry fields and openings	1
Aristida longespica	slimspike triple-awned grass	Common		Dry fields and openings	1
Aristida oligantha	prairie triple-awned grass	Occasional		Dry openings and roadsides	1
*Artemisia ludoviciana var. gnaphaloides	white sage	Occasional		Grassy roadsides	1
Asclepias hirtella	prairie milkweed	Common		Dry to moist openings	1
Asclepias sullivantii	Sullivant's milkweed	Rare		Moist field along Patrol Road south of Scheid Road	1
Asclepias syriaca	common milkweed	Frequent		Dry to moist fields and roadsides	1, 2
Asclepias tuberosa	butterfly-weed	Occasional		Dry openings and roadsides	1
Asplenium platyneuron	Ebony spleenwort	rare		Woods	2
Aster ericoides	white heath aster	Rare, frequent 2		Grassy strip along Patrol Road southeast of Taft Road, fields and thickets	1, 2
Aster laevis	smooth aster	Rare		White oak grove on Taft Road	1
Aster lateriflorus	calico aster	Common, frequent 2		Moist woods and thickets	1, 2
Aster novae-angliae	New England aster	Occasional		Dry fields and roadsides	1, 2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Aster pilosus	common white aster	Common		Dry fields, roadsides, and about buildings	1
Aster umbellatus	flat-top aster	Frequent		Dry to moist fields and roadsides	1
Baptisia lactea	prairie false indigo	Occasional	P	Dry openings in bunker area	1
Baptisia tinctoria	yellow false indigo	Occasional		Dry openings in bunker area	1
*Berberis thunbergii	Japanese barberry	Occasional		Woodland borders	1
Bidens coronata	northern tickseed-sunflower	Common		Moist fields and ditches	1
Bidens frondosa	Beggar ticks	rare		Ditches	2
Boehmeria cylindrica	false nettle	Occasional		Ponds and ditches	1, 2
*Brassica nigra	black mustard	Occasional		Roadsides	1
*Bromus inermis	smooth brome	Frequent		Dry to moist fields and roadsides	1
*Bromus tectorum	downy chess	Occasional		Dry openings and roadsides on shale	1
Cacalia atriplicifolia	pale Indian-plantain	Occasional		Dry fields and roadsides	1
Calamagrostis canadensis	blue-joint	Occasional		Moist fields and ditches	1
Callitriche heterophylla	water-starwort	Occasional		Pond margins and seasonally-moist depressions	1
*Campsis radicans	trumpet-vine	Occasional		Disturbed openings and roadsides	1
*Capsella bursa-pastoris	shepherd's-purse	Occasional		Roadsides and about buildings	1
*Cardamine hirsuta	bitter-cress	Occasional		Roadsides and about buildings	1
*Carduus nutans	musk-thistle	Occasional		Dry fields and roadsides	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Carex alata	broad-winged sedge	Rare	P	Grassy field along Patrol Road south of Scheid Road, also in grassy strip between Patrol Road and artificial pond southeast of Taft Road	1
Carex amphibola	NA	Occasional		Thickets and woods borders	1, 2
Carex annectens var. annectens	NA	Occasional		Moist, grassy fields	1
Carex annectens var. xanthocarpa	yellow-fruited sedge	Occasional		Moist, grassy fields	1
Carex blanda	NA	Frequent		Moist woods	1
Carex cephaloidea	thin-leaf sedge	Rare	E	Woods border along Pentolite Road west of reactor	1
Carex complanata var. hirsutella	NA	Frequent		Dry fields and woods borders	1
Carex conoidea	field sedge	Rare	T	Grassy depression along Taft Road south of North Magazine Road	1
Carex cristatella	NA	Occasional		Moist fields and ditches	1
Carex davisii	NA	Occasional		Woods and borders	2
Carex festucacea	fescue sedge	Occasional		Moist, grassy fields	1
Carex gracillima	NA	Occasional		Moist woods	1
Carex granularis	meadow sedge	Common		Moist, grassy fields and ditches	1
Carex hirtifolia	NA	Rare		Disturbed oak woods along angling road	1
Carex hystericina	Bottlebrush sedge	Rare, occasional -2		Moist depression along Taft Road; ditches-2	1, 2
Carex muhlenbergii	NA	Rare		Moist areas	2
Carex normalis	NA	Occasional		Woods and borders	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Acer negundo	box-elder maple	Frequent		Stream banks, ditches, and moist woods	1, 2
*Acer platanoides	Norway maple	Occasional		Disturbed woods	1
Acer rubrum	red maple	Common		Dry to moist woods	1, 2
Acer saccharum	Sugar maple	Occasional		Dry to moist woods	2
*Achillea millefolium	Yarrow	Frequent		Dry fields, roadsides, and about buildings	1, 2
Agalinis purpurea	purple false-foxglove	Frequent		Moist openings and ditches	1
Agrimonia parviflora	southern agrimony	Frequent		Moist fields and ditches	1, 2
*Agropyron repens	Quack grass	Occasional		Old fields and roadsides	2
Agrostis hyemalis	Ticklegrass	Occasional		Dry, grassy fields and shaley openings	1
*Agrostis gigantea	Redtop	Common		Moist fields, ditches, and roadsides	1, 2
Agrostis perennans	autumn bent-grass	Frequent		Dry woods and borders on shale	1
Ailanthus altissima	Tree of heaven	Occasional		Woods	2
Alisma subcordatum	water-plantain	Occasional		Ponds and ditches	1
*Alliaria petiolata	garlic mustard	Frequent		Dry to moist wood lots	1, 2
Ambrosia artemisiifolia	common ragweed	Frequent, occasional 2		Dry fields and roadsides	1, 2
Ambrosia trifida	giant ragweed	Occasional		Dry fields and roadsides	1
Andropogon gerardii	big bluestem	Frequent, occasional 2		Dry to moist fields and roadsides	1, 2
*Andropogon virginicus	broom-sedge	Occasional, frequent 2		Dry fields and roadsides	1, 2
Anemone virginianum	Thimble weed	Occasional		Fields	2
Antennaria parlinii	pussy-toes	Occasional		Dry fields and openings, especially on shale	1

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Anthoxanthum odoratum	vernal-grass	Occasional		Dry fields and openings, especially on shale	1
Apocynum cannabinum	Dogbane	Frequent		Dry to moist fields and roadsides	1
*Arabidopsis thaliana	mouse-ear cress	Occasional		Road berms and about buildings	1
Arabis glabra	Tower mustard	Occasional		Roadsides and waste places	2
*Arctium minus	Burdock	Occasional		Disturbed fields and about buildings	1
Arenaria lateriflora	grove sandwort	Rare	T	Woods along Ransom Brook north of reactor	1
Aristida dichotoma	Churchmouse grass	Occasional		Dry fields and openings	1
Aristida longespica	slimspike triple-awned grass	Common		Dry fields and openings	1
Aristida oligantha	prairie triple-awned grass	Occasional		Dry openings and roadsides	1
*Artemisia ludoviciana var. gnaphaloides	white sage	Occasional		Grassy roadsides	1
Asclepias hirtella	prairie milkweed	Common		Dry to moist openings	1
Asclepias sullivantii	Sullivant's milkweed	Rare		Moist field along Patrol Road south of Scheid Road	1
Asclepias syriaca	common milkweed	Frequent		Dry to moist fields and roadsides	1, 2
Asclepias tuberosa	butterfly-weed	Occasional		Dry openings and roadsides	1
Asplenium platyneuron	Ebony spleenwort	rare		Woods	2
Aster ericoides	white heath aster	Rare, frequent 2		Grassy strip along Patrol Road southeast of Taft Road, fields and thickets	1, 2
Aster laevis	smooth aster	Rare		White oak grove on Taft Road	1
Aster lateriflorus	calico aster	Common, frequent 2		Moist woods and thickets	1, 2
Aster novae-angliae	New England aster	Occasional		Dry fields and roadsides	1, 2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Aster pilosus	common white aster	Common		Dry fields, roadsides, and about buildings	1
Aster umbellatus	flat-top aster	Frequent		Dry to moist fields and roadsides	1
Baptisia lactea	prairie false indigo	Occasional	P	Dry openings in bunker area	1
Baptisia tinctoria	yellow false indigo	Occasional		Dry openings in bunker area	1
*Berberis thunbergii	Japanese barberry	Occasional		Woodland borders	1
Bidens coronata	northern tickseed-sunflower	Common		Moist fields and ditches	1
Bidens frondosa	Beggar ticks	rare		Ditches	2
Boehmeria cylindrica	false nettle	Occasional		Ponds and ditches	1, 2
*Brassica nigra	black mustard	Occasional		Roadsides	1
*Bromus inermis	smooth brome	Frequent		Dry to moist fields and roadsides	1
*Bromus tectorum	downy chess	Occasional		Dry openings and roadsides on shale	1
Cacalia atriplicifolia	pale Indian-plantain	Occasional		Dry fields and roadsides	1
Calamagrostis canadensis	blue-joint	Occasional		Moist fields and ditches	1
Callitriche heterophylla	water-starwort	Occasional		Pond margins and seasonally-moist depressions	1
*Campsis radicans	trumpet-vine	Occasional		Disturbed openings and roadsides	1
*Capsella bursa-pastoris	shepherd's-purse	Occasional		Roadsides and about buildings	1
*Cardamine hirsuta	bitter-cress	Occasional		Roadsides and about buildings	1
*Carduus nutans	musk-thistle	Occasional		Dry fields and roadsides	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Carex alata	broad-winged sedge	Rare	P	Grassy field along Patrol Road south of Scheid Road, also in grassy strip between Patrol Road and artificial pond southeast of Taft Road	1
Carex amphibola	NA	Occasional		Thickets and woods borders	1, 2
Carex annectens var. annectens	NA	Occasional		Moist, grassy fields	1
Carex annectens var. xanthocarpa	yellow-fruited sedge	Occasional		Moist, grassy fields	1
Carex blanda	NA	Frequent		Moist woods	1
Carex cephaloidea	thin-leaf sedge	Rare	E	Woods border along Pentolite Road west of reactor	1
Carex complanata var. hirsutella	NA	Frequent		Dry fields and woods borders	1
Carex conoidea	field sedge	Rare	T	Grassy depression along Taft Road south of North Magazine Road	1
Carex cristatella	NA	Occasional		Moist fields and ditches	1
Carex davisii	NA	Occasional		Woods and borders	2
Carex festucacea	fescue sedge	Occasional		Moist, grassy fields	1
Carex gracillima	NA	Occasional		Moist woods	1
Carex granularis	meadow sedge	Common		Moist, grassy fields and ditches	1
Carex hirtifolia	NA	Rare		Disturbed oak woods along angling road	1
Carex hystericina	Bottlebrush sedge	Rare, occasional -2		Moist depression along Taft Road; ditches-2	1, 2
Carex muhlenbergii	NA	Rare		Moist areas	2
Carex normalis	NA	Occasional		Woods and borders	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Carex pensylvanica	Pennsylvania sedge	Common		Dry woods	1, 2
Carex rosea	NA	Frequent		Dry to moist woods	1
Carex scoparia	NA	Frequent		Moist, grassy fields	1
Carex stipata	NA	Frequent		Moist fields and ditches	1
Carex stricta	tussock sedge	Occasional		Moist fields and ditches	1
Carex swanii	Swan's sedge	Occasional		Dry, grassy fields	1
Carex tribuloides	NA	Occasional		Moist, grassy fields and ditches	1
Carex umbellata	NA	Occasional		Well-drained, grassy fields on sandy soil	1
Carex vulpinoidea	fox sedge	Common		Moist fields, ditches, and about ponds	1
Carya ovata	shagbark hickory	Rare		Sandy soil along fence at far southeast boundary	1
Celtis occidentalis	Hackberry	Occasional		dry to moist woods and borders	1, 2
Cephalanthus occidentalis	Buttonbush	Occasional		Moist depressions and ditches	1
Cerastium arvense	field chickweed	Rare		White oak grove along Taft Road	1
*Cerastium fontanum	mouse-ear chickweed	Frequent		Road berms and about buildings	1
*Cerastium semidecandrum	NA	Occasional		Road berms and about buildings	1
*Chaenorrhinum minus	dwarf snapdragon	Occasional		Road berms and about buildings	1
Chamaecrista fasciculata	partridge-pea	Occasional		Dry openings on shale	1
*Chrysanthemum leucanthemum	ox-eye daisy	Occasional		Dry to moist fields and roadsides	1, 2
*Cichorium intybus	Chicory	Occasional		Roadsides	1, 2
Cinna arundinacea	Wood reed grass	Occasional		Moist woods	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Cirsium arvense	Canada thistle	Common		Disturbed fields and roadsides	1, 2
Cirsium discolor	prairie thistle	Frequent, occasional 2		Grassy fields and roadsides	1, 2
*Cirsium vulgare	bull thistle	Frequent		Disturbed fields and roadsides	1
Clinopodium vulgaris	wild basil	Occasional		Dry roadsides and openings	1
*Confolvulus arvensis	field bindweed	Occasional		Disturbed fields and roadsides	1
*Convallaria majalis	lily-of-the-valley	Rare		Grassy field along Columbus Avenue	1
Conyza canadensis	Horseweed	Frequent		Dry fields and roadsides	1
Cornus amomum	swamp dogwood	Frequent, occasional 2		Moist fields and thickets	1, 2
Cornus drummondii	rough-leaved dogwood	Frequent		Moist borders, thickets, and roadsides	1, 2
Cornus florida	flowering dogwood	Occasional		Woodland borders and roadsides	1
Cornus racemosa	gray dogwood	Frequent		Dry fields and roadsides	1, 2
*Coronilla varia	crown-vetch	Occasional		Grassy fields and roadsides	1
Crataegus mollis	downy hawthorn	Frequent		Thickets and woodland borders	1, 2
Crataegus punctata	dotted hawthorn	Frequent		Thickets and woodland borders	1
Cryptotaenia canadensis	honewort	Occasional		Dry to moist woods	1
Cuscuta gronovii	dodder	Frequent		Moist fields and ditches	1
Cyperus bipartitus (rivularis)	Umbrella sedge	Occasional		Moist fields and disturbed areas	2
*Cyperus esculentus	yellow nutgrass	Occasional		Moist, disturbed openings	1, 2
Cyperus flavescens	Umbrella sedge	Occasional		Moist fields and disturbed areas	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Cyperus strigosus	umbrella-sedge	Frequent		Moist openings, ponds, and ditches	1, 2
*Dactylis glomerata	orchard-grass	Occasional		Dry to moist fields and roadsides	1, 2
Danthonia spicata	poverty-grass	Occasional		Dry openings over shale	1
Datura stramonium	jimson-weed	Occasional		Disturbed openings and roadsides	1
*Daucus carota	wild carrot	Frequent, occasional 2		Dry fields and roadsides	1, 2
*Dianthus armeria	Deptford pink	Occasional, rare 2		Dry openings and roadsides on shale	1, 2
Diodia teres	buttonweed	Occasional		Dry openings over shale	1
*Dipsacus fullonum	common teasel	Frequent		Dry, disturbed openings and roadsides	1, 2
*Draba verna	early whitlow-wort	Occasional		Dry roadsides and about buildings	1
Dryopteris carthusiana	spinulose woodfern	Frequent		Moist woods and shaded borders	1
*Eleagnus umbellata	autumn-olive	Occasional		Roadsides and woodland borders	1, 2
Eleocharis acicularis	needle spikerush	Frequent		Margins of artificial pond	1
Eleocharis erythropoda	red-footed spikerush	Occasional		Moist openings and ditches	1
Eleocharis obtusa	NA	Common		Moist openings and ditches	1
Eleocharis smallii	Small's spikerush	Frequent		Margins of artificial pond	1
Eleocharis tenuis	NA	Frequent		Moist openings and ditches	1
*Elytrigia repens	quack-grass	Frequent		Dry fields and roadsides	1
Equisetum arvense	horsetail	Frequent		Moist openings, roadsides, and ditches	1, 2
Equisetum hyemale	scouring-rush	Occasional		Moist roadsides and ditches	1, 2
Eragrostis frankii	NA	Occasional		Moist openings and ditches	1

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Eragrostis spectabilis	showy lovegrass	Occasional		Dry to moist fields	1
Erechtites hieracifolia	Pilewort	Common		Disturbed woods, borders, and roadsides	1
Erigeron philadelphicus	Philadelphia fleabane	Frequent		Roadsides and borders	1
Erigeron strigosus	smooth fleabane	Occasional		Dry openings and roadsides	1, 2
Eupatorium perfoliatum	Boneset	Occasional, frequent 2		Moist fields, ponds, and ditches	1, 2
Eupatorium purpureum	purple joe-pye-weed	Occasional		Borders of moist woods	1
Eupatorium rugosum	White snake root	Common		Woods and fields	2
Euphorbia corollata	Flowering spurge	Occasional		Dry fields	1
Euphorbia maculata	Prostrate spurge	Occasional		Dry openings, road berms, and about buildings	1
Euphorbia natans	spurge	Occasional		Disturbed areas; roadsides	2
Euthamia graminifolia	grass-leaved goldenrod	Common		Dry to moist fields and roadsides	1, 2
*Festuca elatior	tall fescue	Occasional		Roadsides and grassy fields	1
*Festuca obtusa	Fescue	Frequent		Old fields	2
Fragaria virginiana	wild strawberry	Frequent, common		Dry to moist fields and roadsides	1, 2
Fraxinus americana	white ash	Frequent		Dry to moist woods and borders	1
Fraxinus pensylvanica	green ash	Frequent, common 2		Moist woods and stream banks	1, 2
Galine aparine	Cleavers	Occasional		Moist woods and borders	1
Galium circaezans	wild licorice	Rare		Dry woods along angling road, woods	1, 2
Galium tinctorium	Southern bedstraw	Rare		Moist depression along Taft Road	1
Galium triflorum	Bedstraw	Occasional		Woods	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Gentiana clausa	Closed gentian	Occasional	P	Fields	2
Gerardia tenuifolia	Slender gerardia	frequent		Fields	2
Geum vernum	spring avens	Occasional		Moist woods and borders	1
Geum virginianum	white avens	Occasional		Woods borders and roadsides	1, 2
*Glechoma hederacea	ground-ivy	Frequent		Moist openings, roadsides, and about buildings	1, 2
Gleditsia triacanthos	honey-locust	Occasional		Dry to moist woods and borders	1, 2
Glyceria striata	manna-grass	Occasional		Moist woods	1, 2
Gnaphalium obtusifolium	Cudweed	Frequent		Dry openings on shale, disturbed areas	1, 2
Gratiola virginiana	round-fruited hedge-hyssop	Rare	P	ca 20 plants; moist, shaded ground by pond west of Snake Road	1
Hackelia virginiana	Virginia stickseed	Occasional		Successional woods/thickets	2
Hedyotis caerula	Bluets	Occasional		Dry openings and roadsides on shale	1
Helenium autumnale	Sneezeweed	Occasional		Woods	2
Helenium flexuosum	Southern sneezeweed	Occasional		Moist, open ground and ditches	1
Helianthus mollis	ashy sunflower	Rare	T	ca 200 plants in grassy field south and southwest of junction of Fox and Patrol Roads; the exact number of individuals in this population is uncertain since excessive browsing by deer has reduced the plants to leafy tufts.	1
Helianthus tuberosus	Jerusalem atrichoke	Occasional		Fields and roadsides	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Hibiscus moscheutos	rose-mallow	Rare		Moist swale along Ransom Road	1
*Hieracium piloselloides	king-devil	Occasional		Dry openings on shale, roadsides	1, 2
Hypericum gentianoides	orange-grass	Frequent		Dry openings	1
Hypericum gymnanthum	least St. John's-wort	Rare	E	ca 50 plants; moist, open ground along Patrol Road south of Fox Road	1
Hypericum majus	tall St. John's-wort	Rare	P	Moist, shaded ground by pond west of Snake Road	1
Hypericum mutilum	little St. John's-wort	Frequent		Moist openings, ponds, and ditches	1
*Hypericum perforatum	dotted St. John's-wort	Frequent		Disturbed fields and roadsides	1, 2
Hypericum punctatum	St. John's wort	Rare		Fields	2
Hypoxis hirsuta	yellow-eyed-grass	Occasional		Grassy fields	1
*Inula helenium	Elecampane	Rare		Moist roadside along Taft Road	1
Ipomoea pandurata	wild sweet-potato	Occasional		Dry openings over shale	1
Iris versicolor	Northern blue flag	Occasional		Moist woods and ditches	1
Isanthus brachiatus	false pennyroyal	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Juglans nigra	black walnut	Rare		A few young trees at edge of grassy field southwest of junction of Fox and Patrol Roads, woods (2b)	1
Juncus acuminatus	NA	Common		Moist openings and ditches	1
Juncus biflorus	NA	Occasional		Moist openings and ditches	1
Juncus brachycarpus	NA	Occasional		Moist openings	1

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Juncus canadensis	Canada rush	Frequent		Moist openings	1
Juncus dudleyi	Dudley's rush	Frequent		Moist openings	1
Juncus effusus	Common rush	Frequent		Moist openings, ponds, and ditches	1
Juncus marginatus	NA	Occasional		Moist openings	1
Juncus tenuis	path rush	Frequent		Dry openings, road berms, and about buildings	1
Juncus torreyi	Torrey's rush	Occasional		Moist fields	2
Juniperus virginiana	Red cedar	Rare		Shrubby fields	2
*Lamium purpureum	dead-nettle	Frequent		Disturbed fields, roadsides, and about buildings	1
Leersia oryzoides	rice cutgrass	Occasional		Moist fields and ditches	1, 2
Leersia virginica	White grass	Occasional		Moist woods	2
Lemna minor	little duckweed	Occasional		Ponds and standing water	1
*Lepidium campestre	field-cress	Occasional		Roadsides and about buildings	1
Lepidium virginicum	poor man's pepper	Frequent		Roadsides, disturbed openings, and about buildings	1
Lespedeza capitata	bush-clover	Occasional		Dry fields	1
Leucospora multifida	NA	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Liatris scariosa var. novae-angliae	northern blazing-star	Rare		Dry ground along Patrol Road at Olemacher Ditch	1
Liatris spicata	spiked blazing-star	Occasional		Moist openings	1
*Linaria vulgaris	butter-and-eggs	Occasional		Roadsides and about buildings	1

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Lindernia dubia	false pimpernel	Occasional		Moist openings, ditches, and pond margins	1
Linum medium	wild flax	Frequent		Dry to moist openings	1
Linum virginianum	Virginia flax	Rare		About pond in northern bunker area	1
Lobelia inflata	Indian tobacco	Occasional		Fields and borders	2
Lobelia siphilitica	Great lobelia	Frequent		Fields and woods	2
Lonicera japonica	Japanese honeysuckle	Occasional		Fields and woods	2
*Lonicera maackii	Amur honeysuckle	Rare		Roadsides and thickets along Columbus Avenue near Scheid Ditch	1
*Lonicera morrowii	Asiatic honeysuckle	Frequent		Thickets, borders, and roadsides	1
*Lonicera tatarica	Tatarian honeysuckle	Frequent		Thickets, borders, and roadsides	1
*Lotus corniculatus	bird's-foot trefoil	Occasional		Grassy fields and road berms	1
Ludwigia alternifolia	rattlebox	Occasional		Ponds and ditches	1
Ludwigia palustris	water-purslane	Frequent		Ponds and ditches	1
Ludwigia polycarpa	NA	Rare		Moist, shaded ground by pond on Snake Road	1
Lycopus americanus	American water-horehound	Frequent, occasional 2		Ponds and ditches	1, 2
Lycopus uniflorus	northern water-horehound	Frequent		Moist woods and shaded borders	1
Lysimachia terrestris	swamp loosestrife	Occasional		Moist openings	1
Lythrum alatum	prairie loosestrife	Occasional		Moist openings	1
Maclura pomifera	osage-orange	Occasional		Disturbed woods and borders	1, 2
*Matricaria matricarioides	pineapple-weed	Occasional		Roadsides and about buildings	1

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Medicago lupulina	Black medic	Occasional		Old fields and disturbed areas	2
*Melilotus alba	white sweet-clover	Occasional		Disturbed fields and roadsides	1
*Melilotus officinalis	yellow sweet-clover	Occasional, frequent 2		Disturbed fields and roadsides	1, 2
Mimulus ringens	monkey-flower	Occasional		Moist openings and ditches	1
Monarda fistulosa	bergamont	Occasional		Grassy fields	1
Muhlenbergia frondosa	muhly grass	Frequent		Moist fields and ditches	1, 2
Mollugo verticillata	Indian chickweed	Occasional		Fields and waste places	2
Najas flexilis	northern naiad	Occasional		Artificial ponds	1
*Najas minor	Eurasian naiad	Frequent		Artificial ponds	1
*Nepeta cataria	catnip	Occasional		Roadsides and weedy openings	1
Nyssa sylvatica	blackgum	Occasional		Thickets and woods borders	1
Oenothera biennis	evening-primrose	Frequent		Dry fields, roadsides, and about buildings	1, 2
Oenothera tetragona	northern sundrops	Frequent		Moist, grassy fields	1
Onoclea sensibilis	Sensitive fern	frequent		Wet areas	2
Osmorhiza claytoni	Sweet cicely	Occasional		Successional woods	2
Osmunda cinnamomea	cinnamon fern	Rare		Depressions in moist woods along angling road	1
Osmunda regalis	royal fern	Occasional		Depressions in moist woods	1
*Oxalis europea	Sorrel	Common		Old fields and disturbed areas	2
Oxalis violacea	purple wood-sorrel	Occasional		Drier oak woods and borders on shale	1
Panicum dichotomiflorum	Panic grass	Occasional		Old fields	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Panicum flexile	wiry witch-grass	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Panicum lanuginosum	hairy panic-grass	Frequent		Dry, grassy fields and roadsides	1, 2
Panicum oligosanthes	sand panic-grass	Occasional		Dry, grassy fields	1
Panicum rigidulum	stiff panic-grass	Frequent		Moist openings and ditches	1
Panicum virgatum	switch-grass	Occasional		Dry fields	1
Parietaria pensylvanica	pellitory	Occasional		Dry, disturbed wood lots and borders	1
Paronychia fastigata	forked chickweed	Occasional		Dry woods and borders on shale	1
Parthenocissus quinquefolia	Virginia-creeper	Occasional, frequent 2		Dry to moist woods borders and thickets	1, 2
Parthenocissus vitacea	grape-woodbine	Rare		Dry opening north of Center Magazine Road	1
*Pastinaca sativa	wild parsnip	Occasional		Roadsides	1
Penstemon digitalis	tall white beard-tongue	Frequent		Grassy fields and roadsides	1, 2
Phalaris arundinacea	reed canary-grass	Common, occasional 2		Moist fields and ditches	1, 2
*Phleum pratense	timothy	Frequent		Disturbed fields and roadsides	1, 2
Phragmites australis	reed-grass	Occasional		Moist openings and ditches	1
Phryma leptostachya	lopseed	Rare		Edge of woods along Scheid Ditch near Columbus Avenue	1
Phytolacca americana	pokeberry	Occasional		Moist woods and borders, disturbed areas	1, 2
Pilea pumila	Canada clearweed	Occasional		Moist woods	2
*Plantago lanceolata	English plantain	Frequent, occasional 2		Disturbed openings and about buildings	1, 2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Plantago major	broad-leaved plantain	Frequent, occasional 2		Road berms and about buildings (1) disturbed areas and old fields (2)	1, 2
Platanthera lacera	ragged fringe-orchid	Rare		Ditch along south Patrol Road	1
Platanus occidentalis	sycamore	Occasional		Moist woods and stream banks	1
*Poa annua	early bluegrass	Common		Road berms and about buildings	1
*Poa compressa	Canada bluegrass	Frequent		Dry openings, especially on shale, and roadsides	1
*Poa pratensis	Bluegrass	Frequent		Old fields	2
Podophyllum peltatum	may-apple	Occasional		Dry to moist woods	1
Polygala sanguinea	blood milkwort	Frequent		Moist openings	1
Polygala verticillata	whorled milkwort	Occasional		Moist openings	1
*Polygonum caespitosum	NA	Rare		Moist, shaded ground in bunker area	1
*Polygonum hydropiper	water-pepper	Occasional		Margins of ponds	1
Polygonum hydropiperoides	false water-pepper	Occasional		Wet ditches and pond margins	1
Polygonum sagittatum	arrow-leaved tearthumb	Occasional		Moist thickets and ditches	1
Polygonum scandens	climbing false buckwheat	Occasional		Thickets and roadsides	1
Polygonum virginianum	Virginia knotweed	Common		Moist to dry woods	2
Populus deltoides	cottonwood	Frequent, common 2		Moist woods, borders, and stream banks	1, 2
Potamogeton diversifolius	snailseed pondweed	Frequent		Artificial ponds	1
Potamogeton foliosus	leafy pondweed	Occasional		Artificial ponds	1
Potamogeton nodosus	longleaf pondweed	Occasional		Artificial ponds	1

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Potentilla simplex	cinquefoil	Frequent		Dry openings and roadsides on shale	1, 2
Prunella vulgaris	self-heal	Occasional, frequent 2		Roadsides and about buildings	1, 2
Prunus americana	wild plum	Occasional		Thickets and roadsides	1
Prunus serotina	wild black cherry	Frequent Common 2		Dry to moist woods and borders	1, 2
Pteridium aquilinum	Bracken fern	Occasional		Fields	2
Pycnanthemum tenuifolium	narrow-leaved mountain-mint	Frequent		Moist openings, especially on shale	1
Pycnanthemum virginianum	Virginia mountain-mint	Occasional		Moist openings and ditches	1
Pyrus coronaria	crab-apple	Frequent		Thickets and borders	1
Quercus alba	white oak	Occasional		Dry woods and sandy ridges; a small grove on Taft Road has an unusually pure stand of this species	1
Quercus bicolor	swamp white oak	Frequent		Moist woodlands	1
Quercus imbricaria	shingle oak	Frequent, occasional 2		Moist to dry woodlands	1, 2
Quercus macrocarpa	bur oak	Rare		ca 5 trees on sandy ridge in bunker area south of North Magazine Road; a few trees in area 2a	1
Quercus palustris	pin oak	Common, occasional 2		Moist woods	1, 2
Quercus rubra	Red oak	Occasional		Dry woods	2
Ranunculus recurvatus	Hooked crowfoot	Occasional		Successional woods, thickets	2
Ratibida pinnata	green-headed coneflower	Occasional		Roadsides and dry fields	1

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Rhexia virginica	Virginia meadow-beauty	Occasional	P	Moist openings and pond margins, south of North Magazine Road and along the angling road	1
Rhus glabra	Smooth sumac	Occasional		Old fields and disturbed areas	2
Rosa carolina	pasture rose	Occasional		Dry fields	1
*Rosa multiflora	multiflora rose	Occasional, rare 2		Disturbed openings, borders, and thickets	1, 2
Rosa setigera	prairie rose	Rare		Grassy roadside and thickets along Patrol Road at Olemacher Ditch, old fields	1, 2
Rotala ramosior	toothcup	Occasional		Moist openings and about ponds	1
Rubus allegheniensis	blackberry	common		Woods, fields, and borders	2
Rubus flagellaris	dewberry	Frequent, common 2		Dry openings and roadsides on shale	1, 2
Rubus occidentalis	Black raspberry	common		Dry woods, and borders	2
Rudbeckia hirta	black-eyed susan	Frequent		Dry fields and roadsides	1
*Rumex acetosella	red sorrel	Occasional		Dry openings over shale	1
*Rumex crispus	curly dock	Occasional		Roadsides and about buildings	1, 2
Sagittaria latifolia	broad-leaved arrowhead	Occasional		Ponds and ditches	1
Salix amygdaloides	peachleaf willow	Occasional		Ditches and about ponds	1
Salix discolor	pussy willow	Occasional		Moist openings, ponds, and ditches	1
Salix exigua	sandbar willow	Frequent		Moist openings, stream banks, and ditches	1, 2
Salix nigra	black willow	Common		Moist woods, stream banks, and ditches	1, 2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Sambucus canadensis	elder-berry	Frequent		Moist openings, stream banks, and ditches	1
*Saponaria officinalis	soapwort	Frequent		Dry fields, roadsides, and about buildings	1
Sassafras albidum	sassafras	Occasional		Dry woods and borders	1, 2
Satureja vulgaris	Wild basil	Occasional		Fields	2
Schizachyrium scoparium	little bluestem	Frequent		Dry fields and roadsides	1
Scirpus acutus	hardstem bulrush	Rare		Moist depression west of Taft Road	1
Scirpus atrovirens	dark green bulrush	Common, occasional 2		Moist openings, roadsides, and ditches	1, 2
Scirpus cyperinus	woolgrass	Occasional		About artificial ponds	1
Scirpus fluviatilis	river bulrush	Rare		Moist depression west of Taft Road	1
Scirpus pendulus	NA	Occasional		Moist openings	1
Scirpus validus	softstem bulrush	Occasional		Moist openings, ponds, and ditches	1
Scleria triglomerata	tall nut-rush	Rare	P	Moist swale in northern bunker area	1
Scutellaria lateriflora	mad-dog skullcap	Occasional		Moist depressions and ditches	1
Senecio aureus	golden ragwort	Occasional		Moist woods borders	1
*Setaria faberi	nodding foxtail-grass	Occasional, common 2		Grassy roadsides in the bunker area	1, 2
*Setaria viridis	green foxtail-grass	Frequent, common 2		Dry roadsides and about buildings	1, 2
Silphium terebinthinaceum	prairie-dock	Rare		Dry openings at crossing of Patrol Road and Olemacher Ditch	1
Sisyrinchium albidum	prairie blue-eyed-grass	Frequent, occasional 2		Grassy fields	1, 2
Sisyrinchium angustifolium	common blue-eyed-grass	Frequent, occasional 2		Grassy fields	1, 2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
*Solanum caroliniense	horse-nettle	Occasional, common 2		Dry openings and roadsides	1, 2
*Solanum dulcamara	Bittersweet-nightshade	Occasional		Roadsides, ditches, thickets, and about buildings	1
Solidago bicolor	White goldenrod	Occasional		Woods	2
Solidago canadensis	Canada goldenrod	Common		Grassy fields	1, 2
Solidago juncea	early goldenrod	Frequent		Dry to moist fields and roadsides	1
Solidago nemoralis	gray goldenrod	Common		Dry fields and roadsides	1
Solidago riddellii	Riddell's goldenrod	Frequent		Fields and disturbed areas; ditch banks	1, 2
Sparganium eurycarpum	giant bur-reed	Rare		Wet ditch along Ransom Road	1
Spartina pectinata	prairie cord-grass	Frequent		Moist depressions, fields, and ditches	1
Spiranthes ochroleuca	creamy ladies'-tresses	Occasional, rare 2		Ditches and moist openings	1, 2
Sporobolus asper	tall dropseed	Rare		A single stand in dry opening along angling road	1
Sporobolus neglectus	NA	Frequent		Dry openings and road berms	1
Stellaria longifolia	long-leaved stitchwort	Occasional		Moist, grassy fields	1
*Stellaria media	chickweed	Common		Road berms and about buildings	1
Symphoricarpos orbiculatus	coralberry	Occasional		Thickets, woods borders, and roadsides	1
Symplocarpus foetidus	Skunk cabbage	Rare		Moist woods	2
*Taraxacum officinalis	dandelion	Frequent, occasional 2		Roadsides and about buildings	1, 2
Teucrium canadense	American germander	Occasional		Moist openings	1
Thalictrum sp.	Meadow rue	rare		Shrubby field	2

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Thelypteris palustris	marsh fern	Occasional, frequent 2		Moist depressions and roadsides	1, 2
Toxicodendron radicans	Poison ivy	Frequent		Upland and facultative woods, old fields	2
Triadenum virgnianum	pink St. John's-wort	Rare		Moist swale in northern bunker area	1
Tridens flavus	purpletop	Occasional		Moist fields and roadsides	1, 2
*Trifolium pratense	red clover	Occasional		Grassy fields and roadsides	1
*Trifolium repens	common white clover	Common		Grassy roadsides and about buildings	1
Typha latifolia	broad-leaved cat-tail	Frequent		Moist openings, ponds, and ditches	1, 2
Ulmus americana	American elm	Occasional		Moist woods and stream banks	1, 2
Ulmus rubra	slippery elm	Occasional		Moist woods and stream banks	1
Urtica dioica var. procera	American stinging nettle	Occasional, common 2		Moist fields and openings	1, 2
*Verbascum blattaria	moth-mullein	Occasional, rare 2		Disturbed fields and roadsides	1, 2
*Verbascum thapsus	common mullein	Frequent, occasional 2		Disturbed fields	1, 2
Verbena hastata	purple vervain	Frequent		Moist fields, stream banks, and ditches	1
Verbena simplex	prairie vervain	Rare		A single stand in dry opening along angling road	1
Verbena urticifolia	white vervain	Occasional, frequent 2		Moist woods borders and roadsides	1, 2
Verbesina alternifolia	wingstem	Frequent, occasional 2		Moist woods borders, stream banks, and ditches	1, 2
Vernonia gigantea	tall ironweed	Occasional		Dry to moist fields	1
*Veronica officinalis	common speedwell	Occasional		Dry openings on shale	1
*Veronica serpyllifolia	thyme-leaved speedwell	Occasional		Roadsides and about buildings	1

See footnotes at end of table.

Appendix A Table

Vascular Plant Species Observed On Site
Plum Brook Ordnance Works
Oxford and Perkins Townships, Ohio
TNT Area C

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Viburnum lentago	nannyberry	Frequent		Moist thickets and borders	1
Viola lanceolata	lance-leaved violet	Frequent	P	Ditches and moist openings	1
Viola sagittata	arrow-leaved violet	Frequent		Grassy fields and dry banks	1
Viola sororia	common blue violet	Common		Grassy fields, roadsides, and about buildings	1
Vitis riparia	riverbank grape	Frequent		Woods borders, thickets, and stream banks	1, 2
Vitis vulpina	fox grape	Occasional		Woods borders and thickets	1
Zanichellia palustris	horned pondweed	Rare		Artificial pond west of Snake Road	1

[a] Common = Species which occur in large numbers throughout.
Frequent = Species regularly encountered, but occurring in lesser numbers than common ones.
Occasional = Species found in several places, but never present in large numbers.
Rare = Species found in few places and in low numbers.
[b] T = Ohio Threatened Species.
P = Ohio Potentially Threatened Species.
E = Ohio Endangered Species.
[c] 1 = Biological Inventory of Plum Brook Station (Ohio Department of Natural Resources, 1994).
2 = IT site reconnaissance September 11 and 12, 2000 and May 21, 2001.
* Non-native species.

See footnotes at end of table.

APPENDIX B

LETTER FROM BOTANICAL EXPERT

From: Crandall Todd [tcrandall@davey.com]
Sent: Monday, October 01, 2001 6:26 AM
To: 'mweisberg@TheITGroup.com'
Subject: Plum Brook

I finally have a definite identification on that sedge from the Michigan expert. It is Carex pellita, which is found throughout the state. It is not rare, and is not on any state or federal list.

APPENDIX C

COMPILATION OF RISK-BASED SCREENING ECOTOXICITY VALUES

Table C-1

Soil Screening Concentrations
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 1 of 2)

Chemical	Ecological PRGs[a] (mg/kg)	Tox. Benchmark for COPECs for Effects on Soil, Litter Inv., and Microbes[b] (earthworm/microbial) (mg/kg)	Tox. Benchmarks for COPECs Terrestrial Plants. (mg/kg)	USEPA Region V EDQL[d] (mg/kg)	Screening Value[e] (mg/kg)
Inorganics					
Aluminum	NA	NA/600	50	NA	600
Arsenic	9.9	60/100	10	5.7	9.9
Barium	283	NA/3,000	500	1.04	283
Antimony	5	NA/NA	5	0.14	5
Beryllium	10	NA/NA	10	1.06	10
Cadmium	4	20/20	4	0.002	4
Calcium	NA	NA/NA	NA	NA	NA
Chromium	0.4	0.4/10	1	0.4	0.4
Cobalt	20	NA/1,000	20	0.14	20
Copper	60	50/100	100	0.313	60
Iron	NA	NA/200	NA	NA	200
Lead	40.5	500/900	50	0.054	40.5
Magnesium	NA	NA/NA	NA	NA	NA
Manganese	NA	NA/100	500	NA	100
Mercury	0.00051	0.1/30	0.3	0.1	0.00051
Nickel	30	200/90	30	13.6	30
Potassium	NA	NA/NA	NA	NA	NA
Selenium	0.21	70/100	1	0.028	0.21
Silver	2	NA/50	2	4.04	2
Sodium	NA	NA/NA	NA	NA	NA
Vanadium	2	NA/20	2	1.59	2
Zinc	8.5	200/100	50	6.62	8.5
Volatile Organics					
2-Butanone	NA	NA/NA	NA	89.6	89.6
Acetone	NA	NA/NA	NA	2.5	2.5
Benzene	NA	NA/NA	NA	0.25	0.25
Carbon disulfide	NA	NA/NA	NA	0.094	0.094
Ethylbenzene	NA	NA/NA	NA	5.16	5.16
m,p-Xylene	NA	NA/NA	NA	10[f]	10
Methylene chloride	NA	NA/NA	NA	10.4	10.4
o-Xylene	NA	NA/NA	NA	10[f]	10
Styrene	300	NA/NA	300	4.69	300
Toluene	200	NA/NA	200	5.45	200
Semivolatile Organics					
2-Methylnaphthalene	NA	NA/NA	NA	3.24	3.24
Acenaphthylene	NA	NA/NA	NA	682	682
Anthracene	NA	NA/NA	NA	1,480	1,480
Benzo(a)anthracene	NA	NA/NA	NA	5.21	5.21
Benzo(a)pyrene	NA	NA/NA	NA	1.52	1.52
Benzo(b)fluoranthene	NA	NA/NA	NA	59.8	59.8
Benzo(ghi)perylene	NA	NA/NA	NA	119	119
Benzo(k)fluoranthene	NA	NA/NA	NA	148	148
bis(2-Ethylhexyl) phthalate	NA	NA/NA	NA	0.926	0.926
Chrysene	NA	NA/NA	NA	4.73	4.73
Dibenzo(ah)anthracene	NA	NA/NA	NA	18.4	18.4

Table C-1

Soil Screening Concentrations
TNT Area C
Plum Brook Ordnance Works, Sandusky, Ohio

(Page 2 of 2)

Chemical	Ecological PRGs[a] (mg/kg)	Tox. Benchmark for COPECs for Effects on Soil, Litter Inv., and Microbes[b] (earthworm/microbial) (mg/kg)	Tox. Benchmarks for COPECs Terrestrial Plants. (mg/kg)	USEPA Region V EDQL[d] (mg/kg)	Screening Value[e] (mg/kg)
Diethyl phthalate	100	NA/NA	100	24.8	100
Di-n-butyl phthalate	200	NA/NA	200	0.15	200
Fluoranthene	NA	NA/NA	NA	122	122
Indeno(1,2,3-cd)pyrene	NA	NA/NA	NA	109	109
Phenanthrene	NA	NA/NA	NA	45.7	45.7
Pyrene	NA	NA/NA	NA	78.5	78.5
PCBs					
Aroclor-1254	0.371	NA/NA	40	0.0003	0.371
Aroclor-1260	0.371	NA/NA	40	0.0003	0.371
Nitroaromatics					
1,3,5-Trinitrobenzene	NA	NA/NA	NA	0.376	0.376
1,3-Dinitrobenzene	NA	NA/NA	NA	0.656	0.656
2,4,6-Trinitrotoluene	NA	NA/NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA/NA	NA	1.28	1.28
2,6-Dinitrotoluene	NA	NA/NA	NA	0.033	0.033
2-Amino-4,6-dinitrotoluene	NA	NA/NA	NA	NA	NA
2-Nitrotoluene	NA	NA/NA	NA	NA	NA
3-Nitrotoluene	NA	NA/NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	NA	NA/NA	NA	NA	NA
4-Nitrotoluene	NA	NA/NA	NA	NA	NA
Dinitrotoluene	NA	NA/NA	NA	0.65	0.65
Nitrobenzene	NA	40/1000	NA	1.31	40
Tetryl	NA	NA/NA	NA	NA	NA

[a] Preliminary Remediation Goals (PRG) for Ecological Endpoints (Efroymson et. al., 1997a).
[b] Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotropic Process: 1997 Revisions, Efroymson, R.A., et al. November 1997b.
[c] Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants, Efroymson, R.A., et al. November 1997c.
[d] Ecological Data Quality Levels (EDQL) (USEPA Region V, 1999).
[e] Hierarchy employed for selection of screening criteria, as recommended by OEPA, is as follows:
First source : Ecological PRGs (Efroymson, et al., 1997a)
Second source : Efroymson et. al., 1997b
Third source : Efroymson et. al., 1997c
Fourth source : EDQL (USEPA, 1999).
[f] Value is for xylenes (total).

Table C-2

Surface Water Screening Concentrations
TNT Area C
Plum Brook Ordnance Site
Sandusky, Ohio

Chemical	Ohio EPA Water Quality Criteria[a] (total) (mg/L)	Ecological PRGs[b] (mg/L)	USEPA Region V EDQLs[c] (mg/L)	Lowest Screening Value[d] (mg/L)
Inorganics				
Aluminum	NA	0.087	NA	0.087
Barium	NA	0.004	5	0.004
Beryllium	NA	0.00066	0.0076	0.00066
Cadmium	0.022	0.0011	0.00066	0.00066
Calcium	NA	NA	NA	NA
Chromium	5.6	0.21	0.042	0.042
Cobalt	NA	0.023	0.005	0.005
Copper	0.052	0.012	0.005	0.005
Iron	NA	1	NA	1
Lead	0.71	0.0032	0.0013	0.0013
Magnesium	NA	NA	NA	NA
Manganese	NA	0.12	NA	0.12
Nickel	1.5	0.16	0.029	0.029
Potassium	NA	NA	NA	NA
Selenium	0.005	0.00039	0.005	0.00039
Sodium	NA	NA	NA	NA
Vanadium	NA	0.02	0.019	0.019
Zinc	0.39	0.11	0.0589	0.0589
Nitroaromatics				
2,4,6-Trinitrotoluene	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	0.23	0.23
2,6-Dinitrotoluene	NA	NA	0.042	0.042
2-Amino-4,6-Dinitrotoluene	NA	NA	NA	NA
2-Nitrotoluene	NA	NA	NA	NA
3-Nitrotoluene	NA	NA	NA	NA
4-Nitrotoluene	NA	NA	NA	NA
4-Amino-2,6-Dinitrotoluene	NA	NA	NA	NA
Dinitrotoluene	NA	NA	NA	NA
Semivolatile Organics				
Di-n-butyl phthalate	NA	0.001	0.003	0.001
Volatile Organics				
Acetone	NA	1.5	78	1.5
Carbon disulfide	NA	0.00092	0.0841	0.00092
Methylene chloride	NA	2.2	0.43	0.43

[a] Water Quality Criteria for the Lake Erie Drainage Basin (Ohio Adminstrative Code. 3745-1-33).
[b] Preliminary Remediation Goals (PRG) for Ecological Endpoints (Efroymson et. al., 1997).
[c] Ecological Data Quality Levels (EDQL) (USEPA Region V, October 1999).
[d] Screening value is based on the lowest available value presented for each constituent.

Table C-3

Sediment Screening Concentrations
TNT Area C
Plum Brook Ordnance Site, Sandusky, Ohio

(Page 1 of 2)

Chemical	USEPA Region V EDQLs[a] (mg/kg)	Ecological PRGs[b] (mg/kg)	Ontario MOE PSQG[c] (mg/kg)	Screening Value[d] (mg/kg)
Inorganics				
Aluminum	NA	NA	NA	NA
Arsenic	5.9	42	6	5.9
Barium	NA	NA	NA	NA
Beryllium	NA	NA	NA	NA
Cadmium	0.596	4.2	0.6	0.596
Calcium	NA	NA	NA	NA
Chromium	26	159	26	26
Cobalt	50	NA	50	50
Copper	16	77.7	16	16
Iron	NA	NA	20,000	20,000
Lead	31	110	31	31
Magnesium	NA	NA	NA	NA
Manganese	NA	NA	460	460
Mercury (Inorganic)	0.174	0.7	0.2	0.174
Nickel	16	38.5	16	16
Potassium	NA	NA	NA	NA
Selenium	NA	NA	NA	NA
Sodium	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA
Zinc	120	270	120	120
Volatile Organics				
2-Butanone	0.137	0.27	NA	0.137
Acetone	0.453	0.0091	NA	0.453
Benzene	0.142	0.16	NA	0.142
Methylene chloride	1.26	18	NA	1.26
Toluene	52.5	0.05	NA	52.5
Semivolatile Organics				
Benzo(a)anthracene	0.0317	0.69	0.32	0.0317
Benzo(a)pyrene	0.0319	0.394	0.37	0.0319
Benzo(b)fluoranthene	10.4	4	0.24	10.4
bis(2-Ethylhexyl) phthalate	0.182	2.7	NA	0.182
Chrysene	0.0571	0.85	0.34	0.0571
Di-n-butyl phthalate	NA	0.001	NA	0.001

Table C-3

Sediment Screening Concentrations
TNT Area C
Plum Brook Ordnance Site, Sandusky, Ohio

Chemical	USEPA Region V EDQLs[a] (mg/kg)	Ecological PRGs[b] (mg/kg)	Ontario MOE PSQG[c] (mg/kg)	Screening Value[d] (mg/kg)
Fluoranthene	0.111	0.834	0.75	0.111
Pyrene	0.053	1.4	0.49	0.053
Total PAH	NA	13.66	4	13.66
PCBs				
Aroclor 1260	0.0341	63	0.005	0.0341
Nitroaromatics				
1,3,5-Trinitrobenzene	0.000121	NA	NA	0.000121
2,4,6-Trinitrotoluene	NA	NA	NA	NA
2,4-Dinitrotoluene	0.0751	NA	NA	0.0751
2,6-Dinitrotoluene	0.0206	NA	NA	0.0206
2-Amino-4,6-dinitrotoluene	NA	NA	NA	NA
4-Amino-2,6-dinitrotoluene	NA	NA	NA	NA
RDX	NA	NA	NA	NA
Dinitrotoluene	NA	NA	NA	NA
Nitrobenzene	0.488	NA	NA	0.488

[a] Ecological Data Quality Levels (EDQL) (USEPA Region V, 1999).
[b] Preliminary Remediation Goals (PRG) for Ecological Endpoints (Efroymson et. al., 1997a).
[c] Provincial Sediment Quality Guideline (PSQG) for Metals and Nutrients. Ontario Ministry of the Environment (OMOE), 1993 (low effect values).
[d] Hierarchy employed for selection of screening criteria, as recommended by OEPA, is as follows:
First source: EDQL (USEPA Region V, 1999)
Second source: PRGs for Ecological Endpoints, Efroymson, et al., 1997a
Third source: OMOE, 1993.

APPENDIX D

ECOLOGICAL TOXICITY PROFILES FOR THE CHEMICALS OF POTENTIAL ECOLOGICAL CONCERN PLUM BROOK ORDNANCE WORKS

Table of Contents

Page

D.1.0 Introduction D-1
D.2.0 Inorganic Compounds D-1
D.2.1 Aluminum D-1
D.2.2 Lead D-3
D.2.3 Selenium D-6
D.3.0 Organic Compounds D-9
D.3.1 Aroclor-1260 (PCB) D-9
D.3.2 2-Amino-4,6-Dinitrotoluene D-15
D.3.3 2,4,6-Trinitrotoluene D-18

D.1.0 Introduction

A large variety of both inorganic and organic chemicals have been measured in environmental media at Plum Brook Ordnance Works at concentrations in excess of background measurements. This appendix contains toxicity information related to each of the chemicals of potential ecological concern that were identified as being risk drivers (i.e., contributing a large percentage of the total hazard index for a particular receptor). General toxicity information is presented for plants, wildlife, and freshwater aquatic biota, as available. Much of the information was obtained from biological and toxicological databases, such as the hazardous substance database (National Library of Medicine [NLM], 1996), registry of toxic effects of chemical substances [RTECS], 1999), Integrated Risk Information System (U.S. Environmental Protection Agency [EPA], 2001) and from wildlife hazard reports published by the U.S. Fish and Wildlife Service (i.e., Eisler, 1986).

D.2.0 Inorganic Compounds

D.2.1 Aluminum

Aluminum is a natural element that comprises 8% of the earth's crust, thus it is always present in high concentrations in the soil. Natural concentrations of aluminum in water are below 0.1 ppm, and concentrations in air range from 0.005 to 0.18 ug/m^3 (ATSDR, 1990).

Mammals. Aluminum is not expected to biomagnify in terrestrial food chains (ATSDR, 1990). Studies have shown that aluminum is present in natural diets, in amounts varying from very low in animal products to relatively high in plants (Browning, 1969). Animal studies have shown that most aluminum that enters the organism, orally, is excreted in the feces, and the small amount that enters the bloodstream leaves in the urine (Thienes and Haley, 1972).

Because aluminum is only sparingly absorbed from the gut, acute toxicity values for ingested aluminum are unavailable, since death occurs from intestinal blockage due to precipitated aluminum species rather than systemic aluminum toxicity (Seiler et al., 1988). Aluminum compounds have been evaluated as non-mutagenic by standard mutagenic assays (Friberg et al., 1986). Ondreicka et al. (1966) studied the effects on reproduction by supplying 19.3 mg aluminum/kilogram/day to mice in drinking water over three generations. While there were no effects on the number of litters or number of offspring per litter, growth of generations 2 and 3

was significantly reduced. In this RA, a mouse NOAEL of 1.93 mg/kg-day and LOAEL of 19.3 mg/kg-day from Sample et al. (1996) have been used.

Birds. Chickens fed 1,400 ppm aluminum lowered the level of inorganic phosphorus in the blood and bones causing severe rickets (Browning, 1969). Ringed doves were fed 1,000 ppm aluminum in their diet for four months. No significant differences in reproduction were observed at this dose level (Carriere et al., 1986). Therefore, 1,000 ppm was considered the subchronic dose level (Sample et al., 1996). In this RA, a ringed dove NOAEL of 110 mg/kg-day and LOAEL of 1,100 mg/kg-day from Sample et al. (1996) have been used.

Fish. The EPA lists acute and chronic values for aluminum at 750 and 87 ug/L, respectively. These values are pH dependent and only applicable when the pH is between 6.5 and 9.0 standard units (EPA, 1988).

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D.2.2 Lead

Global production of lead from both smelter and mining operations has been high throughout this century. Lead is commonly used in storage batteries as well as ammunition, solder, and casting materials. In addition, tetraethyl lead was a principal additive to gasolines as an anti-knock agent, and was commonly used as an additive in paints. In short, lead is one of the most ubiquitous pollutants in the civilized world.

Lead is strongly sorbed in sediments and the rate is strongly correlated with grain size and organic content. In the absence of soluble complexing species, lead is almost totally adsorbed to clay particles at pHs greater than 6 (Moore and Ramamoorthy, 1984).

Mammals. In laboratory studies, breeding mice exposed to low doses of lead in drinking water (25 ppm) resulted in loss of the strain in two generations with many abnormalities (Schroeder and Mitchner, 1971). Exposure of rats in this same experiment resulted in many early deaths and runts. Blood δ-aminolevulinic acid dehydratase (ALAD) activity associated with exposure to lead was reduced in white-footed mice living near a metal smelter (Beyer et al., 1985). Amounts of whole-body lead content and feeding habits of roadside rodents have been correlated with highest body burdens in insectivores such as shrews; intermediate in herbivores, and lowest in granivores (Boggess, 1977; Getz et al., 1977). For the current RA, rat NOAEL and LOAEL values of 8.0 and 80 mg/kg-day have been used from Sample et al. (1996).

Birds. Most of the information on the effects of lead to terrestrial vertebrates is concerned with the poisoning of waterfowl by lead shot. Apparent symptoms include loss of appetite and mobility, avoidance of other birds, lethargy, weakness, emaciation, tremors, dropped wings, green feces, impaired locomotion, loss of balance and depth perception, nervous system damage, inhibition of heme synthesis, damage to kidneys and liver, and death (Eisler, 1988; Mudge, 1983). Anemia, kidney disease, testicular and liver lesions, and neurological disorders have been associated with high brain lead concentrations in mourning doves (*Zeneida macroura*) (Kendall, 1992). Hatchlings of chickens, Japanese quail, mallards and pheasants are relatively more

tolerant to moderate lead exposure, including no effect on growth at dietary levels of 500 ppm and no effect on survival at 2,000 ppm (Hoffman, et al., 1985). For the current RA, American kestrel NOAEL and LOAEL values of 3.85 and 38.5 mg/kg-day have been used from Sample et al. (1996).

Fish. All life stages are sensitive to the toxic effects of lead; however, embryos are more sensitive to lead than are later juvenile stages (Davies et al. 1976). Lead uptake depends on exposure time, aqueous concentration, pH, temperature, salinity, diet, and other factors. For example, gill, liver, kidney, and erythrocytes accumulate lead from aqueous sources in proportion to exposure time and concentration (Holcombe et al., 1976). Direct erythrocyte injury is considered the first and most important sign of lead poisoning in catfish (Dawson, 1935). Respiratory distress occurs in fish living in rivers receiving lead mining wastes in England (Carpenter, 1924; 1925; 1926). Fish are thought to be asphyxiated as a result of a mucous coating over the gills (National Academy of Sciences, 1972).

Invertebrates. The majority of benthic invertebrates do not bioconcentrate lead from water or abiotic sediment particles. There is some evidence of bioaccumulation through the food web of organic forms of lead, such as tetraethyl lead. Anderson et al. (1980) reported lead LC_{50}s of 258 ppm for the chironomid and that growth of this amphipod was not reduced above this level in freshwater sediments. In addition, Suter and Mabrey (1994) reported effect levels in the water flea (*Daphnia magna*) to be in the 12.26 ppb range, while Khangrot and Ray (1989) reported a *D. magna* LC_{50} of 4.89 ppm.

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D.2.3 Selenium

Selenium occurs both naturally and by anthropogenic means. Naturally occurring selenium is widely but unevenly distributed in the earth's crust, and is commonly found in sedimentary rocks. When the rocks erode, to form soil, selenium combines with oxygen to form several substances, the most common being sodium selenite. However, anthropogenic sources far outweigh natural ones (EPA, 1984). Coal and petroleum combustion are the main sources of selenium pollution, accounting for approximately 70 percent of selenium redistribution (Vokal-Borek, 1979). Selenium is an essential trace element nutrient for plants and animals; it constitutes an integral part of the enzyme glutathione peroxidase and may have a role in other biologically active compounds (Eisler, 1985). However, it is harmful at slightly higher concentrations.

Mammals. No information has been located concerning the potential effects of selenium to wildlife. However, there is sufficient evidence from studies on livestock to indicate the potential for toxic effects in wildlife. There are three basic types of livestock poisoning (Eisler, 1985); acute, resulting from consumption in a single feeding of seleniferous weeds containing from 400 to 800 ppm; blind staggers, from consumption of moderately toxic seleniferous weeds over an extended period of time; and alkali disease, caused by the consumption of moderately seleniferous grains and forage grasses over a period of several weeks to months. Acute selenium poisoning in domestic livestock is characterized by abnormal movements, lowered head, drooped ears, abdominal pain, increased urination, and dilated pupils (Eisler, 1985). Elimination is primarily in the urine, with smaller quantities excreted with the feces, breath, perspiration, and bile. Pathological changes in the heart, lungs, rumen, liver, kidney, and other organs are caused by selenosis (Eisler, 1985). For the current RA, rat NOAEL and LOAEL values of 0.2 and 0.3 mg/kg-day have been used from Sample et al. (1996).

Birds. Studies with adult mallards indicated that 100 ppm dietary selenium (as sodium selenite) was fatal within one month, but that survival was high at 25 ppm after three months. Poor egg hatchability was recorded in the 25 ppm selenite group, but not the 10 ppm selenite group. However, hatching percent was reduced in eggs of adults fed 10 ppm selenium as selenomethionine, an organoselenium compound (Eisler, 1985). Reduced hatching of Japanese quail eggs was recorded at 6 and 12 ppm selenite in feed (El-Bergearmi et al., 1977). Research by Harr (1978) has demonstrated that selenium administered in natural feedstuffs is only about one-fourth as toxic as are similar exposures in water or purified feed. For the current RA, mallard duck NOAEL and LOAEL values of 0.5 and 1.0 mg/kg-day have been used from Sample et al. (1996).

Fish. Selenium is an essential nutrient for fish, and beneficial effects of low levels of selenium are well known. In rainbow trout, dietary levels of 0.07 ppm and/or aqueous levels of 0.0004 ppm are essential (Hilton et al., 1980). Manifestations of selenium deprivation in fish include increased mortality, reduced growth, hepatic injury, muscle lesions, and depressed glutathione peroxidase activity (Posten et al., 1976; Hilton et al., 1980). However, excess levels of selenium are more poisonous than either arsenic or mercury (Copeland, 1971) and represent a threat to teleost survival (Sakurayama, 1960; Glenn et al., 1964; Adams, 1976; Cardwell et al., 1976; Neal, 1977; Halter et al., 1980; Hilton et al., 1980). Adams (1976) reported 48-day LC_{50} values of 0.4, 0.5, and 1.1 ppm selenium, as selenite, for bluegills (*Lepomis macrochirus*), rainbow trout (*Salmo gairdneri*), and fathead minnows (*Pimephales promelas*), respectively. In this study, species-specific differences altered these LC_{50} values by about three-fold. Moreover, 48-day LC_{50} values for selenate and selenite differ by two-fold (2.0 and 1.1 ppm, respectively) in fathead minnows (Adams, 1976).

Invertebrates. Experiments by Maier and Knight (1993) examined the comparative acute toxicity of waterborne selenate, selenite, and seleno-DL-methionine to 4th-instar *Chironomus decorus*, resulting in 48-hour LC_{50} concentrations of 23.7, 48.2, and 194 mg selenium per liter, respectively. Subsequent accumulation studies utilizing *C. decorus* larvae, exposed to the 48-hour LC_{50} selenium concentrations, showed initial rapid intake and subsequent plateauing with maximum concentrations attained by 16 hours. Final whole body selenium levels were approximately 63 mg selenium/kg for selenate and 85 mg selenium/kg for selenite. Brasher and Ogle (1993) conducted a series of experiments to determine the comparative toxicity of selenite and selenate to the amphipod *Hyallela azteca*. In 48-hour, 96-hour, and 120-hour LC_{50} tests, selenite was two to four times more toxic than selenate, the difference increasing as exposure

time increased. This difference in toxicity was even more pronounced in the 24-day reproductive bioassay, where selenite caused a significant decrease in the number of young per female at 200 ug/L while selenate had no effect up through 700 ug/L (the highest concentration tested).

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D.3.0 Organic Compounds

D.3.1 Aroclor-1260 (PCB)

Polychlorinated biphenyls (PCB) are a group of synthetic chlorinated aromatic hydrocarbon molecules that have a worldwide distribution due to their wide use and persistence in the environment (Eisler, 1986). PCBs are often referred to by the trade name Aroclor followed by a four-digit number. The first two digits represent the 12 carbons of the biphenyl structure, and the second two digits represent the approximate weight percentage of chlorine in the product (Hooper, et al., 1990). Aroclors are comprised of several different PCB species and isomers.

Plants. PCBs are among the most abundant chlorinated hydrocarbons in the environment (Risebrough, et al., 1968). Total PCB concentrations in terrestrial plants are usually less than 0.3 mg/kg (dry weight) (Buckley, 1983, as cited in Eisler, 1986). Soil-to-plant transfer factors for PCBs are generally low, ranging from 0 to 0.5 (Pal et al., 1980). Uptake by plants is dependent on the degree of chlorination of the PCB compound, with uptake greater for the lipophilic, highly chlorinated forms (Pal et al., 1980). Plant uptake of PCBs is also dependent on the solubility of the PCB. PCBs within plants can be metabolized; however, the degree and rate of metabolism is related to the degree of chlorination (Pal et al., 1980). Greater metabolism occurs for the less chlorinated PCBs (Pal et al., 1980).

Very few studies have been conducted to investigate the effects of PCBs on the growth of terrestrial plants. From the available data, a soil concentration of 40 mg/kg (dry weight) has been

proposed by Will and Suter (1994) as a benchmark screening value for PCB toxicity to terrestrial plants.

The more highly chlorinated PCBs are more persistent in the environment. Studies have shown mono-, di-, and trichlorinated biphenyls to be more biologically degradable by microorganisms than tetra-, penta-, and hexachlorobiphenyl compounds (Pal, et al., 1980). Several species of soil bacteria are known to metabolize and decompose PCBs. These include *Achromobacter*, which degrade mono- and dichlorinated biphenyls to benzoic acid (Hooper, et al., 1990).

Wildlife. According to Pal et al. (1980), PCBs are detected more frequently in mammals, birds, fish, and eggs than in plants. In, 1979, 83 percent of European starlings (*Sturnus vulgaris*) collected nationwide contained measurable amounts of PCBs (Cain and Bunck, 1983, as cited in Eisler, 1986). Maximum PCB concentrations in eggs of American bald eagles (*Haliaetus leucocephalus*) collected nationwide during 1979 ranged from 5.6 to 81 mg/kg (wet weight) (Wiemeyer, et al., 1984, as cited in Eisler, 1986). PCB concentrations in small mammals collected from relatively uncontaminated sites usually range from 0 to 1.3 mg/kg (wet weight) (Talmage and Walton, 1991). PCBs are readily absorbed through the gastrointestinal tract, respiratory system, and skin (Eisler, 1986). They can cross the placenta of mammals (Rogan et al., 1988). Simple PCBs are metabolized in the body and excreted in urine and bile (Eisler, 1986). Exposure of vertebrates to PCB congeners can induce the production of mixed-function oxidase enzymes that metabolize foreign compounds (Parkinson and Safe, 1981, as cited in Dillon and Burton, 1991). In some instances, as with Aroclor-1254, metabolites may be more toxic than the parent compounds (Aulerich and Ringer, 1986). Nonortho-substituted coplanar PCBs are among the most toxic PCB isomers to mammals and birds (Kannan, et al., 1989; Brunström, 1989).

Among mammals, mink (*Mustela vison*) are especially sensitive to PCBs (Eisler, 1986). A concentration of 0.64 mg/kg in the diet can induce reproductive failure in mink (Fleming et al., 1983, as cited in Eisler, 1986). Mink diets containing 6.7 to 8.6 mg/kg (wet weight) Aroclor-1242 and -1254, respectively, resulted in the death of 50 percent of the animals within a nine-month period (Ringer, 1983, as cited in Eisler, 1986). Acute oral toxicity studies with mink have the revealed toxicity of Aroclor-1221 to be greater than that for either Aroclor-1242 or -1254 (Aulerich and Ringer, 1977). Based on white-footed mouse and mink toxicity data, extrapolated NOAELs for chronic exposure of various mammalian wildlife species to specific Aroclor-1254 have been determined (Opresko, et al., 1994). Estimated NOAEL values for the white-footed

mouse, cottontail rabbit, and red fox are 0.13, 0.035, and 0.083 mg/kg per day, respectively (Opresko, et al., 1994). Calculated chronic benchmark values for mammalian wildlife range from 0.15 to 1.38 mg/L for exposure to Aroclor-1254 in drinking water only (Opresko, et al., 1994). Mammalian wildlife NOAELs have also been estimated for Aroclors-1016, -1242, and -1248. The values for Aroclor-1248, which are the lowest among the PCBs listed, are 0.060 mg/kg per day for the mouse, 0.016 mg/kg per day for the cottontail rabbit, and 0.010 mg/kg per day for the fox. Drinking water NOAELs for these species are 0.2, 0.17, and 0.069 mg/L, respectively. Certain PCB congeners have been shown to induce mutagenic, carcinogenic, and teratogenic effects in mammals (Eisler, 1986). Symptoms of PCB toxicity in mink fed diets supplemented with PCBs included anorexia; bloody stools; reproductive failure; increased infant mortality; and the presence of fatty livers, hemorrhagic gastric ulcers, and kidney degeneration (Aulerich and Ringer, 1977). For this RA, the NOAEL and LOAEL values utilized for Aroclor-1260 are 0.068 mg/kg/d and 0.68 mg/kg/d, based on rats exposed to Aroclor-1260 (Sample et al., 1996).

The toxicity of PCB compounds to birds is influenced by the species of bird and its associated food habits, health and body fat content, gender, and age (Eisler, 1986). Concentrations of PCBs in brain tissue greater than 310 mg/kg (wet weight) are lethal (Stickel, et al., 1984). Dietary LD_{50} values for various species of birds exposed to PCB Aroclor mixtures were highest for Aroclor-1221 and generally decreased with increasing percent chlorination (Heath, et al., 1972, as cited in Eisler, 1986). Toxicological benchmark values for wild birds have been estimated based on experiments with ring-necked pheasants (Opresko, et al., 1994). A benchmark value of approximately 3 mg/L was estimated for chronic exposure of these birds to Aroclor-1254 in drinking water only (Opresko, et al., 1994). NOAELs have also been estimated for birds exposed to Aroclor-1242 (Opresko et al., 1994). Based on a screech owl oral NOAEL of 0.41 mg/kg per day, values for the heron and hawk were calculated as 0.175 and 0.22 mg/kg per day, respectively. The drinking water NOAEL for these birds was 3.9 mg/L. Exposure to PCBs can result in adverse effects on reproduction, growth, metabolism, and behavior (Eisler, 1986). Eggshell thinning may also occur as a result of exposure of the female birds to PCBs (Hayes, 1975, as cited in NLM, 1996). Exposure to PCBs can also render a bird more susceptible to certain types of viral infections (Friend and Trainer, 1970). For this RA, the NOAEL and LOAEL values utilized for avian species are 0.18 mg/kg-day and 1.8 mg/kg-day, based on the ring-neck pheasant exposed to Aroclor-1260 (Sample, et al., 1996).

Aquatic Life. PCBs are bioconcentrated, bioaccumulated, and biomagnified in freshwater environments. Bioconcentration factors for freshwater invertebrates exposed to Aroclor-1254 have been reported to range from 60 to 27,000 (Eisler, 1986). National surveys of PCB concentrations in freshwater fish collected from 1978 to 1979 revealed total PCB concentrations in whole fish to average 1.4 mg/kg (wet weight) (Schmitt, et al., 1983, as cited in Eisler, 1986). Concentrations of specific Aroclors were measured in later surveys conducted from 1980 to 1981 where mean concentrations of Aroclor-1248, Aroclor-1254, and Aroclor-1260 in whole fish were reported to be 0.1, 0.2, and 0.3 mg/kg (wet weight), respectively (Schmitt, et al., 1983, as cited in Eisler, 1986). Diet appears to be the major route of PCB uptake in freshwater fish (Eisler, 1986). Aquatic invertebrates have been shown to contribute to the cycling of PCBs in freshwater environments by their uptake of sediment-associated PCBs and their subsequent migration to the water column or surface, where they can be ingested by other organisms (Eisler, 1986). PCB concentrations that exceed 1,000 mg/kg (wet weight) have been measured in the fat of snapping turtles (*Chelydra serpentina*) collected from contaminated environments (Meyers-Schöne and Walton, 1994).

Because of the strong hydrophobicity of PCBs, these compounds localize in sediments and accumulate in the lipids of freshwater biota (Hooper, et al., 1990). The high affinity of PCBs for lipids and the relative resistance of highly chlorinated congeners to metabolism are responsible for the biomagnification of these compounds in aquatic environments (Sanders and Chandler, 1972, as cited in Hooper, et al., 1990). Dechlorination of PCBs by bacteria in anaerobic sediments has been reported to reduce the toxicity of these compounds (Brown, et al., 1987).

The toxicity of PCBs to aquatic biota increases with percent chlorination of the PCB mixture (Birge, et al., 1978, as cited in Pal, et al., 1980). Laboratory toxicity tests have shown PCB toxicity to increase with exposure time (Eisler, 1986). Also, younger developmental stages are more sensitive to PCBs than older stages (Eisler, 1986). Federal Water Quality Criteria exist for the protection of freshwater aquatic life from exposure to PCBs. The values for acute and chronic exposure to PCBs in freshwater systems are 2.0 μg/L and 1.4 x 10E-2 μg/L, respectively (EPA, 1986). Suter and Mabrey (1994) derived acute and chronic advisory values for freshwater biota exposed to specific PCBs. The test EC20 for fish can be used as a benchmark indicative of production within a population. It is the highest tested concentration of a specific PCB causing less than 20 percent reduction in either the weight of young fish per initial female fish in a life cycle or partial life-cycle test or the weight of young per egg in an early life-stage test (Suter and Mabrey, 1994). A similar value can be determined for daphnids, which reflects the highest tested

concentration of a PCB causing less than 20 percent reduction in the product of growth, fecundity, and survivorship in a chronic test with a daphnid species (Suter and Mabrey, 1994).

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D.3.2 2-Amino-4,6-Dinitrotoluene

Little information is available for 2-amino-4, 6-dinitrotoluene (DNT) and 4-amino-2,6-DNT. Information is thus also provided for DNT.

DNT compounds are used in organic synthesis, dyes, explosives, and in isocyanate production (NLM, 1996). 2,6 DNT is expected to be slightly mobile in soils (NLM, 1996). Biodegradation of 2,6-DNT is expected to occur in soils (NLM, 1996). In aquatic environments, 2,6-DNT will have a slight tendency to adsorb to sediments, suspended solids, and biota (NLM, 1996). Volati-

lization of 2,6-DNT and 2,4-DNT from water is relatively low; however, photolysis is a significant removal mechanism for the compound (NLM, 1996).

Plants. Based on information presented in Talmage, et al. (1999), soil amended with 80 mg/kg of 2-amino-4,6-DNT was not toxic to yellow nutsedge over a 42-day period. This concentration was deemed a NOAEL value.

Wildlife. As with plants, data on concentrations of dinitrotoluenes in mammalian and avian wildlife species could not be found in the open literature. The liver and small intestine are the major sites of 2,6-DNT and 2,4-DNT metabolism (Schut, et al., 1983, and Rickert, et al., 1983, as cited in NLM, 1996).

Large differences exist in the toxicity of the various dinitrotoluene isomers in laboratory mammals (ACGIH, 1980, as cited in NLM, 1996). The 2,4-, 2,6- and 3,4- dinitrotoluene isomers have been found to be the most toxic DNT isomers to rats (ACGIH, 1980, as cited in NLM, 1996). Adverse reproductive effects have been documented in rats exposed to 2,4-DNT (NLM, 1996). Inhalation of fumes or dust containing 2,4-DNT may produce changes in blood chemistry (EPA, 1980, as cited in NLM, 1996). Experimentally determined LD_{50} values for rats and mice orally exposed to 2,6-DNT are 117 and 621 mg/kg, respectively (NLM, 1996). LD_{50} values for rats, mice, and guinea pigs orally exposed to 2,4-DNT are 268; 790; and 1,300 mg/kg, respectively (NLM, 1996). No observable effects were observed in rats exposed to 2,4-DNT at 0.57 and 0.71 mg/kg/d (Ellis, et al., 1978, as cited in NLM, 1996). 2,6-DNT and 2,4-DNT have been shown to be mutagenic (NLM, 1996). Laboratory studies have found 2,4-DNT to be carcinogenic (NLM, 1996). 2,6-DNT has been shown to be a potent hepatocarcinogen in laboratory rats (Dixit, et al., 1986, as cited in NLM, 1996). Signs of 2,6-DNT poisoning that have been noted in laboratory mammals include decreased appetite, weight loss, and inhibition of muscular coordination (EPA, 1980, as cited in NLM, 1996). Signs of 2,4-DNT toxicity in rats include changes in body weight and behavior, humpback, and jerky coordination (Kozuka, et al., 1979, as cited in NLM, 1996).

For this risk assessment, for mammalian species, LD_{50} values for rats exposed to 2-amino-4,6-DNT and 4-amino-2,6-DNT are 1,394 mg/kg per day and 959 mg/kg per day, respectively (TOMES, 1999). These LD_{50} values were utilized to derive NOAELs of 13.9 mg/kg per day and 9.59 mg/kg per day, respectively ($LD_{50}/100$). These LD_{50} values were also utilized to derive

LOAELs of 69.5 mg/kg per day and 48.0 mg/kg per day, respectively (LD_{50}/20). For avian species 2,4,6-TNT toxicity results were used as a surrogate.

Aquatic Life. Limited data exist on concentrations of DNTs in freshwater biota. A bioconcentration factor of 5,225 has been measured for algae exposed to 2,6-DNT in a model waste stabilization pond (Davis, et al., 1981, as cited in NLM, 1996). The EPA has estimated a bioconcentration factor of 3.8 for aquatic organisms that contain about 7.6 percent lipid (EPA, 1980, as cited in NLM, 1996).

Aquatic toxicity data for DNTs are limited. Federal water quality criteria do not exist for the protection of freshwater aquatic life from acute and chronic exposure to 2,6-DNT or 2,4-DNT (EPA, 1986; EPA, 1992). Concentrations of 2,4-DNT as low as 330 and 230 μg/L are toxic to freshwater aquatic life following acute and chronic exposure, respectively (EPA, 1986).

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D.3.3 2,4,6-Trinitrotoluene

Plants. Information on the concentration of 2,4,6-Trinitrotoluene (2,4,6-TNT) in wild flora or phytotoxicity data on 2,4,6-TNT could not be found in the reviewed literature, except for a screening benchmark of 30 mg/kg for 2,4,6-TNT in soil that is protective of plants (Talmage et al., 1999).

Wildlife. The literature regarding nitroaromatic explosives shows that 2,4,6-TNT is less toxic than 2,4- or 2,6-DNT. A 14-day LD_{50} for mice is reported as 660 mg/kg per day for TNT (Dilley, et al., 1982). Levine, et al. (1990) report reproductive effects in rats as low as 125 mg/kg per day 2,4,6-TNT. For the current risk assessment, mammal data from Talmage et al. (1999) are used. Talmage et al. (1999) presents a chronic NOAEL of 1.6 mg/kg-day for rats, and this value is multiplied by a factor of 5 (per Wentsel et al., 1996) obtain an estimated LOAEL of 8.0 mg/kg-day. For birds, USACHPPM (2000) presents a subchronic NOAEL of 7 mg/kg-day for bobwhite quail. This value is divided by a factor of 10 to obtain an estimated chronic NOAEL of 0.7 mg/kg-day that is used in the current risk assessment. USACHPPM (2000) also presents a subchronic LOAEL of 178 mg/kg-day for bobwhite quail, and this value is divided by a factor of 10 to obtain an estimated chronic LOAEL of 17.8 mg/kg-day that is used in the current risk assessment.

Aquatic Life. No criteria have been established for 2,4,6-TNT for the protection of aquatic life. However, the available data indicate that 2,4,6-TNT is acutely toxic to freshwater fish at levels of approximately 1 mg/L and to invertebrates as low as 0.19 mg/L. Chronic toxicity data indicate effects as low as 0.12 mg/L (Dacre, 1980). Burrows, et al. (1989), indicate that concentrations of 560 and 40 μg/L are protective of aquatic life due to acute and chronic exposure to 2,4,6-DNT, respectively.

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APPENDIX E

ASSESSMENT RECEPTOR PROFILES

Appendix E

Assessment Receptor Profiles

Eastern Cottontail (Sylvilagus floridanus). These medium-size grazing herbivores are found over most of the eastern half of the United States and southern Canada, and have been widely introduced into the western U.S. Environmental Protection Agency ([EPA], 1993). The eastern cottontail is unique to the genus because of the large variety of habitats that it occupies, including glades and woodlands, deserts, swamps, prairies, hardwood forests, rain forests, and boreal forests (EPA, 1993). Open grassy areas are generally are used for grazing at night, whereas dense, heavy cover typically is used for shelter during the day (EPA, 1993). During the summer seasons these rabbits consume herbaceous plants (e.g. grasses, clover, timothy, and alfalfa), whereas winter diet typically consists of woody vines, shrubs and trees (e.g.. birch, maple, and apple) (EPA, 1993). Home range is 3 to 20 acres, with larger ranges in the summer and smaller ranges in the winter (Burt and Grossenheider, 1980). Populations fluctuate from 1 to 4 cottontail per four acres to several per acre in winter conditions (Burt and Grossenheider, 1980). The eastern cottontail breeds from February through September and usually produces 3 to 4 litters per year of 1 to 9 young (usually 4 to 5); however, this rabbit's' death rate vies with its birth rate, and few rabbits live for more than one year (Whitaker, 1995). The average longevity is 1.25 years (EPA, 1993).

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Deer Mouse (Peromyscus maniculatus). This medium-sized mouse is found in the eastern United States from the Hudson Bay to Pennsylvania, the southern Appalachians, central Arkansas, and central Texas. In the west it is found from Mexico to the south Yukon and north-

west territories (Whitaker, 1995). Deer mice habitat includes nearly every dry land habitat within its range, including forest, grasslands, or a mixture of the two (Burt and Grossenheider, 1980). Nocturnal and active year-round, these mice construct nests in the ground, trees, stumps, and buildings (Burt and Grossenheider, 1980). Omnivorous, the deer mouse feeds on nuts and seeds (e.g., jewel weed and black cherry pits), fruits, beetles, caterpillars, and other insects. Deer mice may cache their food during the fall and winter in the more northern parts of their range (EPA, 1993). Home range is 0.15 to 3 acres (Burt and Grossenheider, 1980; EPA, 1993). Density of populations is 4 to 12 mice per acre, and average life span is 2 years in the wild (Burt and Grossenheider, 1980). The breeding season is from February to November, depending on latitude. Three to five young are born in each of two to four litters per year (Burt and Grossenheider, 1980). They are greyish to reddish-brown with a white belly, with a distinctly short-haired, bicolor tail (Whitaker, 1995). Weight range is 14.8 (EPA, 1993) to 33 grams (Whitaker, 1995).

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Mallard Duck (Anas platyrhynchos). The mallard duck is widespread throughout most of the United States and is the most abundant of the United States ducks. It is large, migratory duck with an average body size of 58 centimeters from bill to tail tip. Wintering mallards prefer the natural bottom-land wetlands and rivers where water depths are 20 to 40 centimeters. The primary habitat requirement for nesting is thought to be dense grassy vegetation. Nests are generally located within a few kilometers of water (EPA, 1993).

In winter, mallards feed primarily on seeds, invertebrates, agricultural grains and, to a limited extent, leaves, stems, buds, rootlets, and tubers. In spring, females shift mostly to a diet of invertebrates to support molting and egg laying activities. Ducklings also feed mainly on

invertebrates to help support their rapid growth rates. Mallards are serially monogamous and remate annually. Each pair of mallards establishes a territory and the drake defends it against other mallards. Average home range size varies, depending upon the type of habitat available. High rates of nest failure require the females to renest persistently, with average clutch size decreasing as the breeding season progresses. Annual adult mortality rates vary with year, depending on location, hunting pressure, age, and sex. Females suffer greater natural mortality rates than do males (EPA, 1993).

The typical home range of the mallard is from 540 to 620 hectares (ha) for adult female and male birds, respectively, for wetlands and river habitat in Minnesota (USEPA, 1993). For the current ERA, an average home range of 580 ha was used. The typical migration schedule is from mid-March through mid-May for the spring migration. The fall migration typically starts in mid-October, and peaks in November (USEPA, 1993).

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Red-Tailed Hawk (Buteo jamacensis). This carnivorous hawk is one of the most common and widespread members of the genus *Buteo* in the continental United States and Canada (Brown and Amadon, 1968). Red-tailed hawks live in a variety of habitats, such as farmlands, woodlands, mountains, and deserts, as long as there is open country interdispersed with woods, bluffs, or streamside trees. They are primarily carnivorous, feeding on (greater than 85 percent) small rodents, as well as fish. Other prey items include amphibians, reptiles, crayfish, and other birds (Adamcik, et al., 1979; Ehrlich, et al., 1988). Home range has been reported as approximately 66.8 acres, with a population density of 0.16 pairs per acre (Janes, 1984), although EPA (1993) reports an average territory size of 842 hectares (2,080 acres). Breeding population density is one nest per 0.009 acre or one individual per 0.004 acre. Body weight for male red-tails is 1,028.6 to 1,142.9 grams, and for females 1,371.4 to 1,600 grams (Brown and Amadon, 1968), although EPA (1993) reports an average body weight of 957 grams. They typically mate for life or until one of the pair dies, with pairs clinging to territories year after year (Austing, 1964).

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Raccoon (Procyon lotor). Raccoons are native only in the Americas. Their range extends from the southern edge of the southern provinces of Canada and most of the United States, except for portions of the Rocky Mountain states, central Nevada, and Utah (Whitaker, 1995). The raccoon weighs from 3 to 15 kilograms (Merritt, 1987; EPA, 1993) and has a head and body length of 46 to 71 centimeters and a tail length of 20 to 30 centimeters (Burt and Grossenheider, 1980). The raccoon is nocturnal and solitary, except when breeding or caring for its young. During particularly cold spells, the raccoon may sleep for several days at a time but does not hibernate (Whitaker, 1995). The raccoon is found along lakes near wooded areas or rock cliffs (Burt and Grossenheider, 1980), but prefers wooded streams (Whitaker, 1995). The raccoon is highly omnivorous and is an opportunistic feeder, consuming virtually any animal or plant matter that is available (Merritt, 1987; EPA, 1993). Animal matter predominates the diet during the spring and early summer; plant matter predominates during late summer, autumn, and winter (Merritt, 1987; EPA, 1993). The home range of the raccoon extends up to 3.2 kilometers across, but usually it is less than 1.6 kilometers. Population densities range from one per acre (highest) to one per 15 acres (considered high) (Burt and Grossenheider, 1980). Captive raccoons live for approximately 14 years (Burt and Grossenheider, 1980). Average body weight is 5.1 kilograms (EPA, 1993).

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U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook, Volume I of II***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc., New York.

Short-tailed Shrew (Blarina brevicauda). This shrew is the largest found in North America. It is solid grey above and below, with a short tail, and weighs between 15 and 29 grams (Whitaker, 1995). Total length of this shrew is 76 to 102 millimeters (Burt and Grossenheider, 1980). The range of this shrew extends from southeastern Canada and the northeastern U.S. to Nebraska, Missouri, Kentucky, and in the mountains to Alabama (Whitaker, 1995). Preferable habitat for the shrew includes forests, grasslands, marshes, and brushy areas. It will make a nest of dry leaves, grass, and hair beneath logs, stumps, rocks, or debris (Burt and Grossenheider, 1980). This underground tunneler may burrow as deep as 6 feet, and has a voracious appetite, eating one half of its own body weight per day of earthworms, other terrestrial vertebrates, and sometimes young mice (Whitaker, 1995). Mean population densities range from 5.7 in the winter, to 28 per acre in the summer (EPA, 1993). Their home range varies from 0.5 to 1 acre (Burt and Grossenheider, 1980). Longevity is typically around 20 months (EPA, 1993), with five to eight young born to each of two to three litters (Burt and Grossenheider, 1980).

References:

Burt, W. H. and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc., New York.

White-tailed Deer (Odocoileus virginianus). The white-tailed deer is a member of the Family Cervidae. They are large, even-toed, hoofed mammals with long legs. Their coat is predominantly light brown or chestnut colored, with the underparts being white. Deer are primarily herbivorous grazers and browsers, constantly moving from one food source to the next. The deer's diet changes seasonally. When available, farm crops such as winter wheat, corn, alfalfa, soy beans, and hay are important components of the species diet. Other top food items include wild crab apples, sumac, grasses, green briar, clover, jewelweed, acorns, and dogwood. In regions where the climate varies from season to season, deer may make annual migrations of 10 to 20 miles in the search for food. However, in Ohio, deer typically have rather small home ranges (2 to 3 square miles) and are reluctant to leave this range. The average weight for the species is 88 kilograms for males and 61 kilograms for females. Breeding season ranges from November through February, with the young offspring born in May and early June. Virtually all yearling and adult does conceive each year, and in Ohio usually carry twins. Triplets and quadruplets have also been recorded Gottschang (1981).

References:

Gottschang, J. L., 1981, ***A Guide to the Mammals of Ohio***, The Ohio State University Press, pp. 143-149.

Marsh Wren (Cistothorus palustris). The marsh wren is a small bird (4 to 4.5 inches in length) which inhabits freshwater cattail marshes and salt marshes. Nesting pairs are not likely to occupy other habitats and the species avoids the wet meadow and sedge meadow habitats preferred by sedge wrens. Marsh wrens breed throughout most of the northern half of the United States and in coastal areas as far south as Florida. The species eats mostly insects, and occasionally snails and other invertebrates. The average body weight is 0.01 kilograms, and the average home range for the species is 0.054 hectares. Because the species is polygamous, there may be more females than males inhabiting a breeding marsh. Densities as high as 120 birds per hectare have been recorded (EPA, 1993). Marsh wrens' nests are globular structures placed at heights of 2 to 5 feet in dense vegetation. The males commonly build dummy nests in addition to the one where the eggs will be laid (Peterjohn and Rice, 1991).

References:

U.S. Environmental Protection Agency (EPA), Office of Research and Development, 1993, ***Wildlife Exposure Factors Handbook***, EPA/600/R-93/187a.

Peterjohn, B. G., and Rice, D. L., 1991, ***The Ohio Breeding Bird Atlas***, The Ohio Department of Natural Resources.

APPENDIX F

GLOSSARY OF TERMS

Glossary of Terms

Bioconcentration. For aquatic organisms, bioconcentration is the uptake and retention of a substance by an aquatic organism from the surrounding water through gill membranes or other external body surfaces. Terrestrial bioconcentration focuses on uptake and retention of contaminants from the surrounding medium on the organism level (as by the earthworm, for example).

Bioaccumulation. This refers to the uptake and retention of a substance by an aquatic organism from its surrounding medium and food. Terrestrial bioaccumulation, as with aquatic bioaccumulation, is defined as an organism's uptake and retention of a substance from its surrounding medium and food.

Biomagnification. This refers to the process by which tissue concentrations of bioaccumulated toxic substances increase as the substances pass up through two or more trophic levels. The definition of this term is similar for both terrestrial and aquatic organisms.

APPENDIX G

ECOLOGICAL RISK CHARACTERIZATION SPREADSHEETS

Table G-1

Plum Brook Ordnance Works
TNT Area C

Chemical Data

Chemical Name	Surface Soil Conc. (mg/kg)	Total Soil Conc. (mg/kg)	Water Conc. (mg/L)	log Kow (organics)	Soil-to-Plant TF	Shallow-rooted Plant Conc. (mg/kgdw)	Deep-rooted Plant Conc. (mg/kgdw)	Soil-to-Invert. BAF	Invert. Conc. (mg/kgdw)	Food-to-Muscle TF
Organics										
Aroclor-1260	4.71E+00	1.71E+00		7.15E+00	2.87E-03	1.35E-02	4.90E-03	2.73E+01	1.28E+02	4.44E-01
Benzo(a)anthracene	6.64E+00	3.35E+00		5.61E+00	2.21E-02	1.47E-01	7.39E-02	5.80E-01	3.85E+00	1.16E-02
Benzo(a)pyrene	6.33E+00	3.32E+00		6.06E+00	1.22E-02	7.70E-02	4.04E-02	4.60E-01	2.91E+00	3.36E-02
Carbon disulfide			2.31E-02	1.84E+00	3.35E+00	0.00E+00	0.00E+00	1.48E+01	0.00E+00	1.46E-06
Chrysene	4.60E+00	6.32E-01		5.61E+00	2.21E-02	1.02E-01	1.39E-02	5.50E-01	2.53E+00	1.16E-02
Di-n-butyl phthalate			5.25E-03	5.56E+00	2.38E-02	0.00E+00	0.00E+00	2.27E+01	0.00E+00	1.01E-02
2-Amino-4,6-DNT	3.80E+01	3.80E+01	9.84E-04	2.00E+00	2.70E+00	1.03E+02	1.03E+02	1.00E-01	3.80E+00	2.14E-06
4-Amino-2,6-DNT	6.34E+00	1.46E+01	5.49E-04	2.00E+00	2.70E+00	1.71E+01	3.95E+01	1.00E-01	6.34E-01	2.14E-06
1,3-DNB	7.51E-01	1.00E-01		1.49E+00	5.33E+00	4.00E+00	5.33E-01	1.00E-01	7.51E-02	6.37E-07
2,4-DNT	1.06E+01	2.02E+01		1.98E+00	2.79E+00	2.95E+01	5.63E+01	1.00E-01	1.06E+00	2.03E-06
2,6-DNT	6.95E+00	4.45E-01		2.28E+00	1.87E+00	1.30E+01	8.30E-01	1.00E-01	6.95E-01	4.16E-06
Dinitrotoluene			7.92E-03	2.28E+00	1.87E+00	0.00E+00	0.00E+00	1.00E-01	0.00E+00	4.16E-06
2-Nitrotoluene		2.00E-01	1.04E-02	2.30E+00	1.81E+00	0.00E+00	3.62E-01	1.00E-01	0.00E+00	4.38E-06
3-Nitrotoluene	1.71E+00	2.00E-01	1.47E-03	2.45E+00	1.49E+00	2.54E+00	2.97E-01	1.00E-01	1.71E-01	6.25E-06
4-Nitrotoluene		2.00E-01	4.30E-03	2.42E+00	1.55E+00	0.00E+00	3.09E-01	1.00E-01	0.00E+00	5.82E-06
Tetryl	6.26E-01	2.00E-01		1.65E+00	4.31E+00	2.70E+00	8.61E-01	1.00E-01	6.26E-02	9.33E-07
1,3,5-TNB	7.93E+00	4.08E-01		1.18E+00	8.06E+00	6.39E+01	3.29E+00	1.00E-01	7.93E-01	3.04E-07
2,4,6-TNT	4.13E+04	4.13E+04	3.44E-04	2.00E+00	2.70E+00	1.12E+05	1.12E+05	1.00E-01	4.13E+03	2.14E-06
Inorganics										
Aluminum			3.22E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.50E-03
Barium			8.27E-02	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	2.00E-04
Cadmium			5.19E-03	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	4.00E-04
Calcium	4.28E+04	5.79E+04	1.93E+02	---	1.90E+00	8.13E+04	1.10E+05	1.00E+00	4.28E+04	2.00E-03
Chromium		1.00E+01		---	1.00E-03	0.00E+00	1.00E-02	7.00E-02	0.00E+00	9.00E-03
Copper	4.34E+01	3.00E+01	3.68E-03	---	8.00E-01	3.47E+01	2.40E+01	2.50E-01	1.09E+01	9.00E-03
Iron			1.53E+01	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	2.00E-02
Lead	9.34E+02	5.78E+02	6.89E-03	---	1.10E-03	1.03E+00	6.36E-01	9.30E-01	8.69E+02	4.00E-04
Magnesium	7.10E+03	7.07E+03	4.12E+01	---	7.80E-01	5.54E+03	5.51E+03	1.00E+00	7.10E+03	2.00E-02
Manganese	1.37E+03	8.51E+02	3.01E+00	---	6.80E-01	9.32E+02	5.79E+02	3.20E-01	4.38E+02	5.00E-04
Mercury	1.98E-01	1.08E-01		---	5.50E-01	1.09E-01	5.94E-02	1.00E+00	1.98E-01	2.50E-01
Nickel		1.88E+01			3.60E-01	0.00E+00	6.77E+00	3.80E-01	0.00E+00	5.00E-03
Potassium			2.55E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.00E-02
Selenium			3.11E-03	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.50E-02
Sodium	2.36E+02	2.16E+02	4.86E+00	---	6.50E-02	1.53E+01	1.40E+01	1.00E+00	2.36E+02	8.00E-02
Zinc	3.21E+02	1.99E+02		---	4.30E-01	1.38E+02	8.56E+01	3.00E-01	9.63E+01	1.00E-01

Table G-1

Toxicity Data

Plum Brook Ordnance Works
TNT Area C

Chemical Name	Mammals NOAEL (mg/kg/d)	Mammals Test Species	Mammals Body Wt. (kg)	Birds NOAEL (mg/kg/d)	Birds Test Species	Birds Body Wt. (kg)
Organics						
Aroclor-1260	6.80E-02	mouse	0.014	1.80E-01	ring-neck pheasant	1
Benzo(a)anthracene	1.00E+00	mouse	0.03	--	--	--
Benzo(a)pyrene	1.00E+00	mouse	0.03	--	--	--
Carbon disulfide	3.19E+01	rat	0.35	--	--	--
Chrysene	1.00E+00	mouse	0.03	--	--	--
Di-n-butyl phthalate	5.50E+02	mouse	0.03	1.10E-01	ringed dove	0.155
2-Amino-4,6-DNT	1.39E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
4-Amino-2,6-DNT	9.59E+00	rat	0.35	7.00E-01	Bobwhite quail	0.19
1,3-DNB	1.13E-01	rat	0.35	4.20E-01	red-winged black bird	0.077
2,4-DNT	2.00E-01	dog	11	7.00E-01	Bobwhite quail	0.19
2,6-DNT	2.00E-01	dog	11	7.00E-01	Bobwhite quail	0.19
Dinitrotoluene	2.00E-01	dog	11	7.00E-01	Bobwhite quail	0.19
2-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
3-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
4-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
Tetryl	1.30E+00	rat	0.35	--	--	--
1,3,5-TNB	2.68E+00	rat	0.35	4.20E-01	red-winged black bird	0.077
2,4,6-TNT	1.60E+00	rat	0.35	7.00E-01	Bobwhite quail	0.19
Inorganics						
Aluminum	1.93E+00	mouse	0.03	1.10E+02	ringed dove	0.155
Barium	5.10E+00	rat	0.435	2.08E+01	chicks	0.121
Cadmium	1.00E+00	rat	0.303	1.45E+00	mallard duck	1.153
Calcium	1.05E+03	rabbit	3.8	2.83E+03	Jap. quail	0.072
Chromium	2.74E+03	rat	0.35	1.00E+00	black duck	1.25
Copper	1.17E+01	mink	1	4.70E+01	chicks	0.534
Iron	2.60E+01	rabbit	3.8	5.00E+01	poultry	1.6
Lead	8.00E+00	rat	0.35	3.85E+00	Am. Kestrel	0.13
Magnesium	1.58E+02	rabbit	3.8	1.50E+02	poultry	1.6
Manganese	8.80E+01	rat	0.35	9.77E+02	Jap. Quail	0.072
Mercury	1.00E+00	mink	1	4.50E-01	Jap. Quail	0.15
Nickel	4.00E+01	rat	0.35	7.74E+01	mallard duck	0.782
Potassium	1.60E+03	rabbit	3.8	1.00E+03	poultry	1.6
Selenium	2.00E-01	rat	0.35	5.00E-01	mallard duck	1.00
Sodium	1.60E+03	rabbit	3.8	1.00E+03	poultry	1.6
Zinc	1.60E+02	rat	0.35	1.45E+01	hens	1.935

Table G-1

Plum Brook Ordnance Works
TNT Area C

Omnivorous Rodent: **Deer mouse *(Peromyscus manicalatus)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Plant/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics																
Aroclor-1260	6.71E-02	8.00E+00	8.38E-03	1.00E+00	1.00E+00	1.81E-02	2.16E+00	1.56E-03	1.86E-01	9.47E+00	1.13E+03	1.13E+03	0.00E+00	0.00E+00	1.13E+03	4.93E+01
Benzo(a)anthracene	1.19E+00	8.00E+00	1.49E-01	1.00E+00	1.00E+00	2.56E-02	1.71E-01	1.69E-02	1.13E-01	2.84E-01	1.91E+00	2.19E+00	0.00E+00	0.00E+00	2.19E+00	4.42E-02
Benzo(a)pyrene	1.19E+00	8.00E+00	1.49E-01	1.00E+00	1.00E+00	2.44E-02	1.63E-01	8.88E-03	5.96E-02	2.15E-01	1.44E+00	1.66E+00	0.00E+00	0.00E+00	1.66E+00	9.75E-02
Carbon disulfide	7.03E+01	8.00E+00	8.79E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.43E-03	3.91E-04	3.91E-04	5.89E-08
Chrysene	1.19E+00	8.00E+00	1.49E-01	1.00E+00	1.00E+00	1.77E-02	1.19E-01	1.17E-02	7.86E-02	1.87E-01	1.25E+00	1.45E+00	0.00E+00	0.00E+00	1.45E+00	2.93E-02
Di-n-butyl phthalate	6.56E+02	8.00E+00	8.20E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.80E-04	9.51E-06	9.51E-06	9.24E-05
2-Amino-4,6-DNT	3.07E+01	8.00E+00	3.84E+00	1.00E+00	1.00E+00	1.46E-01	3.81E-02	1.19E+01	3.09E+00	2.80E-01	7.30E-02	3.20E+00	1.46E-04	3.81E-05	3.20E+00	3.08E-04
4-Amino-2,6-DNT	2.11E+01	8.00E+00	2.64E+00	1.00E+00	1.00E+00	2.44E-02	9.24E-03	1.98E+00	7.48E-01	4.68E-02	1.77E-02	7.75E-01	8.16E-05	3.09E-05	7.75E-01	5.14E-05
1,3-DNB	2.49E-01	8.00E+00	3.11E-02	1.00E+00	1.00E+00	2.89E-03	9.29E-02	4.62E-01	1.48E+01	5.54E-03	1.78E-01	1.51E+01	0.00E+00	0.00E+00	1.51E+01	3.51E-06
2,4-DNT	1.04E+00	8.00E+00	1.31E-01	1.00E+00	1.00E+00	4.08E-02	3.13E-01	3.41E+00	2.61E+01	7.82E-02	5.99E-01	2.70E+01	0.00E+00	0.00E+00	2.70E+01	8.39E-05
2,6-DNT	1.04E+00	8.00E+00	1.31E-01	1.00E+00	1.00E+00	2.68E-02	2.05E-01	1.50E+00	1.15E+01	5.13E-02	3.93E-01	1.21E+01	0.00E+00	0.00E+00	1.21E+01	7.67E-05
Dinitrotoluene	1.04E+00	8.00E+00	1.31E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-03	9.02E-03	9.02E-03	5.73E-08
2-Nitrotoluene	9.92E+01	8.00E+00	1.24E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E-03	1.25E-04	1.25E-04	7.94E-08
3-Nitrotoluene	9.92E+01	8.00E+00	1.24E+01	1.00E+00	1.00E+00	6.59E-03	5.31E-04	2.93E-01	2.36E-02	1.26E-02	1.02E-03	2.52E-02	2.19E-04	1.76E-05	2.52E-02	2.29E-05
4-Nitrotoluene	9.92E+01	8.00E+00	1.24E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.39E-04	5.15E-05	5.15E-05	4.36E-08
Tetryl	2.87E+00	8.00E+00	3.58E-01	1.00E+00	1.00E+00	2.41E-03	6.73E-03	3.11E-01	8.68E-01	4.62E-03	1.29E-02	8.88E-01	0.00E+00	0.00E+00	8.88E-01	3.48E-06
1,3,5-TNB	5.91E+00	8.00E+00	7.39E-01	1.00E+00	1.00E+00	3.05E-02	4.13E-02	7.38E+00	9.99E+00	5.85E-02	7.92E-02	1.01E+01	0.00E+00	0.00E+00	1.01E+01	2.66E-05
2,4,6-TNT	3.53E+00	8.00E+00	4.41E-01	1.00E+00	1.00E+00	1.59E+02	3.61E+02	1.29E+04	2.92E+04	3.05E+02	6.91E+02	3.03E+04	5.11E-05	1.16E-04	3.03E+04	3.35E-01
Inorganics																
Aluminum	2.30E+00	8.00E+00	2.88E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.79E-01	1.66E+00	1.66E+00	8.41E-03
Barium	1.19E+01	8.00E+00	1.48E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	8.28E-03	8.28E-03	2.88E-05
Cadmium	2.13E+00	8.00E+00	2.66E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.71E-04	2.90E-03	2.90E-03	3.61E-06
Calcium	4.22E+03	8.00E+00	5.27E+02	1.00E+00	1.00E+00	1.65E+02	3.13E-01	9.38E+03	1.78E+01	3.16E+03	5.99E+00	2.41E+01	2.87E+01	5.45E-02	2.42E+01	2.98E+02
Chromium	6.04E+03	8.00E+00	7.54E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	3.35E+01	8.00E+00	4.19E+00	1.00E+00	1.00E+00	1.67E-01	3.99E-02	4.01E+00	9.56E-01	8.01E-01	1.91E-01	1.19E+00	5.47E-04	1.30E-04	1.19E+00	5.24E-01
Iron	1.04E+02	8.00E+00	1.30E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.27E+00	1.75E-01	1.75E-01	5.33E-01
Lead	1.76E+01	8.00E+00	2.21E+00	1.00E+00	1.00E+00	3.60E+00	1.63E+00	1.19E-01	5.38E-02	6.41E+01	2.91E+01	3.07E+01	1.02E-03	4.64E-04	3.07E+01	3.18E-01
Magnesium	6.32E+02	8.00E+00	7.91E+01	1.00E+00	1.00E+00	2.73E+01	3.46E-01	6.39E+02	8.08E+00	5.24E+02	6.63E+00	1.51E+01	6.12E+00	7.75E-02	1.51E+01	2.80E+02
Manganese	1.94E+02	8.00E+00	2.43E+01	1.00E+00	1.00E+00	5.28E+00	2.18E-01	1.08E+02	4.43E+00	3.23E+01	1.33E+00	5.98E+00	4.47E-01	1.84E-02	6.00E+00	8.53E-01
Mercury	2.87E+00	8.00E+00	3.58E-01	1.00E+00	1.00E+00	7.63E-04	2.13E-03	1.26E-02	3.51E-02	1.46E-02	4.08E-02	7.80E-02	0.00E+00	0.00E+00	7.80E-02	8.18E-02
Nickel	8.82E+01	8.00E+00	1.10E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium	6.39E+03	8.00E+00	7.99E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.79E-01	4.74E-04	4.74E-04	4.44E-02
Selenium	4.41E-01	8.00E+00	5.51E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.62E-04	8.39E-03	8.39E-03	8.12E-05
Sodium	6.39E+03	8.00E+00	7.99E+02	1.00E+00	1.00E+00	9.09E-01	1.14E-03	1.77E+00	2.22E-03	1.74E+01	2.18E-02	2.51E-02	7.22E-01	9.04E-04	2.60E-02	1.95E+01
Zinc	3.53E+02	8.00E+00	4.41E+01	1.00E+00	1.00E+00	1.24E+00	2.80E-02	1.59E+01	3.61E-01	7.11E+00	1.61E-01	5.50E-01	0.00E+00	0.00E+00	5.50E-01	2.84E+01
TOTAL							**3.67E+02**		**2.93E+04**		**1.87E+03**	**3.16E+04**		**2.02E+00**	**3.16E+04**	

Body Weight (kg)	0.0148
Water intake (L/d)	0.0022
Food intake (kg(dw)/d)	0.0028
Soil intake (kg/d)	0.000057
Plant intake (kg(dw)/d) – 61% of diet	0.001708
Invertebrate intake (kg(dw)/d) – 39% of diet	0.001092

Table G-1

Plum Brook Ordnance Works
TNT Area C

Opportunistic Omnivore: **Raccoon *(Procyon lotor)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Mouse Intake (mg/kg-d)	Mouse Intake Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics																	
Aroclor-1260	1.56E-02	8.00E+00	1.95E-03	1.00E+00	1.00E+00	1.11E-02	5.70E+00	2.89E-04	1.49E-01	1.96E+00	1.01E+03	1.26E-01	6.46E+01	1.08E+03	0.00E+00	0.00E+00	1.08E+03
Benzo(a)anthracene	2.77E-01	8.00E+00	3.46E-02	1.00E+00	1.00E+00	1.56E-02	4.51E-01	3.14E-03	9.06E-02	5.89E-02	1.70E+00	1.13E-04	3.26E-03	2.25E+00	0.00E+00	0.00E+00	2.25E+00
Benzo(a)pyrene	2.77E-01	8.00E+00	3.46E-02	1.00E+00	1.00E+00	1.49E-02	4.30E-01	1.65E-03	4.76E-02	4.45E-02	1.29E+00	2.49E-04	7.18E-03	1.77E+00	0.00E+00	0.00E+00	1.77E+00
Carbon disulfide	1.63E+01	8.00E+00	2.04E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-10	7.36E-11	7.36E-11	9.74E-04	4.77E-04	4.77E-04
Chrysene	2.77E-01	8.00E+00	3.46E-02	1.00E+00	1.00E+00	1.08E-02	3.13E-01	2.17E-03	6.28E-02	3.87E-02	1.12E+00	7.46E-05	2.15E-03	1.50E+00	0.00E+00	0.00E+00	1.50E+00
Di-n-butyl phthalate	1.52E+02	8.00E+00	1.90E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E-07	1.24E-08	1.24E-08	2.21E-04	1.16E-05	1.16E-05
2-Amino-4,6-DNT	7.13E+00	8.00E+00	8.92E-01	1.00E+00	1.00E+00	8.94E-02	1.00E-01	2.20E+00	2.47E+00	5.81E-02	6.52E-02	7.86E-07	8.81E-07	2.63E+00	4.15E-05	4.65E-05	2.63E+00
4-Amino-2,6-DNT	4.91E+00	8.00E+00	6.14E-01	1.00E+00	1.00E+00	1.49E-02	2.43E-02	3.67E-01	5.98E-01	9.70E-03	1.58E-02	1.31E-07	2.14E-07	6.38E-01	2.31E-05	3.77E-05	6.38E-01
1,3-DNB	5.78E-02	8.00E+00	7.23E-03	1.00E+00	1.00E+00	1.77E-03	2.44E-01	8.57E-02	1.19E+01	1.15E-03	1.59E-01	8.95E-09	1.24E-06	1.23E+01	0.00E+00	0.00E+00	1.23E+01
2,4-DNT	2.42E-01	8.00E+00	3.03E-02	1.00E+00	1.00E+00	2.49E-02	8.23E-01	6.32E-01	2.09E+01	1.62E-02	5.35E-01	2.14E-07	7.06E-06	2.22E+01	0.00E+00	0.00E+00	2.22E+01
2,6-DNT	2.42E-01	8.00E+00	3.03E-02	1.00E+00	1.00E+00	1.64E-02	5.40E-01	2.78E-01	9.16E+00	1.06E-02	3.51E-01	1.95E-07	6.45E-06	1.01E+01	0.00E+00	0.00E+00	1.01E+01
Dinitrotoluene	2.42E-01	8.00E+00	3.03E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-10	4.82E-09	4.82E-09	3.34E-04	1.10E-02	1.10E-02
2-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.02E-10	7.03E-11	7.03E-11	4.38E-04	1.52E-04	1.52E-04
3-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	1.00E+00	1.00E+00	4.02E-03	1.40E-03	5.44E-02	1.89E-02	2.62E-03	9.08E-04	5.83E-08	2.03E-08	2.12E-02	6.20E-05	2.15E-05	2.12E-02
4-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-10	3.86E-11	3.86E-11	1.81E-04	6.30E-05	6.30E-05
Tetryl	6.65E-01	8.00E+00	8.32E-02	1.00E+00	1.00E+00	1.47E-03	1.77E-02	5.77E-02	6.94E-01	9.57E-04	1.15E-02	8.86E-09	1.07E-07	7.23E-01	0.00E+00	0.00E+00	7.23E-01
1,3,5-TNB	1.37E+00	8.00E+00	1.71E-01	1.00E+00	1.00E+00	1.87E-02	1.09E-01	1.37E+00	7.99E+00	1.21E-02	7.07E-02	6.78E-08	3.95E-07	8.17E+00	0.00E+00	0.00E+00	8.17E+00
2,4,6-TNT	8.19E-01	8.00E+00	1.02E-01	1.00E+00	1.00E+00	9.72E+01	9.49E+02	2.39E+03	2.34E+04	6.32E+01	6.17E+02	8.54E-04	8.34E-03	2.49E+04	1.45E-05	1.42E-04	2.49E+04
Inorganics																	
Aluminum	5.34E-01	8.00E+00	6.68E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E-05	3.21E-04	3.21E-04	1.36E-01	2.03E+00	2.03E+00
Barium	2.76E+00	8.00E+00	3.45E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.34E-08	2.13E-07	2.13E-07	3.49E-03	1.01E-02	1.01E-02
Cadmium	4.94E-01	8.00E+00	6.17E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.21E-09	1.49E-07	1.49E-07	2.19E-04	3.55E-03	3.55E-03
Calcium	9.78E+02	8.00E+00	1.22E+02	1.00E+00	1.00E+00	1.01E+02	8.23E-01	1.74E+03	1.42E+01	6.55E+02	5.35E+00	7.60E-01	6.22E-03	2.04E+01	8.14E+00	6.65E-02	2.05E+01
Chromium	1.40E+03	8.00E+00	1.75E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	7.79E+00	8.00E+00	9.73E-01	1.00E+00	1.00E+00	1.02E-01	1.05E-01	7.43E-01	7.64E-01	1.66E-01	1.71E-01	1.34E-03	1.37E-03	1.04E+00	1.55E-04	1.59E-04	1.04E+00
Iron	2.42E+01	8.00E+00	3.02E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.36E-03	4.50E-04	4.50E-04	6.45E-01	2.14E-01	2.14E-01
Lead	4.09E+00	8.00E+00	5.12E-01	1.00E+00	1.00E+00	2.20E+00	4.29E+00	2.20E-02	4.30E-02	1.33E+01	2.60E+01	8.10E-04	1.58E-03	3.03E+01	2.90E-04	5.67E-04	3.03E+01
Magnesium	1.47E+02	8.00E+00	1.83E+01	1.00E+00	1.00E+00	1.67E+01	9.10E-01	1.19E+02	6.46E+00	1.09E+02	5.92E+00	7.14E-01	3.89E-02	1.33E+01	1.74E+00	9.47E-02	1.34E+01
Manganese	4.50E+01	8.00E+00	5.63E+00	1.00E+00	1.00E+00	3.22E+00	5.73E-01	1.99E+01	3.54E+00	6.70E+00	1.19E+00	2.17E-03	3.86E-04	5.31E+00	1.27E-01	2.25E-02	5.33E+00
Mercury	6.65E-01	8.00E+00	8.32E-02	1.00E+00	1.00E+00	4.66E-04	5.60E-03	2.33E-03	2.80E-02	3.03E-03	3.64E-02	2.09E-04	2.51E-03	7.25E-02	0.00E+00	0.00E+00	7.25E-02
Nickel	2.05E+01	8.00E+00	2.56E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium	1.48E+03	8.00E+00	1.85E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-04	6.10E-07	6.10E-07	1.08E-01	5.80E-04	5.80E-04
Selenium	1.02E-01	8.00E+00	1.28E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-07	1.62E-05	1.62E-05	1.31E-04	1.02E-02	1.03E-02
Sodium	1.48E+03	8.00E+00	1.85E+02	1.00E+00	1.00E+00	5.55E-01	2.99E-03	3.28E-01	1.77E-03	3.61E+00	1.95E-02	4.97E-02	2.68E-04	2.45E-02	2.05E-01	1.10E-03	2.56E-02
Zinc	8.19E+01	8.00E+00	1.02E+01	1.00E+00	1.00E+00	7.55E-01	7.38E-02	2.96E+00	2.89E-01	1.47E+00	1.44E-01	7.25E-02	7.08E-03	5.13E-01	0.00E+00	0.00E+00	5.13E-01
TOTAL							**9.65E+02**		**2.34E+04**		**1.67E+03**		**6.47E+01**	**2.61E+04**		**2.47E+00**	**2.61E+04**

Body Weight (kg)	5.1
Water intake (L/d)	0.215
Food intake (kg(dw)/d)	0.26
Soil Intake (kg/d)	0.012
Mouse Intake (kg(dw)/d) -- 5 % of diet	0.013
Plant intake (kg(dw)/d) -- 42% of diet	0.1092
Invertebrate intake (kg(dw)/d) -- 30% of diet	0.078

Table G-1

Plum Brook Ordnance Works

Herbivorous Rodent: **Eastern Cottontail *(Sylvilagus floridanus)*** **TNT Area C**

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Hazard Quotient	Soil/Plant Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	4.06E-02	8.00E+00	5.08E-03	1.00E+00	1.00E+00	2.50E-02	4.92E+00	1.15E-03	2.26E-01	5.14E+00	0.00E+00	0.00E+00	5.14E+00	4.02E-01
Benzo(a)anthracene	7.23E-01	8.00E+00	9.03E-02	1.00E+00	1.00E+00	3.52E-02	3.90E-01	1.24E-02	1.38E-01	5.27E-01	0.00E+00	0.00E+00	5.27E-01	1.91E-02
Benzo(a)pyrene	7.23E-01	8.00E+00	9.03E-02	1.00E+00	1.00E+00	3.36E-02	3.71E-01	6.53E-03	7.23E-02	4.44E-01	0.00E+00	0.00E+00	4.44E-01	4.66E-02
Carbon disulfide	4.26E+01	8.00E+00	5.32E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.24E-03	4.22E-04	4.22E-04	1.14E-07
Chrysene	7.23E-01	8.00E+00	9.03E-02	1.00E+00	1.00E+00	2.44E-02	2.70E-01	8.61E-03	9.53E-02	3.65E-01	0.00E+00	0.00E+00	3.65E-01	1.32E-02
Di-n-butyl phthalate	3.97E+02	8.00E+00	4.97E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.10E-04	1.03E-05	1.03E-05	1.79E-04
2-Amino-4,6-DNT	1.86E+01	8.00E+00	2.33E+00	1.00E+00	1.00E+00	2.01E-01	8.65E-02	8.71E+00	3.74E+00	3.83E+00	9.56E-05	4.11E-05	3.83E+00	6.63E-04
4-Amino-2,6-DNT	1.28E+01	8.00E+00	1.60E+00	1.00E+00	1.00E+00	3.36E-02	2.10E-02	1.45E+00	9.08E-01	9.29E-01	5.33E-05	3.33E-05	9.29E-01	1.11E-04
1,3-DNB	1.51E-01	8.00E+00	1.89E-02	1.00E+00	1.00E+00	3.98E-03	2.11E-01	3.40E-01	1.80E+01	1.82E+01	0.00E+00	0.00E+00	1.82E+01	7.59E-06
2,4-DNT	6.32E-01	8.00E+00	7.91E-02	1.00E+00	1.00E+00	5.62E-02	7.11E-01	2.50E+00	3.17E+01	3.24E+01	0.00E+00	0.00E+00	3.24E+01	1.80E-04
2,6-DNT	6.32E-01	8.00E+00	7.91E-02	1.00E+00	1.00E+00	3.68E-02	4.66E-01	1.10E+00	1.39E+01	1.44E+01	0.00E+00	0.00E+00	1.44E+01	1.64E-04
Dinitrotoluene	6.32E-01	8.00E+00	7.91E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.70E-04	9.73E-03	9.73E-03	1.11E-07
2-Nitrotoluene	6.01E+01	8.00E+00	7.51E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-03	1.35E-04	1.35E-04	1.54E-07
3-Nitrotoluene	6.01E+01	8.00E+00	7.51E+00	1.00E+00	1.00E+00	9.06E-03	1.21E-03	2.15E-01	2.87E-02	2.99E-02	1.43E-04	1.90E-05	2.99E-02	4.87E-05
4-Nitrotoluene	6.01E+01	8.00E+00	7.51E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.18E-04	5.56E-05	5.56E-05	8.43E-08
Tetryl	1.74E+00	8.00E+00	2.17E-01	1.00E+00	1.00E+00	3.32E-03	1.53E-02	2.29E-01	1.05E+00	1.07E+00	0.00E+00	0.00E+00	1.07E+00	7.50E-06
1,3,5-TNB	3.58E+00	8.00E+00	4.47E-01	1.00E+00	1.00E+00	4.20E-02	9.39E-02	5.42E+00	1.21E+01	1.22E+01	0.00E+00	0.00E+00	1.22E+01	5.76E-05
2,4,6-TNT	2.14E+00	8.00E+00	2.67E-01	1.00E+00	1.00E+00	2.19E+02	8.20E+02	9.47E+03	3.55E+04	3.63E+04	3.34E-05	1.25E-04	3.63E+04	7.20E-01
Inorganics														
Aluminum	1.39E+00	8.00E+00	1.74E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.13E-01	1.79E+00	1.79E+00	1.63E-02
Barium	7.19E+00	8.00E+00	8.99E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.04E-03	8.94E-03	8.94E-03	5.57E-05
Cadmium	1.29E+00	8.00E+00	1.61E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.04E-04	3.13E-03	3.13E-03	7.00E-06
Calcium	2.55E+03	4.00E+00	6.38E+02	1.00E+00	1.00E+00	2.27E+02	3.55E-01	6.90E+03	1.08E+01	1.12E+01	1.88E+01	2.94E-02	1.12E+01	4.95E+02
Chromium	3.66E+03	8.00E+00	4.57E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	2.03E+01	8.00E+00	2.54E+00	1.00E+00	1.00E+00	2.30E-01	9.06E-02	2.94E+00	1.16E+00	1.25E+00	3.58E-04	1.41E-04	1.25E+00	9.91E-01
Iron	6.30E+01	4.00E+00	1.58E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.49E+00	9.43E-02	9.43E-02	1.03E+00
Lead	1.07E+01	8.00E+00	1.34E+00	1.00E+00	1.00E+00	4.95E+00	3.71E+00	8.71E-02	6.52E-02	3.77E+00	6.70E-04	5.01E-04	3.77E+00	6.99E-02
Magnesium	3.83E+02	4.00E+00	9.58E+01	1.00E+00	1.00E+00	3.76E+01	3.93E-01	4.70E+02	4.90E+00	5.30E+00	4.00E+00	4.18E-02	5.34E+00	3.55E+02
Manganese	1.18E+02	8.00E+00	1.47E+01	1.00E+00	1.00E+00	7.26E+00	4.94E-01	7.90E+01	5.38E+00	5.87E+00	2.92E-01	1.99E-02	5.89E+00	1.50E+00
Mercury	1.74E+00	8.00E+00	2.17E-01	1.00E+00	1.00E+00	1.05E-03	4.84E-03	9.24E-03	4.25E-02	4.74E-02	0.00E+00	0.00E+00	4.74E-02	8.92E-02
Nickel	5.34E+01	8.00E+00	6.68E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium	3.87E+03	4.00E+00	9.68E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E-01	2.56E-04	2.56E-04	8.59E-02
Selenium	2.67E-01	8.00E+00	3.34E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.02E-04	9.05E-03	9.05E-03	1.57E-04
Sodium	3.87E+03	4.00E+00	9.68E+02	1.00E+00	1.00E+00	1.25E+00	1.29E-03	1.30E+00	1.34E-03	2.64E-03	4.72E-01	4.88E-04	3.12E-03	8.39E+00
Zinc	2.14E+02	8.00E+00	2.67E+01	1.00E+00	1.00E+00	1.70E+00	6.37E-02	1.17E+01	4.38E-01	5.02E-01	0.00E+00	0.00E+00	5.02E-01	4.65E+01
TOTAL							**8.32E+02**		**3.56E+04**	**3.64E+04**		**2.01E+00**	**3.64E+04**	

Body Weight (kg)	1.132
Water intake (L/d)	0.11
Food intake (kg(dw)/d)	0.096
Soil intake (kg/d)	0.006
Plant intake (kg(dw)/d) -- 100% of diet	0.096

Table G-1

Plum Brook Ordnance Works
TNT Area C

Insectivorous mammal: **Short-tailed shrew *(Blarina brevicauda)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	1.07E-01	8.00E+00	1.34E-02	1.00E+00	1.00E+00	9.46E-02	7.09E+00	1.88E+01	1.41E+03	1.42E+03	0.00E+00	0.00E+00	1.42E+03	1.30E+02
Benzo(a)anthracene	1.90E+00	8.00E+00	2.38E-01	1.00E+00	1.00E+00	1.85E-01	7.80E-01	5.65E-01	2.38E+00	3.16E+00	0.00E+00	0.00E+00	3.16E+00	1.34E-01
Benzo(a)pyrene	1.90E+00	8.00E+00	2.38E-01	1.00E+00	1.00E+00	1.84E-01	7.73E-01	4.27E-01	1.80E+00	2.57E+00	0.00E+00	0.00E+00	2.57E+00	3.17E-01
Carbon disulfide	1.12E+02	8.00E+00	1.40E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.54E-03	2.53E-04	2.53E-04	8.03E-08
Chrysene	1.90E+00	8.00E+00	2.38E-01	1.00E+00	1.00E+00	3.50E-02	1.47E-01	3.71E-01	1.56E+00	1.71E+00	0.00E+00	0.00E+00	1.71E+00	7.26E-02
Di-n-butyl phthalate	1.05E+03	8.00E+00	1.31E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.05E-04	6.16E-06	6.16E-06	1.26E-04
2-Amino-4,6-DNT	4.90E+01	8.00E+00	6.12E+00	1.00E+00	1.00E+00	2.10E+00	3.44E-01	5.57E-01	9.11E-02	4.35E-01	1.51E-04	2.47E-05	4.35E-01	8.82E-05
4-Amino-2,6-DNT	3.37E+01	8.00E+00	4.21E+00	1.00E+00	1.00E+00	8.08E-01	1.92E-01	9.30E-02	2.21E-02	2.14E-01	8.42E-05	2.00E-05	2.14E-01	2.99E-05
1,3-DNB	3.97E-01	8.00E+00	4.96E-02	1.00E+00	1.00E+00	5.53E-03	1.12E-01	1.10E-02	2.22E-01	3.34E-01	0.00E+00	0.00E+00	3.34E-01	1.63E-07
2,4-DNT	1.66E+00	8.00E+00	2.08E-01	1.00E+00	1.00E+00	1.12E+00	5.38E+00	1.55E-01	7.48E-01	6.12E+00	0.00E+00	0.00E+00	6.12E+00	4.00E-05
2,6-DNT	1.66E+00	8.00E+00	2.08E-01	1.00E+00	1.00E+00	2.46E-02	1.18E-01	1.02E-01	4.90E-01	6.09E-01	0.00E+00	0.00E+00	6.09E-01	8.14E-06
Dinitrotoluene	1.66E+00	8.00E+00	2.08E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-03	5.84E-03	5.84E-03	7.81E-08
2-Nitrotoluene	1.58E+02	8.00E+00	1.98E+01	1.00E+00	1.00E+00	1.11E-02	5.60E-04	0.00E+00	0.00E+00	5.60E-04	1.59E-03	8.07E-05	6.41E-04	8.59E-07
3-Nitrotoluene	1.58E+02	8.00E+00	1.98E+01	1.00E+00	1.00E+00	1.11E-02	5.60E-04	2.51E-02	1.27E-03	1.83E-03	2.25E-04	1.14E-05	1.84E-03	3.52E-06
4-Nitrotoluene	1.58E+02	8.00E+00	1.98E+01	1.00E+00	1.00E+00	1.11E-02	5.60E-04	0.00E+00	0.00E+00	5.60E-04	6.59E-04	3.34E-05	5.94E-04	1.06E-06
Tetryl	4.57E+00	8.00E+00	5.71E-01	1.00E+00	1.00E+00	1.11E-02	1.94E-02	9.18E-03	1.61E-02	3.55E-02	0.00E+00	0.00E+00	3.55E-02	2.92E-07
1,3,5-TNB	9.41E+00	8.00E+00	1.18E+00	1.00E+00	1.00E+00	2.26E-02	1.92E-02	1.16E-01	9.88E-02	1.18E-01	0.00E+00	0.00E+00	1.18E-01	6.53E-07
2,4,6-TNT	5.62E+00	8.00E+00	7.02E-01	1.00E+00	1.00E+00	2.29E+03	3.25E+03	6.06E+02	8.62E+02	4.12E+03	5.27E-05	7.51E-05	4.12E+03	9.58E-02
Inorganics														
Aluminum	3.67E+00	8.00E+00	4.58E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.94E-01	1.08E+00	1.08E+00	1.15E-02
Barium	1.89E+01	8.00E+00	2.36E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E-02	5.36E-03	5.36E-03	3.92E-05
Cadmium	3.39E+00	8.00E+00	4.23E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.96E-04	1.88E-03	1.88E-03	4.92E-06
Calcium	6.71E+03	8.00E+00	8.39E+02	1.00E+00	1.00E+00	3.20E+03	3.82E+00	6.28E+03	7.48E+00	1.13E+01	2.96E+01	3.53E-02	1.13E+01	2.94E+02
Chromium	9.61E+03	8.00E+00	1.20E+03	1.00E+00	1.00E+00	5.53E-01	4.60E-04	0.00E+00	0.00E+00	4.60E-04	0.00E+00	0.00E+00	4.60E-04	7.70E-02
Copper	5.34E+01	8.00E+00	6.68E+00	1.00E+00	1.00E+00	1.66E+00	2.49E-01	1.59E+00	2.38E-01	4.87E-01	5.64E-04	8.45E-05	4.87E-01	4.53E-01
Iron	1.66E+02	8.00E+00	2.07E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E+00	1.13E-01	1.13E-01	7.26E-01
Lead	2.81E+01	8.00E+00	3.51E+00	1.00E+00	1.00E+00	3.20E+01	9.11E+00	1.27E+02	3.63E+01	4.54E+01	1.06E-03	3.01E-04	4.54E+01	9.86E-01
Magnesium	1.01E+03	8.00E+00	1.26E+02	1.00E+00	1.00E+00	3.91E+02	3.11E+00	1.04E+03	8.27E+00	1.14E+01	6.32E+00	5.02E-02	1.14E+01	4.45E+02
Manganese	3.09E+02	8.00E+00	3.86E+01	1.00E+00	1.00E+00	4.71E+01	1.22E+00	6.43E+01	1.66E+00	2.88E+00	4.62E-01	1.19E-02	2.90E+00	8.65E-01
Mercury	4.57E+00	8.00E+00	5.71E-01	1.00E+00	1.00E+00	5.98E-03	1.05E-02	2.90E-02	5.09E-02	6.13E-02	0.00E+00	0.00E+00	6.13E-02	1.35E-01
Nickel	1.40E+02	8.00E+00	1.76E+01	1.00E+00	1.00E+00	1.04E+00	5.92E-02	0.00E+00	0.00E+00	5.92E-02	0.00E+00	0.00E+00	5.92E-02	8.05E-02
Potassium	1.02E+04	8.00E+00	1.27E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.91E-01	3.07E-04	3.07E-04	6.05E-02
Selenium	7.02E-01	8.00E+00	8.78E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.77E-04	5.43E-03	5.43E-03	1.11E-04
Sodium	1.02E+04	8.00E+00	1.27E+03	1.00E+00	1.00E+00	1.20E+01	9.39E-03	3.46E+01	2.72E-02	3.66E-02	7.45E-01	5.86E-04	3.72E-02	5.86E+01
Zinc	5.62E+02	8.00E+00	7.02E+01	1.00E+00	1.00E+00	1.10E+01	1.57E-01	1.41E+01	2.01E-01	3.58E-01	0.00E+00	0.00E+00	3.58E-01	3.89E+01
TOTAL							**3.29E+03**		**2.33E+03**	**5.62E+03**		**1.31E+00**	**5.62E+03**	

Body Weight (kg)	0.015
Water intake (L/d)	0.0023
Food intake (kg(dw)/d)	0.0022
Soil intake (kg/d)	0.00083
Invertebrate intake (kg(dw)/d)--100% of diet	0.0022

Table G-1

Plum Brook Ordnance Works
TNT Area C

Herbivorous Mammal: **White-tailed deer *(Odocoileus virginianus)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Soil/Plant Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics													
Aroclor-1260	1.65E-02	8.00E+00	2.07E-03	9.00E-02	9.00E-02	2.78E-04	1.34E-01	1.45E-05	7.00E-03	1.41E-01	0.00E+00	0.00E+00	1.41E-01
Benzo(a)anthracene	2.94E-01	8.00E+00	3.68E-02	9.00E-02	9.00E-02	3.92E-04	1.07E-02	2.18E-04	5.93E-03	1.66E-02	0.00E+00	0.00E+00	1.66E-02
Benzo(a)pyrene	2.94E-01	8.00E+00	3.68E-02	9.00E-02	9.00E-02	3.74E-04	1.02E-02	1.19E-04	3.24E-03	1.34E-02	0.00E+00	0.00E+00	1.34E-02
Carbon disulfide	1.73E+01	8.00E+00	2.17E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.32E-03	3.84E-03	3.84E-03
Chrysene	2.94E-01	8.00E+00	3.68E-02	9.00E-02	9.00E-02	2.71E-04	7.38E-03	4.12E-05	1.12E-03	8.50E-03	0.00E+00	0.00E+00	8.50E-03
Di-n-butyl phthalate	1.62E+02	8.00E+00	2.02E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E-03	9.34E-05	9.34E-05
2-Amino-4,6-DNT	7.58E+00	8.00E+00	9.48E-01	9.00E-02	9.00E-02	2.24E-03	2.37E-03	3.03E-01	3.20E-01	3.22E-01	3.54E-04	3.74E-04	3.23E-01
4-Amino-2,6-DNT	5.22E+00	8.00E+00	6.52E-01	9.00E-02	9.00E-02	3.74E-04	5.74E-04	1.16E-01	1.79E-01	1.79E-01	1.98E-04	3.03E-04	1.80E-01
1,3-DNB	6.15E-02	8.00E+00	7.68E-03	9.00E-02	9.00E-02	4.43E-05	5.77E-03	1.57E-03	2.05E-01	2.11E-01	0.00E+00	0.00E+00	2.11E-01
2,4-DNT	2.58E-01	8.00E+00	3.22E-02	9.00E-02	9.00E-02	6.26E-04	1.94E-02	1.66E-01	5.16E+00	5.18E+00	0.00E+00	0.00E+00	5.18E+00
2,6-DNT	2.58E-01	8.00E+00	3.22E-02	9.00E-02	9.00E-02	4.10E-04	1.27E-02	2.45E-03	7.61E-02	8.88E-02	0.00E+00	0.00E+00	8.88E-02
Dinitrotoluene	2.58E-01	8.00E+00	3.22E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.85E-03	8.86E-02	8.86E-02
2-Nitrotoluene	2.45E+01	8.00E+00	3.06E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	1.07E-03	3.49E-04	3.49E-04	3.74E-03	1.22E-03	1.57E-03
3-Nitrotoluene	2.45E+01	8.00E+00	3.06E+00	9.00E-02	9.00E-02	1.01E-04	3.30E-05	8.76E-04	2.86E-04	3.19E-04	5.29E-04	1.73E-04	4.92E-04
4-Nitrotoluene	2.45E+01	8.00E+00	3.06E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	9.13E-04	2.98E-04	2.98E-04	1.55E-03	5.06E-04	8.04E-04
Tetryl	7.07E-01	8.00E+00	8.84E-02	9.00E-02	9.00E-02	3.69E-05	4.18E-04	2.54E-03	2.88E-02	2.92E-02	0.00E+00	0.00E+00	2.92E-02
1,3,5-TNB	1.46E+00	8.00E+00	1.82E-01	9.00E-02	9.00E-02	4.68E-04	2.57E-03	9.71E-03	5.33E-02	5.59E-02	0.00E+00	0.00E+00	5.59E-02
2,4,6-TNT	8.70E-01	8.00E+00	1.09E-01	9.00E-02	9.00E-02	2.44E+00	2.24E+01	3.30E+02	3.03E+03	3.05E+03	1.24E-04	1.14E-03	3.05E+03
Inorganics													
Aluminum	5.68E-01	8.00E+00	7.10E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E+00	1.63E+01	1.63E+01
Barium	2.93E+00	8.00E+00	3.66E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.98E-02	8.13E-02	8.13E-02
Cadmium	5.25E-01	8.00E+00	6.56E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.87E-03	2.85E-02	2.85E-02
Calcium	1.04E+03	8.00E+00	1.30E+02	9.00E-02	9.00E-02	2.53E+00	1.94E-02	3.25E+02	2.50E+00	2.52E+00	6.95E+01	5.35E-01	3.05E+00
Chromium	1.49E+03	8.00E+00	1.86E+02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	2.95E-05	1.59E-07	1.59E-07	0.00E+00	0.00E+00	1.59E-07
Copper	8.27E+00	8.00E+00	1.03E+00	9.00E-02	9.00E-02	2.56E-03	2.48E-03	7.08E-02	6.85E-02	7.10E-02	1.32E-03	1.28E-03	7.22E-02
Iron	2.57E+01	8.00E+00	3.21E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.51E+00	1.72E+00	1.72E+00
Lead	4.35E+00	8.00E+00	5.44E-01	9.00E-02	9.00E-02	5.51E-02	1.01E-01	1.88E-03	3.45E-03	1.05E-01	2.48E-03	4.56E-03	1.09E-01
Magnesium	1.56E+02	8.00E+00	1.95E+01	9.00E-02	9.00E-02	4.19E-01	2.15E-02	1.63E+01	8.35E-01	8.56E-01	1.48E+01	7.61E-01	1.62E+00
Manganese	4.79E+01	8.00E+00	5.98E+00	9.00E-02	9.00E-02	8.09E-02	1.35E-02	1.71E+00	2.85E-01	2.99E-01	1.08E+00	1.81E-01	4.80E-01
Mercury	7.07E-01	8.00E+00	8.84E-02	9.00E-02	9.00E-02	1.17E-05	1.32E-04	1.75E-04	1.98E-03	2.12E-03	0.00E+00	0.00E+00	2.12E-03
Nickel	2.18E+01	8.00E+00	2.72E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	2.00E-02	7.34E-03	7.34E-03	0.00E+00	0.00E+00	7.34E-03
Potassium	1.58E+03	8.00E+00	1.97E+02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.18E-01	4.66E-03	4.66E-03
Selenium	1.09E-01	8.00E+00	1.36E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-03	8.23E-02	8.23E-02
Sodium	1.58E+03	8.00E+00	1.97E+02	9.00E-02	9.00E-02	1.39E-02	7.07E-05	4.14E-02	2.10E-04	2.81E-04	1.75E+00	8.88E-03	9.16E-03
Zinc	8.70E+01	8.00E+00	1.09E+01	9.00E-02	9.00E-02	1.89E-02	1.74E-03	2.53E-01	2.32E-02	2.50E-02	0.00E+00	0.00E+00	2.50E-02
TOTAL							**2.28E+01**		**3.04E+03**	**3.06E+03**		**1.98E+01**	**3.08E+03**

Body Weight (kg)	61
Water Intake (L/d)	4
Food intake (kg(dw)/d)	2
Soil intake (kg/d)	0.04
Plant intake (kg(dw)/d) -- 100% of diet	2

Table G-1

Plum Brook Ordnance Works
TNT Area C

Insectivorous Bird: **Marsh wren *(Cistothorus palustris)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	1.80E-01	8.00E+00	2.25E-02	1.00E+00	1.00E+00	8.95E-02	3.98E+00	3.72E+01	1.65E+03	1.66E+03	0.00E+00	0.00E+00	1.66E+03	1.67E+02
Benzo(a)anthracene	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	1.26E-01	0.00E+00	1.12E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01
Benzo(a)pyrene	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	1.20E-01	0.00E+00	8.44E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.27E-01
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.24E-03	0.00E+00	0.00E+00	9.24E-08
Chrysene	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	8.74E-02	0.00E+00	7.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.60E-02
Di-n-butyl phthalate	1.10E-01	8.00E+00	1.38E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E-03	1.03E-01	1.03E-01	1.45E-04
2-Amino-4,6-DNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	7.22E-01	8.25E+00	1.10E+00	1.26E+01	2.08E+01	2.66E-04	3.04E-03	2.08E+01	3.95E-05
4-Amino-2,6-DNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	1.20E-01	1.38E+00	1.84E-01	2.10E+00	3.48E+00	1.48E-04	1.69E-03	3.48E+00	6.60E-06
1,3-DNB	4.20E-01	8.00E+00	5.25E-02	1.00E+00	1.00E+00	1.43E-02	2.72E-01	2.18E-02	4.15E-01	6.87E-01	0.00E+00	0.00E+00	6.87E-01	2.32E-07
2,4-DNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	2.01E-01	2.30E+00	3.07E-01	3.51E+00	5.81E+00	0.00E+00	0.00E+00	5.81E+00	1.05E-05
2,6-DNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	1.32E-01	1.51E+00	2.02E-01	2.30E+00	3.81E+00	0.00E+00	0.00E+00	3.81E+00	1.40E-05
Dinitrotoluene	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E-03	2.44E-02	2.44E-02	8.99E-08
2-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.81E-03	3.21E-02	3.21E-02	1.25E-07
3-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	3.25E-02	3.71E-01	4.96E-02	5.67E-01	9.38E-01	3.97E-04	4.54E-03	9.43E-01	5.22E-06
4-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-03	1.33E-02	1.33E-02	6.83E-08
Tetryl	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	1.19E-02	0.00E+00	1.82E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.83E-07
1,3,5-TNB	4.20E-01	8.00E+00	5.25E-02	1.00E+00	1.00E+00	1.51E-01	2.87E+00	2.30E-01	4.38E+00	7.25E+00	0.00E+00	0.00E+00	7.25E+00	1.17E-06
2,4,6-TNT	7.00E-01	8.00E+00	8.75E-02	1.00E+00	1.00E+00	7.85E+02	8.97E+03	1.20E+03	1.37E+04	2.27E+04	9.29E-05	1.06E-03	2.27E+04	4.30E-02
Inorganics														
Aluminum	1.10E+02	8.00E+00	1.38E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.69E-01	6.32E-02	6.32E-02	1.32E-02
Barium	2.08E+01	8.00E+00	2.60E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.23E-02	8.59E-03	8.59E-03	4.52E-05
Cadmium	1.45E+00	8.00E+00	1.81E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-03	7.73E-03	7.73E-03	5.67E-06
Calcium	2.83E+03	8.00E+00	3.54E+02	1.00E+00	1.00E+00	8.13E+02	2.30E+00	1.24E+04	3.50E+01	3.73E+01	5.21E+01	1.47E-01	3.75E+01	2.69E+02
Chromium	1.00E+00	8.00E+00	1.25E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	4.70E+01	8.00E+00	5.88E+00	1.00E+00	1.00E+00	8.25E-01	1.40E-01	3.15E+00	5.36E-01	6.76E-01	9.94E-04	1.69E-04	6.76E-01	3.62E-01
Iron	5.00E+01	8.00E+00	6.25E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.13E+00	6.61E-01	6.61E-01	8.36E-01
Lead	3.85E+00	8.00E+00	4.81E-01	1.00E+00	1.00E+00	1.77E+01	3.69E+01	2.52E+02	5.23E+02	5.60E+02	1.86E-03	3.87E-03	5.60E+02	1.09E+00
Magnesium	1.50E+02	8.00E+00	1.88E+01	1.00E+00	1.00E+00	1.35E+02	7.19E+00	2.06E+03	1.10E+02	1.17E+02	1.11E+01	5.93E-01	1.18E+02	4.46E+02
Manganese	9.77E+02	8.00E+00	1.22E+02	1.00E+00	1.00E+00	2.60E+01	2.13E-01	1.27E+02	1.04E+00	1.25E+00	8.13E-01	6.65E-03	1.26E+00	7.79E-01
Mercury	4.50E-01	8.00E+00	5.63E-02	1.00E+00	1.00E+00	3.76E-03	6.69E-02	5.74E-02	1.02E+00	1.09E+00	0.00E+00	0.00E+00	1.09E+00	1.55E-01
Nickel	7.74E+01	8.00E+00	9.68E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium	1.00E+03	8.00E+00	1.25E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.89E-01	5.51E-03	5.51E-03	6.96E-02
Selenium	5.00E-01	8.00E+00	6.25E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.40E-04	1.34E-02	1.34E-02	1.27E-04
Sodium	1.00E+03	8.00E+00	1.25E+02	1.00E+00	1.00E+00	4.48E+00	3.59E-02	6.84E+01	5.48E-01	5.83E-01	1.31E+00	1.05E-02	5.94E-01	6.01E+01
Zinc	1.45E+01	8.00E+00	1.81E+00	1.00E+00	1.00E+00	6.10E+00	3.36E+00	2.79E+01	1.54E+01	1.88E+01	0.00E+00	0.00E+00	1.88E+01	3.44E+01
TOTAL							**9.04E+03**		**1.60E+04**	**2.51E+04**		**1.70E+00**	**2.51E+04**	

Body Weight (kg)	0.01
Water Intake (L/d)	0.0027
Food intake (kg(dw)/d)	0.0029
Soil Intake (kg/d)	0.00019
Plant intake (kg(dw)/d) -- 0% of diet	0
Invertebrate intake (kg(dw)/d) -- 100% of diet	0.0029

Table G-1

Plum Brook Ordnance Works
TNT Area C

Avian predator: **Red-tailed hawk (*Buteo jamaicensis*)**

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Bird Intake (mg/kg-d)	Bird Intake Hazard Quotient	Mouse Intake (mg/kg-d)	Mouse Intake Hazard Quotient	Rabbit Intake (mg/kg-d)	Rabbit Intake Hazard Quotient	Shrew Intake (mg/kg-d)	Shrew Intake Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics																			
Aroclor-1260	1.80E-01	8.00E+00	2.25E-02	6.00E-02	6.00E-02	5.91E-04	2.62E-02	1.44E-01	6.38E+00	4.46E-02	1.98E+00	3.64E-04	1.62E-02	1.18E-01	5.22E+00	1.36E+01	0.00E+00	0.00E+00	1.36E+01
Benzo(a)anthracene	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	8.33E-04	0.00E+00	1.25E-04	0.00E+00	4.00E-05	0.00E+00	1.73E-05	0.00E+00	1.21E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	7.94E-04	0.00E+00	2.81E-04	0.00E+00	8.83E-05	0.00E+00	4.22E-05	0.00E+00	2.87E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	7.93E-11	0.00E+00	5.33E-11	0.00E+00	1.03E-10	0.00E+00	7.27E-11	0.00E+00	0.00E+00	8.26E-05	0.00E+00	0.00E+00
Chrysene	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	5.77E-04	0.00E+00	8.23E-05	0.00E+00	2.65E-05	0.00E+00	1.20E-05	0.00E+00	6.57E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate	1.10E-01	8.00E+00	1.38E-02	6.00E-02	6.00E-02	0.00E+00	0.00E+00	1.24E-07	9.04E-06	8.36E-08	6.08E-06	1.62E-07	1.18E-05	1.14E-07	8.29E-06	3.52E-05	1.88E-05	1.36E-03	1.40E-03
2-Amino-4,6-DNT	7.00E-01	8.00E+00	8.75E-02	6.00E-02	6.00E-02	4.76E-03	5.45E-02	3.39E-08	3.88E-07	2.79E-07	3.19E-06	6.00E-07	6.86E-06	7.98E-08	9.12E-07	5.45E-02	3.52E-06	4.02E-05	5.45E-02
4-Amino-2,6-DNT	7.00E-01	8.00E+00	8.75E-02	6.00E-02	6.00E-02	7.95E-04	9.09E-03	5.66E-09	6.47E-08	4.66E-08	5.32E-07	1.00E-07	1.14E-06	2.70E-08	3.09E-07	9.09E-03	1.96E-06	2.24E-05	9.11E-03
1,3-DNB	4.20E-01	8.00E+00	5.25E-02	6.00E-02	6.00E-02	9.42E-05	1.79E-03	1.99E-10	3.79E-09	3.18E-09	6.05E-08	6.87E-09	1.31E-07	1.48E-10	2.81E-09	1.79E-03	0.00E+00	0.00E+00	1.79E-03
2,4-DNT	7.00E-01	8.00E+00	8.75E-02	6.00E-02	6.00E-02	1.33E-03	1.52E-02	8.97E-09	1.03E-07	7.60E-08	8.68E-07	1.63E-07	1.87E-06	3.62E-08	4.14E-07	1.52E-02	0.00E+00	0.00E+00	1.52E-02
2,6-DNT	7.00E-01	8.00E+00	8.75E-02	6.00E-02	6.00E-02	8.71E-04	9.96E-03	1.20E-08	1.38E-07	6.94E-08	7.93E-07	1.48E-07	1.70E-06	7.37E-09	8.42E-08	9.96E-03	0.00E+00	0.00E+00	9.96E-03
Dinitrotoluene	7.00E-01	8.00E+00	8.75E-02	6.00E-02	6.00E-02	0.00E+00	0.00E+00	7.71E-11	8.82E-10	5.19E-11	5.93E-10	1.00E-10	1.15E-09	7.07E-11	8.08E-10	3.43E-09	2.83E-05	3.23E-04	3.23E-04
2-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	6.00E-02	6.00E-02	0.00E+00	0.00E+00	1.07E-10	1.22E-09	7.19E-11	8.21E-10	1.39E-10	1.59E-09	7.78E-10	8.89E-09	1.25E-08	3.72E-05	4.25E-04	4.25E-04
3-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	6.00E-02	6.00E-02	2.14E-04	2.45E-03	4.47E-09	5.11E-08	2.07E-08	2.37E-07	4.41E-08	5.04E-07	3.19E-09	3.64E-08	2.45E-03	5.25E-06	6.00E-05	2.51E-03
4-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	6.00E-02	6.00E-02	0.00E+00	0.00E+00	5.86E-11	6.70E-10	3.94E-11	4.51E-10	7.63E-11	8.72E-10	9.56E-10	1.09E-08	1.29E-08	1.54E-05	1.76E-04	1.76E-04
Tetryl	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	7.85E-05	0.00E+00	2.43E-10	0.00E+00	3.15E-09	0.00E+00	6.79E-09	0.00E+00	2.65E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5-TNB	4.20E-01	8.00E+00	5.25E-02	6.00E-02	6.00E-02	9.94E-04	1.89E-02	1.00E-09	1.91E-08	2.41E-08	4.59E-07	5.22E-08	9.94E-07	5.91E-10	1.13E-08	1.89E-02	0.00E+00	0.00E+00	1.89E-02
2,4,6-TNT	7.00E-01	8.00E+00	8.75E-02	6.00E-02	6.00E-02	5.18E+00	5.92E+01	3.68E-05	4.21E-04	3.03E-04	3.47E-03	6.52E-04	7.45E-03	8.68E-05	9.92E-04	5.92E+01	1.23E-06	1.40E-05	5.92E+01
Inorganics																			
Aluminum	1.10E+02	8.00E+00	1.38E+01	6.00E-02	6.00E-02	0.00E+00	0.00E+00	1.13E-05	8.23E-07	7.61E-06	5.54E-07	1.47E-05	1.07E-06	1.04E-05	7.54E-07	3.20E-06	1.15E-02	8.37E-04	8.40E-04
Barium	2.08E+01	8.00E+00	2.60E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	3.87E-08	1.49E-08	2.61E-08	1.00E-08	5.05E-08	1.94E-08	3.55E-08	1.37E-08	5.80E-08	2.96E-04	1.14E-04	1.14E-04
Cadmium	1.45E+00	8.00E+00	1.81E-01	6.00E-02	6.00E-02	0.00E+00	0.00E+00	4.86E-09	2.68E-08	3.27E-09	1.81E-08	6.33E-09	3.49E-08	4.46E-09	2.46E-08	1.04E-07	1.85E-05	1.02E-04	1.02E-04
Calcium	2.83E+03	8.00E+00	3.54E+02	6.00E-02	6.00E-02	5.37E+00	1.52E-02	2.30E-01	6.50E-04	2.70E-01	7.63E-04	4.48E-01	1.27E-03	2.66E-01	7.52E-04	1.86E-02	6.90E-01	1.95E-03	2.05E-02
Chromium	1.00E+00	8.00E+00	1.25E-01	6.00E-02	6.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.97E-05	5.58E-04	5.58E-04	0.00E+00	0.00E+00	5.58E-04
Copper	4.70E+01	8.00E+00	5.88E+00	6.00E-02	6.00E-02	5.44E-03	9.26E-04	3.10E-04	5.28E-05	4.75E-04	8.08E-05	8.97E-04	1.53E-04	4.10E-04	6.98E-05	1.28E-03	1.32E-05	2.24E-06	1.28E-03
Iron	5.00E+01	8.00E+00	6.25E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	7.17E-04	1.15E-04	4.82E-04	7.72E-05	9.34E-04	1.49E-04	6.57E-04	1.05E-04	4.46E-04	5.47E-02	8.75E-03	9.19E-03
Lead	3.85E+00	8.00E+00	4.81E-01	6.00E-02	6.00E-02	1.17E-01	2.43E-01	9.36E-04	1.94E-03	2.88E-04	5.98E-04	6.33E-05	1.31E-04	8.93E-04	1.86E-03	2.48E-01	2.46E-05	5.12E-05	2.48E-01
Magnesium	1.50E+02	8.00E+00	1.88E+01	6.00E-02	6.00E-02	8.90E-01	4.75E-02	3.83E-01	2.04E-02	2.54E-01	1.35E-02	3.21E-01	1.71E-02	4.03E-01	2.15E-02	1.20E-01	1.47E-01	7.85E-03	1.28E-01
Manganese	9.77E+02	8.00E+00	1.22E+02	6.00E-02	6.00E-02	1.72E-01	1.41E-03	6.68E-04	5.47E-06	7.72E-04	6.32E-06	1.36E-03	1.11E-05	7.83E-04	6.41E-06	1.44E-03	1.08E-02	8.81E-05	1.52E-03
Mercury	4.50E-01	8.00E+00	5.63E-02	6.00E-02	6.00E-02	2.48E-05	4.41E-04	1.33E-04	2.36E-03	7.41E-05	1.32E-03	8.07E-05	1.44E-03	1.23E-04	2.18E-03	7.73E-03	0.00E+00	0.00E+00	7.73E-03
Nickel	7.74E+01	8.00E+00	9.68E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.28E-05	7.53E-06	7.53E-06	0.00E+00	0.00E+00	7.53E-06
Potassium	1.00E+03	8.00E+00	1.25E+02	6.00E-02	6.00E-02	0.00E+00	0.00E+00	5.97E-05	4.78E-07	4.02E-05	3.22E-07	7.78E-05	6.22E-07	5.48E-05	4.38E-07	1.86E-06	9.11E-03	7.29E-05	7.48E-05
Selenium	5.00E-01	8.00E+00	6.25E-02	6.00E-02	6.00E-02	0.00E+00	0.00E+00	1.09E-07	1.75E-06	7.35E-08	1.18E-06	1.42E-07	2.28E-06	1.00E-07	1.60E-06	6.80E-06	1.11E-05	1.78E-04	1.85E-04
Sodium	1.00E+03	8.00E+00	1.25E+02	6.00E-02	6.00E-02	2.96E-02	2.37E-04	5.15E-02	4.12E-04	1.77E-02	1.41E-04	7.60E-03	6.08E-05	5.30E-02	4.24E-04	1.27E-03	1.74E-02	1.39E-04	1.41E-03
Zinc	1.45E+01	8.00E+00	1.81E+00	6.00E-02	6.00E-02	4.03E-02	2.22E-02	2.95E-02	1.63E-02	2.57E-02	1.42E-02	4.21E-02	2.32E-02	3.52E-02	1.94E-02	9.53E-02	0.00E+00	0.00E+00	9.53E-02
TOTAL							**5.96E+01**		**6.41E+00**		**2.00E+00**		**4.40E-02**		**5.25E+00**	**7.33E+01**		**2.26E-02**	**7.34E+01**

Body Weight (kg)	0.957
Water intake (L/d)	0.057
Food intake (kg(dw)/d)	0.057
Soil intake (kg/d)	0.002
Bird intake (kg(dw)/d) -- 24% of diet	0.01368
Mouse intake (kg(dw)/d) -- 25.3% of diet	0.01444
Shrew intake (kg(dw)/d) -- 25.3% of diet	0.01444
Rabbit intake (kg(dw)/d) -- 25.3% of diet	0.01444

Table G-2

Plum Brook Ordnance Works
TNT Area C

Chemical Data

Chemical Name	Surface Soil Conc. (mg/kg)	Total Soil Conc. (mg/kg)	Water Conc. (mg/L)	log Kow (organics)	Soil-to-Plant TF	Shallow-rooted Plant Conc. (mg/kgdw)	Deep-rooted Plant Conc. (mg/kgdw)	Soil-to-Invert. BAF	Invert. Conc. (mg/kgdw)	Food-to-Muscle TF
Organics										
Aroclor-1260	4.71E+00	1.71E+00		7.15E+00	2.87E-03	1.35E-02	4.90E-03	2.73E+01	1.28E+02	4.44E-01
Benzo(a)anthracene	6.64E+00	3.35E+00		5.61E+00	2.21E-02	1.47E-01	7.39E-02	5.80E-01	3.85E+00	1.16E-02
Benzo(a)pyrene	6.33E+00	3.32E+00		6.06E+00	1.22E-02	7.70E-02	4.04E-02	4.60E-01	2.91E+00	3.36E-02
Carbon disulfide			2.31E-02	1.84E+00	3.35E+00	0.00E+00	0.00E+00	1.48E+01	0.00E+00	1.46E-06
Chrysene	4.60E+00	6.32E-01		5.61E+00	2.21E-02	1.02E-01	1.39E-02	5.50E-01	2.53E+00	1.16E-02
Di-n-butyl phthalate			5.25E-03	5.56E+00	2.38E-02	0.00E+00	0.00E+00	2.27E+01	0.00E+00	1.01E-02
2-Amino-4,6-DNT	3.80E+01	3.80E+01	9.84E-04	2.00E+00	2.70E+00	1.03E+02	1.03E+02	1.00E-01	3.80E+00	2.14E-06
4-Amino-2,6-DNT	6.34E+00	1.46E+01	5.49E-04	2.00E+00	2.70E+00	1.71E+01	3.95E+01	1.00E-01	6.34E-01	2.14E-06
1,3-DNB	7.51E-01	1.00E-01		1.49E+00	5.33E+00	4.00E+00	5.33E-01	1.00E-01	7.51E-02	6.37E-07
2,4-DNT	1.06E+01	2.02E+01		1.98E+00	2.79E+00	2.95E+01	5.63E+01	1.00E-01	1.06E+00	2.03E-06
2,6-DNT	6.95E+00	4.45E-01		2.28E+00	1.87E+00	1.30E+01	8.30E-01	1.00E-01	6.95E-01	4.16E-06
Dinitrotoluene			7.92E-03	2.28E+00	1.87E+00	0.00E+00	0.00E+00	1.00E-01	0.00E+00	4.16E-06
2-Nitrotoluene		2.00E-01	1.04E-02	2.30E+00	1.81E+00	0.00E+00	3.62E-01	1.00E-01	0.00E+00	4.38E-06
3-Nitrotoluene	1.71E+00	2.00E-01	1.47E-03	2.45E+00	1.49E+00	2.54E+00	2.97E-01	1.00E-01	1.71E-01	6.25E-06
4-Nitrotoluene		2.00E-01	4.30E-03	2.42E+00	1.55E+00	0.00E+00	3.09E-01	1.00E-01	0.00E+00	5.82E-06
Tetryl	6.26E-01	2.00E-01		1.65E+00	4.31E+00	2.70E+00	8.61E-01	1.00E-01	6.26E-02	9.33E-07
1,3,5-TNB	7.93E+00	4.08E-01		1.18E+00	8.06E+00	6.39E+01	3.29E+00	1.00E-01	7.93E-01	3.04E-07
2,4,6-TNT	4.13E+04	4.13E+04	3.44E-04	2.00E+00	2.70E+00	1.12E+05	1.12E+05	1.00E-01	4.13E+03	2.14E-06
Inorganics										
Aluminum			3.22E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.50E-03
Barium			8.27E-02	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	2.00E-04
Cadmium			5.19E-03	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	4.00E-04
Calcium	4.28E+04	5.79E+04	1.93E+02	---	1.90E+00	8.13E+04	1.10E+05	1.00E+00	4.28E+04	2.00E-03
Chromium		1.00E+01		---	1.00E-03	0.00E+00	1.00E-02	7.00E-02	0.00E+00	9.00E-03
Copper	4.34E+01	3.00E+01	3.68E-03	---	8.00E-01	3.47E+01	2.40E+01	2.50E-01	1.09E+01	9.00E-03
Iron			1.53E+01	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	2.00E-02
Lead	9.34E+02	5.78E+02	6.89E-03	---	1.10E-03	1.03E+00	6.36E-01	9.30E-01	8.69E+02	4.00E-04
Magnesium	7.10E+03	7.07E+03	4.12E+01	---	7.80E-01	5.54E+03	5.51E+03	1.00E+00	7.10E+03	2.00E-02
Manganese	1.37E+03	8.51E+02	3.01E+00	---	6.80E-01	9.32E+02	5.79E+02	3.20E-01	4.38E+02	5.00E-04
Mercury	1.98E-01	1.08E-01		---	5.50E-01	1.09E-01	5.94E-02	1.00E+00	1.98E-01	2.50E-01
Nickel		1.88E+01			3.60E-01	0.00E+00	6.77E+00	3.80E-01	0.00E+00	5.00E-03
Potassium			2.55E+00	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.00E-02
Selenium			3.11E-03	---	NA	0.00E+00	0.00E+00	NA	0.00E+00	1.50E-02
Sodium	2.36E+02	2.16E+02	4.86E+00	---	6.50E-02	1.53E+01	1.40E+01	1.00E+00	2.36E+02	8.00E-02
Zinc	3.21E+02	1.99E+02		---	4.30E-01	1.38E+02	8.56E+01	3.00E-01	9.63E+01	1.00E-01

Table G-2

Toxicity Data

Plum Brook Ordnance Works
TNT Area C

Chemical Name	Mammals LOAEL (mg/kg/d)	Mammals Test Species	Mammals Body Wt. (kg)	Birds LOAEL (mg/kg/d)	Birds Test Species	Birds Body Wt. (kg)
Organics						
Aroclor-1260	6.80E-01	mouse	0.014	1.80E+00	ring-neck pheasant	1
Benzo(a)anthracene	1.00E+01	mouse	0.03	--	--	--
Benzo(a)pyrene	1.00E+01	mouse	0.03	--	--	--
Carbon disulfide	1.59E+02	rat	0.35	--	--	--
Chrysene	1.00E+01	mouse	0.03	--	--	--
Di-n-butyl phthalate	1.83E+03	mouse	0.03	1.10E+00	ringed dove	0.155
2-Amino-4,6-DNT	6.95E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
4-Amino-2,6-DNT	4.80E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
1,3-DNB	1.13E+00	rat	0.35	2.10E+00	red-winged black bird	0.077
2,4-DNT	1.50E+00	dog	11	1.78E+01	Bobwhite quail	0.19
2,6-DNT	1.50E+00	dog	11	1.78E+01	Bobwhite quail	0.19
Dinitrotoluene	1.50E+00	dog	11	1.78E+01	Bobwhite quail	0.19
2-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
3-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
4-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
Tetryl	6.50E+00	rat	0.35	--	--	--
1,3,5-TNB	1.33E+01	rat	0.35	2.10E+00	red-winged black bird	0.077
2,4,6-TNT	8.00E+00	rat	0.35	1.78E+01	Bobwhite quail	0.19
Inorganics						
Aluminum	1.93E+01	mouse	0.03	1.10E+03	ringed dove	0.155
Barium	1.98E+01	rat	0.35	4.17E+01	chicks	0.121
Cadmium	1.00E+01	rat	0.303	2.00E+01	mallard duck	1.153
Calcium	5.27E+03	rabbit	3.8	1.42E+04	Jap. quail	0.072
Chromium	1.37E+04	rat	0.35	5.00E+00	black duck	1.25
Copper	1.51E+01	mink	1	6.20E+01	chicks	0.534
Iron	1.30E+02	rabbit	3.8	2.50E+02	poultry	1.6
Lead	8.00E+01	rat	0.35	3.85E+01	Am. Kestrel	0.13
Magnesium	7.90E+02	rabbit	3.8	7.50E+02	poultry	1.6
Manganese	2.84E+02	rat	0.35	9.77E+03	Jap. Quail	0.072
Mercury	5.00E+00	mink	1	9.00E-01	Jap. Quail	0.15
Nickel	8.00E+01	rat	0.35	1.07E+02	mallard duck	0.782
Potassium	7.90E+03	rabbit	3.8	5.00E+03	poultry	1.6
Selenium	3.00E-01	rat	0.35	1.00E+00	mallard duck	1.00
Sodium	7.90E+03	rabbit	3.8	5.00E+03	poultry	1.6
Zinc	3.20E+02	rat	0.35	1.31E+02	hens	1.935

Table G-2

Plum Brook Ordnance Works
TNT Area C

Omnivorous Rodent: Deer mouse *(Peromyscus manicalatus)*

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Plant/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics																
Aroclor-1260	6.71E-01	8.00E+00	8.38E-02	1.00E+00	1.00E+00	1.81E-02	2.16E-01	1.56E-03	1.86E-02	9.47E+00	1.13E+02	1.13E+02	0.00E+00	0.00E+00	1.13E+02	4.93E+01
Benzo(a)anthracene	1.19E+01	8.00E+00	1.49E+00	1.00E+00	1.00E+00	2.56E-02	1.71E-02	1.69E-02	1.13E-02	2.84E-01	1.91E-01	2.19E-01	0.00E+00	0.00E+00	2.19E-01	4.42E-02
Benzo(a)pyrene	1.19E+01	8.00E+00	1.49E+00	1.00E+00	1.00E+00	2.44E-02	1.63E-02	8.88E-03	5.96E-03	2.15E-01	1.44E-01	1.66E-01	0.00E+00	0.00E+00	1.66E-01	9.75E-02
Carbon disulfide	3.52E+02	8.00E+00	4.39E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.43E-03	7.81E-05	7.81E-05	5.89E-08
Chrysene	1.19E+01	8.00E+00	1.49E+00	1.00E+00	1.00E+00	1.77E-02	1.19E-02	1.17E-02	7.86E-03	1.87E-01	1.25E-01	1.45E-01	0.00E+00	0.00E+00	1.45E-01	2.93E-02
Di-n-butyl phthalate	2.19E+03	8.00E+00	2.73E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.80E-04	2.85E-06	2.85E-06	9.24E-05
2-Amino-4,6-DNT	1.53E+02	8.00E+00	1.92E+01	1.00E+00	1.00E+00	1.46E-01	7.64E-03	1.19E+01	6.19E-01	2.80E-01	1.46E-02	6.41E-01	1.46E-04	7.64E-06	6.41E-01	3.08E-04
4-Amino-2,6-DNT	1.06E+02	8.00E+00	1.32E+01	1.00E+00	1.00E+00	2.44E-02	1.85E-03	1.98E+00	1.50E-01	4.68E-02	3.54E-03	1.55E-01	8.16E-05	6.17E-06	1.55E-01	5.14E-05
1,3-DNB	2.49E+00	8.00E+00	3.11E-01	1.00E+00	1.00E+00	2.89E-03	9.29E-03	4.62E-01	1.48E+00	5.54E-03	1.78E-02	1.51E+00	0.00E+00	0.00E+00	1.51E+00	3.51E-06
2,4-DNT	7.83E+00	8.00E+00	9.79E-01	1.00E+00	1.00E+00	4.08E-02	4.17E-02	3.41E+00	3.48E+00	7.82E-02	7.99E-02	3.60E+00	0.00E+00	0.00E+00	3.60E+00	8.39E-05
2,6-DNT	7.83E+00	8.00E+00	9.79E-01	1.00E+00	1.00E+00	2.68E-02	2.73E-02	1.50E+00	1.53E+00	5.13E-02	5.24E-02	1.61E+00	0.00E+00	0.00E+00	1.61E+00	7.67E-05
Dinitrotoluene	7.83E+00	8.00E+00	9.79E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-03	1.20E-03	1.20E-03	5.73E-08
2-Nitrotoluene	1.92E+02	8.00E+00	2.40E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E-03	6.45E-05	6.45E-05	7.94E-08
3-Nitrotoluene	1.92E+02	8.00E+00	2.40E+01	1.00E+00	1.00E+00	6.59E-03	2.75E-04	2.93E-01	1.22E-02	1.26E-02	5.26E-04	1.30E-02	2.19E-04	9.11E-06	1.30E-02	2.29E-05
4-Nitrotoluene	1.92E+02	8.00E+00	2.40E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.39E-04	2.67E-05	2.67E-05	4.36E-08
Tetryl	1.43E+01	8.00E+00	1.79E+00	1.00E+00	1.00E+00	2.41E-03	1.35E-03	3.11E-01	1.74E-01	4.62E-03	2.58E-03	1.78E-01	0.00E+00	0.00E+00	1.78E-01	3.48E-06
1,3,5-TNB	2.94E+01	8.00E+00	3.67E+00	1.00E+00	1.00E+00	3.05E-02	8.32E-03	7.38E+00	2.01E+00	5.85E-02	1.59E-02	2.04E+00	0.00E+00	0.00E+00	2.04E+00	2.66E-05
2,4,6-TNT	1.76E+01	8.00E+00	2.21E+00	1.00E+00	1.00E+00	1.59E+02	7.21E+01	1.29E+04	5.84E+03	3.05E+02	1.38E+02	6.05E+03	5.11E-05	2.32E-05	6.05E+03	3.35E-01
Inorganics																
Aluminum	2.30E+01	8.00E+00	2.88E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.79E-01	1.66E-01	1.66E-01	8.41E-03
Barium	4.37E+01	8.00E+00	5.46E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-02	2.25E-03	2.25E-03	2.88E-05
Cadmium	2.13E+01	8.00E+00	2.66E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.71E-04	2.90E-04	2.90E-04	3.61E-06
Calcium	2.11E+04	8.00E+00	2.63E+03	1.00E+00	1.00E+00	1.65E+02	6.26E-02	9.38E+03	3.56E+00	3.16E+03	1.20E+00	4.82E+00	2.87E+01	1.09E-02	4.83E+00	2.98E+02
Chromium	3.02E+04	8.00E+00	3.77E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	4.33E+01	8.00E+00	5.41E+00	1.00E+00	1.00E+00	1.67E-01	3.09E-02	4.01E+00	7.40E-01	8.01E-01	1.48E-01	9.19E-01	5.47E-04	1.01E-04	9.19E-01	5.24E-01
Iron	5.20E+02	8.00E+00	6.50E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.27E+00	3.50E-02	3.50E-02	5.33E-01
Lead	1.76E+02	8.00E+00	2.21E+01	1.00E+00	1.00E+00	3.60E+00	1.63E-01	1.19E-01	5.38E-03	6.41E+01	2.91E+00	3.07E+00	1.02E-03	4.64E-05	3.07E+00	3.18E-01
Magnesium	3.16E+03	8.00E+00	3.95E+02	1.00E+00	1.00E+00	2.73E+01	6.92E-02	6.39E+02	1.62E+00	5.24E+02	1.33E+00	3.01E+00	6.12E+00	1.55E-02	3.03E+00	2.80E+02
Manganese	6.26E+02	8.00E+00	7.83E+01	1.00E+00	1.00E+00	5.28E+00	6.74E-02	1.08E+02	1.37E+00	3.23E+01	4.13E-01	1.85E+00	4.47E-01	5.72E-03	1.86E+00	8.53E-01
Mercury	1.43E+01	8.00E+00	1.79E+00	1.00E+00	1.00E+00	7.63E-04	4.26E-04	1.26E-02	7.01E-03	1.46E-02	8.15E-03	1.56E-02	0.00E+00	0.00E+00	1.56E-02	8.18E-02
Nickel	1.76E+02	8.00E+00	2.21E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium	3.16E+04	8.00E+00	3.95E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.79E-01	9.60E-05	9.60E-05	4.44E-02
Selenium	6.62E-01	8.00E+00	8.27E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.62E-04	5.59E-03	5.59E-03	8.12E-05
Sodium	3.16E+04	8.00E+00	3.95E+03	1.00E+00	1.00E+00	9.09E-01	2.30E-04	1.77E+00	4.48E-04	1.74E+01	4.41E-03	5.09E-03	7.22E-01	1.83E-04	5.27E-03	1.95E+01
Zinc	7.06E+02	8.00E+00	8.82E+01	1.00E+00	1.00E+00	1.24E+00	1.40E-02	1.59E+01	1.81E-01	7.11E+00	8.06E-02	2.75E-01	0.00E+00	0.00E+00	2.75E-01	2.84E+01
TOTAL							**7.29E+01**		**5.86E+03**		**2.58E+02**	**6.19E+03**		**2.43E-01**	**6.19E+03**	

Body Weight (kg)	0.0148
Water intake (L/d)	0.0022
Food intake (kg(dw)/d)	0.0028
Soil Intake (kg/d)	0.000057
Plant intake (kg(dw)/d) -- 61% of diet	0.001708
Invertebrate intake (kg(dw)/d) -- 39% of diet	0.001092

Table G-2

Plum Brook Ordnance Works
TNT Area C

Opportunistic Omnivore: **Raccoon *(Procyon lotor)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Mouse Intake (mg/kg-d)	Mouse Intake Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics																	
Aroclor-1260	1.56E-01	8.00E+00	1.95E-02	1.00E+00	1.00E+00	1.11E-02	5.70E-01	2.89E-04	1.49E-02	1.96E+00	1.01E+02	1.26E-01	6.46E+00	1.08E+02	0.00E+00	0.00E+00	1.08E+02
Benzo(a)anthracene	2.77E+00	8.00E+00	3.46E-01	1.00E+00	1.00E+00	1.56E-02	4.51E-02	3.14E-03	9.06E-03	5.89E-02	1.70E-01	1.13E-04	3.26E-04	2.25E-01	0.00E+00	0.00E+00	2.25E-01
Benzo(a)pyrene	2.77E+00	8.00E+00	3.46E-01	1.00E+00	1.00E+00	1.49E-02	4.30E-02	1.65E-03	4.76E-03	4.45E-02	1.29E-01	2.49E-04	7.18E-04	1.77E-01	0.00E+00	0.00E+00	1.77E-01
Carbon disulfide	8.16E+01	8.00E+00	1.02E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-10	1.47E-11	1.47E-11	9.74E-04	9.55E-05	9.55E-05
Chrysene	2.77E+00	8.00E+00	3.46E-01	1.00E+00	1.00E+00	1.08E-02	3.13E-02	2.17E-03	6.28E-03	3.87E-02	1.12E-01	7.46E-05	2.15E-04	1.50E-01	0.00E+00	0.00E+00	1.50E-01
Di-n-butyl phthalate	5.08E+02	8.00E+00	6.35E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E-07	3.71E-09	3.71E-09	2.21E-04	3.49E-06	3.49E-06
2-Amino-4,6-DNT	3.56E+01	8.00E+00	4.45E+00	1.00E+00	1.00E+00	8.94E-02	2.01E-02	2.20E+00	4.95E-01	5.81E-02	1.31E-02	7.86E-07	1.77E-07	5.28E-01	4.15E-05	9.33E-06	5.28E-01
4-Amino-2,6-DNT	2.46E+01	8.00E+00	3.07E+00	1.00E+00	1.00E+00	1.49E-02	4.86E-03	3.67E-01	1.20E-01	9.70E-03	3.16E-03	1.31E-07	4.27E-08	1.28E-01	2.31E-05	7.54E-06	1.28E-01
1,3-DNB	5.78E-01	8.00E+00	7.23E-02	1.00E+00	1.00E+00	1.77E-03	2.44E-02	8.57E-02	1.19E+00	1.15E-03	1.59E-02	8.95E-09	1.24E-07	1.23E+00	0.00E+00	0.00E+00	1.23E+00
2,4-DNT	1.82E+00	8.00E+00	2.27E-01	1.00E+00	1.00E+00	2.49E-02	1.10E-01	6.32E-01	2.78E+00	1.62E-02	7.13E-02	2.14E-07	9.42E-07	2.96E+00	0.00E+00	0.00E+00	2.96E+00
2,6-DNT	1.82E+00	8.00E+00	2.27E-01	1.00E+00	1.00E+00	1.64E-02	7.20E-02	2.78E-01	1.22E+00	1.06E-02	4.68E-02	1.95E-07	8.60E-07	1.34E+00	0.00E+00	0.00E+00	1.34E+00
Dinitrotoluene	1.82E+00	8.00E+00	2.27E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.46E-10	6.43E-10	6.43E-10	3.34E-04	1.47E-03	1.47E-03
2-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.02E-10	3.64E-11	3.64E-11	4.38E-04	7.88E-05	7.88E-05
3-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	1.00E+00	1.00E+00	4.02E-03	7.23E-04	5.44E-02	9.77E-03	2.62E-03	4.70E-04	5.83E-08	1.05E-08	1.10E-02	6.20E-05	1.11E-05	1.10E-02
4-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.11E-10	1.99E-11	1.99E-11	1.81E-04	3.26E-05	3.26E-05
Tetryl	3.33E+00	8.00E+00	4.16E-01	1.00E+00	1.00E+00	1.47E-03	3.54E-03	5.77E-02	1.39E-01	9.57E-04	2.30E-03	8.86E-09	2.13E-08	1.45E-01	0.00E+00	0.00E+00	1.45E-01
1,3,5-TNB	6.81E+00	8.00E+00	8.52E-01	1.00E+00	1.00E+00	1.87E-02	2.19E-02	1.37E+00	1.61E+00	1.21E-02	1.42E-02	6.78E-08	7.96E-08	1.64E+00	0.00E+00	0.00E+00	1.64E+00
2,4,6-TNT	4.09E+00	8.00E+00	5.12E-01	1.00E+00	1.00E+00	9.72E+01	1.90E+02	2.39E+03	4.67E+03	6.32E+01	1.23E+02	8.54E-04	1.67E-03	4.99E+03	1.45E-05	2.83E-05	4.99E+03
Inorganics																	
Aluminum	5.34E+00	8.00E+00	6.68E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E-05	3.21E-05	3.21E-05	1.36E-01	2.03E-01	2.03E-01
Barium	1.01E+01	8.00E+00	1.27E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.34E-08	5.79E-08	5.79E-08	3.49E-03	2.75E-03	2.75E-03
Cadmium	4.94E+00	8.00E+00	6.17E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.21E-09	1.49E-08	1.49E-08	2.19E-04	3.55E-04	3.55E-04
Calcium	4.89E+03	8.00E+00	6.11E+02	1.00E+00	1.00E+00	1.01E+02	1.65E-01	1.74E+03	2.85E+00	6.55E+02	1.07E+00	7.60E-01	1.24E-03	4.08E+00	8.14E+00	1.33E-02	4.10E+00
Chromium	7.01E+03	8.00E+00	8.76E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	1.00E+01	8.00E+00	1.26E+00	1.00E+00	1.00E+00	1.02E-01	8.13E-02	7.43E-01	5.92E-01	1.66E-01	1.32E-01	1.34E-03	1.06E-03	8.06E-01	1.55E-04	1.24E-04	8.06E-01
Iron	1.21E+02	8.00E+00	1.51E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.36E-03	8.99E-05	8.99E-05	6.45E-01	4.27E-02	4.28E-02
Lead	4.09E+01	8.00E+00	5.12E+00	1.00E+00	1.00E+00	2.20E+00	4.29E-01	2.20E-02	4.30E-03	1.33E+01	2.60E+00	8.10E-04	1.58E-04	3.03E+00	2.90E-04	5.67E-05	3.03E+00
Magnesium	7.34E+02	8.00E+00	9.17E+01	1.00E+00	1.00E+00	1.67E+01	1.82E-01	1.19E+02	1.29E+00	1.09E+02	1.18E+00	7.14E-01	7.79E-03	2.67E+00	1.74E+00	1.89E-02	2.68E+00
Manganese	1.45E+02	8.00E+00	1.82E+01	1.00E+00	1.00E+00	3.22E+00	1.77E-01	1.99E+01	1.10E+00	6.70E+00	3.69E-01	2.17E-03	1.20E-04	1.64E+00	1.27E-01	6.98E-03	1.65E+00
Mercury	3.33E+00	8.00E+00	4.16E-01	1.00E+00	1.00E+00	4.66E-04	1.12E-03	2.33E-03	5.61E-03	3.03E-03	7.28E-03	2.09E-04	5.01E-04	1.45E-02	0.00E+00	0.00E+00	1.45E-02
Nickel	4.09E+01	8.00E+00	5.12E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium	7.34E+03	8.00E+00	9.17E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-04	1.23E-07	1.23E-07	1.08E-01	1.17E-04	1.17E-04
Selenium	1.54E-01	8.00E+00	1.92E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-07	1.08E-05	1.08E-05	1.31E-04	6.83E-03	6.84E-03
Sodium	7.34E+03	8.00E+00	9.17E+02	1.00E+00	1.00E+00	5.55E-01	6.06E-04	3.28E-01	3.58E-04	3.61E+00	3.94E-03	4.97E-02	5.42E-05	4.95E-03	2.05E-01	2.23E-04	5.18E-03
Zinc	1.64E+02	8.00E+00	2.05E+01	1.00E+00	1.00E+00	7.55E-01	3.69E-02	2.96E+00	1.44E-01	1.47E+00	7.19E-02	7.25E-02	3.54E-03	2.57E-01	0.00E+00	0.00E+00	2.57E-01
TOTAL							**1.92E+02**		**4.69E+03**		**2.30E+02**		**6.47E+00**	**5.11E+03**		**2.97E-01**	**5.11E+03**

Body Weight (kg)	5.1
Water intake (L/d)	0.215
Food intake (kg(dw)/d)	0.26
Soil intake (kg/d)	0.012
Mouse Intake (kg(dw)/d) -- 5 % of diet	0.013
Plant intake (kg(dw)/d) -- 42% of diet	0.1092
Invertebrate intake (kg(dw)/d) -- 30% of diet	0.078

Table G-2

Plum Brook Ordnance Works
TNT Area C

Herbivorous Rodent: **Eastern Cottontail *(Sylvilagus floridanus)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Hazard Quotient	Soil/Plant Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	4.06E-01	8.00E+00	5.08E-02	1.00E+00	1.00E+00	2.50E-02	4.92E-01	1.15E-03	2.26E-02	5.14E-01	0.00E+00	0.00E+00	5.14E-01	4.02E-01
Benzo(a)anthracene	7.23E+00	8.00E+00	9.03E-01	1.00E+00	1.00E+00	3.52E-02	3.90E-02	1.24E-02	1.38E-02	5.27E-02	0.00E+00	0.00E+00	5.27E-02	1.91E-02
Benzo(a)pyrene	7.23E+00	8.00E+00	9.03E-01	1.00E+00	1.00E+00	3.36E-02	3.71E-02	6.53E-03	7.23E-03	4.44E-02	0.00E+00	0.00E+00	4.44E-02	4.66E-02
Carbon disulfide	2.13E+02	8.00E+00	2.66E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.24E-03	8.44E-05	8.44E-05	1.14E-07
Chrysene	7.23E+00	8.00E+00	9.03E-01	1.00E+00	1.00E+00	2.44E-02	2.70E-02	8.61E-03	9.53E-03	3.65E-02	0.00E+00	0.00E+00	3.65E-02	1.32E-02
Di-n-butyl phthalate	1.32E+03	8.00E+00	1.66E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.10E-04	3.08E-06	3.08E-06	1.79E-04
2-Amino-4,6-DNT	9.28E+01	8.00E+00	1.16E+01	1.00E+00	1.00E+00	2.01E-01	1.74E-02	8.71E+00	7.51E-01	7.68E-01	9.56E-05	8.24E-06	7.68E-01	6.63E-04
4-Amino-2,6-DNT	6.41E+01	8.00E+00	8.01E+00	1.00E+00	1.00E+00	3.36E-02	4.19E-03	1.45E+00	1.81E-01	1.86E-01	5.33E-05	6.66E-06	1.86E-01	1.11E-04
1,3-DNB	1.51E+00	8.00E+00	1.89E-01	1.00E+00	1.00E+00	3.98E-03	2.11E-02	3.40E-01	1.80E+00	1.82E+00	0.00E+00	0.00E+00	1.82E+00	7.59E-06
2,4-DNT	4.74E+00	8.00E+00	5.93E-01	1.00E+00	1.00E+00	5.62E-02	9.48E-02	2.50E+00	4.22E+00	4.32E+00	0.00E+00	0.00E+00	4.32E+00	1.80E-04
2,6-DNT	4.74E+00	8.00E+00	5.93E-01	1.00E+00	1.00E+00	3.68E-02	6.21E-02	1.10E+00	1.85E+00	1.92E+00	0.00E+00	0.00E+00	1.92E+00	1.64E-04
Dinitrotoluene	4.74E+00	8.00E+00	5.93E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.70E-04	1.30E-03	1.30E-03	1.11E-07
2-Nitrotoluene	1.16E+02	8.00E+00	1.45E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.01E-03	6.96E-05	6.96E-05	1.54E-07
3-Nitrotoluene	1.16E+02	8.00E+00	1.45E+01	1.00E+00	1.00E+00	9.06E-03	6.24E-04	2.15E-01	1.48E-02	1.55E-02	1.43E-04	9.83E-06	1.55E-02	4.87E-05
4-Nitrotoluene	1.16E+02	8.00E+00	1.45E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.18E-04	2.88E-05	2.88E-05	8.43E-08
Tetryl	8.68E+00	8.00E+00	1.09E+00	1.00E+00	1.00E+00	3.32E-03	3.06E-03	2.29E-01	2.11E-01	2.14E-01	0.00E+00	0.00E+00	2.14E-01	7.50E-06
1,3,5-TNB	1.78E+01	8.00E+00	2.22E+00	1.00E+00	1.00E+00	4.20E-02	1.89E-02	5.42E+00	2.44E+00	2.46E+00	0.00E+00	0.00E+00	2.46E+00	5.76E-05
2,4,6-TNT	1.07E+01	8.00E+00	1.34E+00	1.00E+00	1.00E+00	2.19E+02	1.64E+02	9.47E+03	7.09E+03	7.25E+03	3.34E-05	2.50E-05	7.25E+03	7.20E-01
Inorganics														
Aluminum	1.39E+01	8.00E+00	1.74E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.13E-01	1.79E-01	1.79E-01	1.63E-02
Barium	2.64E+01	8.00E+00	3.31E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.04E-03	2.43E-03	2.43E-03	5.57E-05
Cadmium	1.29E+01	8.00E+00	1.61E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.04E-04	3.13E-04	3.13E-04	7.00E-06
Calcium	1.28E+04	4.00E+00	3.19E+03	1.00E+00	1.00E+00	2.27E+02	7.11E-02	6.90E+03	2.16E+00	2.23E+00	1.88E+01	5.88E-03	2.24E+00	4.95E+02
Chromium	1.83E+04	8.00E+00	2.29E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	2.62E+01	8.00E+00	3.28E+00	1.00E+00	1.00E+00	2.30E-01	7.02E-02	2.94E+00	8.98E-01	9.69E-01	3.58E-04	1.09E-04	9.69E-01	9.91E-01
Iron	3.15E+02	4.00E+00	7.88E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.49E+00	1.89E-02	1.89E-02	1.03E+00
Lead	1.07E+02	8.00E+00	1.34E+01	1.00E+00	1.00E+00	4.95E+00	3.71E-01	8.71E-02	6.52E-03	3.77E-01	6.70E-04	5.01E-05	3.77E-01	6.99E-02
Magnesium	1.92E+03	4.00E+00	4.79E+02	1.00E+00	1.00E+00	3.76E+01	7.86E-02	4.70E+02	9.81E-01	1.06E+00	4.00E+00	8.36E-03	1.07E+00	3.55E+02
Manganese	3.79E+02	8.00E+00	4.74E+01	1.00E+00	1.00E+00	7.26E+00	1.53E-01	7.90E+01	1.67E+00	1.82E+00	2.92E-01	6.17E-03	1.83E+00	1.50E+00
Mercury	8.68E+00	8.00E+00	1.09E+00	1.00E+00	1.00E+00	1.05E-03	9.67E-04	9.24E-03	8.51E-03	9.48E-03	0.00E+00	0.00E+00	9.48E-03	8.92E-02
Nickel	1.07E+02	8.00E+00	1.34E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium	1.91E+04	4.00E+00	4.79E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.48E-01	5.18E-05	5.18E-05	8.59E-02
Selenium	4.01E-01	8.00E+00	5.01E-02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.02E-04	6.03E-03	6.03E-03	1.57E-04
Sodium	1.91E+04	4.00E+00	4.79E+03	1.00E+00	1.00E+00	1.25E+00	2.61E-04	1.30E+00	2.72E-04	5.33E-04	4.72E-01	9.87E-05	6.32E-04	8.39E+00
Zinc	4.27E+02	8.00E+00	5.34E+01	1.00E+00	1.00E+00	1.70E+00	3.18E-02	1.17E+01	2.19E-01	2.51E-01	0.00E+00	0.00E+00	2.51E-01	4.65E+01
TOTAL							**1.65E+02**		**7.11E+03**	**7.27E+03**		**2.29E-01**	**7.27E+03**	

Body Weight (kg)	1.132
Water intake (L/d)	0.11
Food intake (kg(dw)/d)	0.096
Soil intake (kg/d)	0.006
Plant intake (kg(dw)/d) -- 100% of diet	0.096

Table G-2

Plum Brook Ordnance Works
TNT Area C

Insectivorous mammal: **Short-tailed shrew *(Blarina brevicauda)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	1.07E+00	8.00E+00	1.34E-01	1.00E+00	1.00E+00	9.46E-02	7.09E-01	1.88E+01	1.41E+02	1.42E+02	0.00E+00	0.00E+00	1.42E+02	1.30E+02
Benzo(a)anthracene	1.90E+01	8.00E+00	2.38E+00	1.00E+00	1.00E+00	1.85E-01	7.80E-02	5.65E-01	2.38E-01	3.16E-01	0.00E+00	0.00E+00	3.16E-01	1.34E-01
Benzo(a)pyrene	1.90E+01	8.00E+00	2.38E+00	1.00E+00	1.00E+00	1.84E-01	7.73E-02	4.27E-01	1.80E-01	2.57E-01	0.00E+00	0.00E+00	2.57E-01	3.17E-01
Carbon disulfide	5.60E+02	8.00E+00	7.00E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.54E-03	5.06E-05	5.06E-05	8.03E-08
Chrysene	1.90E+01	8.00E+00	2.38E+00	1.00E+00	1.00E+00	3.50E-02	1.47E-02	3.71E-01	1.56E-01	1.71E-01	0.00E+00	0.00E+00	1.71E-01	7.26E-02
Di-n-butyl phthalate	3.48E+03	8.00E+00	4.35E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.05E-04	1.85E-06	1.85E-06	1.26E-04
2-Amino-4,6-DNT	2.44E+02	8.00E+00	3.05E+01	1.00E+00	1.00E+00	2.10E+00	6.89E-02	5.57E-01	1.83E-02	8.72E-02	1.51E-04	4.94E-06	8.72E-02	8.82E-05
4-Amino-2,6-DNT	1.69E+02	8.00E+00	2.11E+01	1.00E+00	1.00E+00	8.08E-01	3.83E-02	9.30E-02	4.41E-03	4.27E-02	8.42E-05	3.99E-06	4.28E-02	2.99E-05
1,3-DNB	3.97E+00	8.00E+00	4.96E-01	1.00E+00	1.00E+00	5.53E-03	1.12E-02	1.10E-02	2.22E-02	3.34E-02	0.00E+00	0.00E+00	3.34E-02	1.63E-07
2,4-DNT	1.25E+01	8.00E+00	1.56E+00	1.00E+00	1.00E+00	1.12E+00	7.17E-01	1.55E-01	9.97E-02	8.17E-01	0.00E+00	0.00E+00	8.17E-01	4.00E-05
2,6-DNT	1.25E+01	8.00E+00	1.56E+00	1.00E+00	1.00E+00	2.46E-02	1.58E-02	1.02E-01	6.54E-02	8.12E-02	0.00E+00	0.00E+00	8.12E-02	8.14E-06
Dinitrotoluene	1.25E+01	8.00E+00	1.56E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.21E-03	7.79E-04	7.79E-04	7.81E-08
2-Nitrotoluene	3.06E+02	8.00E+00	3.82E+01	1.00E+00	1.00E+00	1.11E-02	2.90E-04	0.00E+00	0.00E+00	2.90E-04	1.59E-03	4.17E-05	3.31E-04	8.59E-07
3-Nitrotoluene	3.06E+02	8.00E+00	3.82E+01	1.00E+00	1.00E+00	1.11E-02	2.90E-04	2.51E-02	6.57E-04	9.46E-04	2.25E-04	5.90E-06	9.52E-04	3.52E-06
4-Nitrotoluene	3.06E+02	8.00E+00	3.82E+01	1.00E+00	1.00E+00	1.11E-02	2.90E-04	0.00E+00	0.00E+00	2.90E-04	6.59E-04	1.73E-05	3.07E-04	1.06E-06
Tetryl	2.28E+01	8.00E+00	2.85E+00	1.00E+00	1.00E+00	1.11E-02	3.88E-03	9.18E-03	3.22E-03	7.10E-03	0.00E+00	0.00E+00	7.10E-03	2.92E-07
1,3,5-TNB	4.67E+01	8.00E+00	5.84E+00	1.00E+00	1.00E+00	2.26E-02	3.86E-03	1.16E-01	1.99E-02	2.38E-02	0.00E+00	0.00E+00	2.38E-02	6.53E-07
2,4,6-TNT	2.81E+01	8.00E+00	3.51E+00	1.00E+00	1.00E+00	2.29E+03	6.51E+02	6.06E+02	1.72E+02	8.23E+02	5.27E-05	1.50E-05	8.23E+02	9.58E-02
Inorganics														
Aluminum	3.67E+01	8.00E+00	4.58E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.94E-01	1.08E-01	1.08E-01	1.15E-02
Barium	6.95E+01	8.00E+00	8.69E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.27E-02	1.46E-03	1.46E-03	3.92E-05
Cadmium	3.39E+01	8.00E+00	4.23E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.96E-04	1.88E-04	1.88E-04	4.92E-06
Calcium	3.36E+04	8.00E+00	4.20E+03	1.00E+00	1.00E+00	3.20E+03	7.64E-01	6.28E+03	1.50E+00	2.26E+00	2.96E+01	7.05E-03	2.27E+00	2.94E+02
Chromium	4.81E+04	8.00E+00	6.01E+03	1.00E+00	1.00E+00	5.53E-01	9.21E-05	0.00E+00	0.00E+00	9.21E-05	0.00E+00	0.00E+00	9.21E-05	7.70E-02
Copper	6.90E+01	8.00E+00	8.62E+00	1.00E+00	1.00E+00	1.66E+00	1.93E-01	1.59E+00	1.85E-01	3.77E-01	5.64E-04	6.55E-05	3.77E-01	4.53E-01
Iron	8.29E+02	8.00E+00	1.04E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.35E+00	2.26E-02	2.26E-02	7.26E-01
Lead	2.81E+02	8.00E+00	3.51E+01	1.00E+00	1.00E+00	3.20E+01	9.11E-01	1.27E+02	3.63E+00	4.54E+00	1.06E-03	3.01E-05	4.54E+00	9.86E-01
Magnesium	5.04E+03	8.00E+00	6.30E+02	1.00E+00	1.00E+00	3.91E+02	6.21E-01	1.04E+03	1.65E+00	2.28E+00	6.32E+00	1.00E-02	2.29E+00	4.45E+02
Manganese	9.97E+02	8.00E+00	1.25E+02	1.00E+00	1.00E+00	4.71E+01	3.78E-01	6.43E+01	5.16E-01	8.93E-01	4.62E-01	3.70E-03	8.97E-01	8.65E-01
Mercury	2.28E+01	8.00E+00	2.85E+00	1.00E+00	1.00E+00	5.98E-03	2.09E-03	2.90E-02	1.02E-02	1.23E-02	0.00E+00	0.00E+00	1.23E-02	1.35E-01
Nickel	2.81E+02	8.00E+00	3.51E+01	1.00E+00	1.00E+00	1.04E+00	2.96E-02	0.00E+00	0.00E+00	2.96E-02	0.00E+00	0.00E+00	2.96E-02	8.05E-02
Potassium	5.03E+04	8.00E+00	6.29E+03	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.91E-01	6.21E-05	6.21E-05	6.05E-02
Selenium	1.05E+00	8.00E+00	1.32E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.77E-04	3.62E-03	3.62E-03	1.11E-04
Sodium	5.03E+04	8.00E+00	6.29E+03	1.00E+00	1.00E+00	1.20E+01	1.90E-03	3.46E+01	5.50E-03	7.40E-03	7.45E-01	1.18E-04	7.52E-03	5.86E+01
Zinc	1.12E+03	8.00E+00	1.40E+02	1.00E+00	1.00E+00	1.10E+01	7.84E-02	1.41E+01	1.01E-01	1.79E-01	0.00E+00	0.00E+00	1.79E-01	3.89E+01
TOTAL							**6.55E+02**		**3.22E+02**	**9.77E+02**		**1.58E-01**	**9.77E+02**	

Body Weight (kg)	0.015
Water intake (L/d)	0.0023
Food intake (kg(dw)/d)	0.0022
Soil intake (kg/d)	0.00083
Invertebrate intake (kg(dw)/d)--100% of diet	0.0022

Table G-2

Plum Brook Ordnance Works
TNT Area C

Herbivorous Mammal: **White-tailed deer *(Odocoileus virginianus)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Plant Intake (mg/kg-d)	Plant Intake Hazard Quotient	Soil/Plant Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics													
Aroclor-1260	1.65E-01	8.00E+00	2.07E-02	9.00E-02	9.00E-02	2.78E-04	1.34E-02	1.45E-05	7.00E-04	1.41E-02	0.00E+00	0.00E+00	1.41E-02
Benzo(a)anthracene	2.94E+00	8.00E+00	3.68E-01	9.00E-02	9.00E-02	3.92E-04	1.07E-03	2.18E-04	5.93E-04	1.66E-03	0.00E+00	0.00E+00	1.66E-03
Benzo(a)pyrene	2.94E+00	8.00E+00	3.68E-01	9.00E-02	9.00E-02	3.74E-04	1.02E-03	1.19E-04	3.24E-04	1.34E-03	0.00E+00	0.00E+00	1.34E-03
Carbon disulfide	8.67E+01	8.00E+00	1.08E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.32E-03	7.67E-04	7.67E-04
Chrysene	2.94E+00	8.00E+00	3.68E-01	9.00E-02	9.00E-02	2.71E-04	7.38E-04	4.12E-05	1.12E-04	8.50E-04	0.00E+00	0.00E+00	8.50E-04
Di-n-butyl phthalate	5.39E+02	8.00E+00	6.74E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.89E-03	2.80E-05	2.80E-05
2-Amino-4,6-DNT	3.78E+01	8.00E+00	4.72E+00	9.00E-02	9.00E-02	2.24E-03	4.75E-04	3.03E-01	6.42E-02	6.46E-02	3.54E-04	7.50E-05	6.47E-02
4-Amino-2,6-DNT	2.61E+01	8.00E+00	3.26E+00	9.00E-02	9.00E-02	3.74E-04	1.15E-04	1.16E-01	3.57E-02	3.58E-02	1.98E-04	6.06E-05	3.59E-02
1,3-DNB	6.15E-01	8.00E+00	7.68E-02	9.00E-02	9.00E-02	4.43E-05	5.77E-04	1.57E-03	2.05E-02	2.11E-02	0.00E+00	0.00E+00	2.11E-02
2,4-DNT	1.93E+00	8.00E+00	2.41E-01	9.00E-02	9.00E-02	6.26E-04	2.59E-03	1.66E-01	6.88E-01	6.90E-01	0.00E+00	0.00E+00	6.90E-01
2,6-DNT	1.93E+00	8.00E+00	2.41E-01	9.00E-02	9.00E-02	4.10E-04	1.70E-03	2.45E-03	1.01E-02	1.18E-02	0.00E+00	0.00E+00	1.18E-02
Dinitrotoluene	1.93E+00	8.00E+00	2.41E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.85E-03	1.18E-02	1.18E-02
2-Nitrotoluene	4.73E+01	8.00E+00	5.91E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	1.07E-03	1.81E-04	1.81E-04	3.74E-03	6.33E-04	8.14E-04
3-Nitrotoluene	4.73E+01	8.00E+00	5.91E+00	9.00E-02	9.00E-02	1.01E-04	1.71E-05	8.76E-04	1.48E-04	1.65E-04	5.29E-04	8.95E-05	2.55E-04
4-Nitrotoluene	4.73E+01	8.00E+00	5.91E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	9.13E-04	1.54E-04	1.54E-04	1.55E-03	2.62E-04	4.16E-04
Tetryl	3.54E+00	8.00E+00	4.42E-01	9.00E-02	9.00E-02	3.69E-05	8.36E-05	2.54E-03	5.75E-03	5.83E-03	0.00E+00	0.00E+00	5.83E-03
1,3,5-TNB	7.24E+00	8.00E+00	9.05E-01	9.00E-02	9.00E-02	4.68E-04	5.17E-04	9.71E-03	1.07E-02	1.12E-02	0.00E+00	0.00E+00	1.12E-02
2,4,6-TNT	4.35E+00	8.00E+00	5.44E-01	9.00E-02	9.00E-02	2.44E+00	4.48E+00	3.30E+02	6.06E+02	6.10E+02	1.24E-04	2.28E-04	6.10E+02
Inorganics													
Aluminum	5.68E+00	8.00E+00	7.10E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E+00	1.63E+00	1.63E+00
Barium	1.08E+01	8.00E+00	1.35E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.98E-02	2.21E-02	2.21E-02
Cadmium	5.25E+00	8.00E+00	6.56E-01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.87E-03	2.85E-03	2.85E-03
Calcium	5.20E+03	8.00E+00	6.50E+02	9.00E-02	9.00E-02	2.53E+00	3.89E-03	3.25E+02	5.00E-01	5.04E-01	6.95E+01	1.07E-01	6.10E-01
Chromium	7.45E+03	8.00E+00	9.31E+02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	2.95E-05	3.17E-08	3.17E-08	0.00E+00	0.00E+00	3.17E-08
Copper	1.07E+01	8.00E+00	1.33E+00	9.00E-02	9.00E-02	2.56E-03	1.92E-03	7.08E-02	5.31E-02	5.50E-02	1.32E-03	9.93E-04	5.60E-02
Iron	1.28E+02	8.00E+00	1.60E+01	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.51E+00	3.43E-01	3.43E-01
Lead	4.35E+01	8.00E+00	5.44E+00	9.00E-02	9.00E-02	5.51E-02	1.01E-02	1.88E-03	3.45E-04	1.05E-02	2.48E-03	4.56E-04	1.09E-02
Magnesium	7.80E+02	8.00E+00	9.75E+01	9.00E-02	9.00E-02	4.19E-01	4.30E-03	1.63E+01	1.67E-01	1.71E-01	1.48E+01	1.52E-01	3.23E-01
Manganese	1.54E+02	8.00E+00	1.93E+01	9.00E-02	9.00E-02	8.09E-02	4.19E-03	1.71E+00	8.84E-02	9.26E-02	1.08E+00	5.61E-02	1.49E-01
Mercury	3.54E+00	8.00E+00	4.42E-01	9.00E-02	9.00E-02	1.17E-05	2.64E-05	1.75E-04	3.97E-04	4.23E-04	0.00E+00	0.00E+00	4.23E-04
Nickel	4.35E+01	8.00E+00	5.44E+00	9.00E-02	9.00E-02	0.00E+00	0.00E+00	2.00E-02	3.67E-03	3.67E-03	0.00E+00	0.00E+00	3.67E-03
Potassium	7.79E+03	8.00E+00	9.74E+02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.18E-01	9.42E-04	9.42E-04
Selenium	1.63E-01	8.00E+00	2.04E-02	9.00E-02	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-03	5.49E-02	5.49E-02
Sodium	7.79E+03	8.00E+00	9.74E+02	9.00E-02	9.00E-02	1.39E-02	1.43E-05	4.14E-02	4.25E-05	5.68E-05	1.75E+00	1.80E-03	1.85E-03
Zinc	1.74E+02	8.00E+00	2.18E+01	9.00E-02	9.00E-02	1.89E-02	8.71E-04	2.53E-01	1.16E-02	1.25E-02	0.00E+00	0.00E+00	1.25E-02
TOTAL							**4.53E+00**		**6.08E+02**	**6.12E+02**		**2.39E+00**	**6.14E+02**

Body Weight (kg)	61
Water intake (L/d)	4
Food intake (kg(dw)/d)	2
Soil intake (kg/d)	0.04
Plant intake (kg(dw)/d) -- 100% of diet	2

Table G-2

Plum Brook Ordnance Works
TNT Area C

Insectivorous Bird: **Marsh wren *(Cistothorus palustris)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Invert. Intake (mg/kg-d)	Invert. Intake Hazard Quotient	Soil/Invert. Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index	Tissue Conc. mg/kg(dw)
Organics														
Aroclor-1260	1.80E+00	8.00E+00	2.25E-01	1.00E+00	1.00E+00	8.95E-02	3.98E-01	3.72E+01	1.65E+02	1.66E+02	0.00E+00	0.00E+00	1.66E+02	1.67E+02
Benzo(a)anthracene	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	1.26E-01	0.00E+00	1.12E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01
Benzo(a)pyrene	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	1.20E-01	0.00E+00	8.44E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.27E-01
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.24E-03	0.00E+00	0.00E+00	9.24E-08
Chrysene	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	8.74E-02	0.00E+00	7.34E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.60E-02
Di-n-butyl phthalate	1.10E+00	8.00E+00	1.38E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.42E-03	1.03E-02	1.03E-02	1.45E-04
2-Amino-4,6-DNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	7.22E-01	3.24E-01	1.10E+00	4.95E-01	8.20E-01	2.66E-04	1.19E-04	8.20E-01	3.95E-05
4-Amino-2,6-DNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	1.20E-01	5.41E-02	1.84E-01	8.26E-02	1.37E-01	1.48E-04	6.66E-05	1.37E-01	6.60E-06
1,3-DNB	2.10E+00	8.00E+00	2.63E-01	1.00E+00	1.00E+00	1.43E-02	5.44E-02	2.18E-02	8.30E-02	1.37E-01	0.00E+00	0.00E+00	1.37E-01	2.32E-07
2,4-DNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	2.01E-01	9.05E-02	3.07E-01	1.38E-01	2.29E-01	0.00E+00	0.00E+00	2.29E-01	1.05E-05
2,6-DNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	1.32E-01	5.93E-02	2.02E-01	9.06E-02	1.50E-01	0.00E+00	0.00E+00	1.50E-01	1.40E-05
Dinitrotoluene	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E-03	9.61E-04	9.61E-04	8.99E-08
2-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.81E-03	1.26E-03	1.26E-03	1.25E-07
3-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	3.25E-02	1.46E-02	4.96E-02	2.23E-02	3.69E-02	3.97E-04	1.78E-04	3.71E-02	5.22E-06
4-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.16E-03	5.22E-04	5.22E-04	6.83E-08
Tetryl	0.00E+00	8.00E+00	0.00E+00	1.00E+00	1.00E+00	1.19E-02	0.00E+00	1.82E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.83E-07
1,3,5-TNB	2.10E+00	8.00E+00	2.63E-01	1.00E+00	1.00E+00	1.51E-01	5.74E-01	2.30E-01	8.76E-01	1.45E+00	0.00E+00	0.00E+00	1.45E+00	1.17E-06
2,4,6-TNT	1.78E+01	8.00E+00	2.23E+00	1.00E+00	1.00E+00	7.85E+02	3.53E+02	1.20E+03	5.38E+02	8.91E+02	9.29E-05	4.17E-05	8.91E+02	4.30E-02
Inorganics														
Aluminum	1.10E+03	8.00E+00	1.38E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.69E-01	6.32E-03	6.32E-03	1.32E-02
Barium	4.17E+01	8.00E+00	5.21E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.23E-02	4.28E-03	4.28E-03	4.52E-05
Cadmium	2.00E+01	8.00E+00	2.50E+00	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-03	5.61E-04	5.61E-04	5.67E-06
Calcium	1.42E+04	8.00E+00	1.77E+03	1.00E+00	1.00E+00	8.13E+02	4.59E-01	1.24E+04	7.01E+00	7.47E+00	5.21E+01	2.94E-02	7.50E+00	2.69E+02
Chromium	5.00E+00	8.00E+00	6.25E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Copper	6.20E+01	8.00E+00	7.75E+00	1.00E+00	1.00E+00	8.25E-01	1.06E-01	3.15E+00	4.06E-01	5.12E-01	9.94E-04	1.28E-04	5.13E-01	3.62E-01
Iron	2.50E+02	8.00E+00	3.13E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.13E+00	1.32E-01	1.32E-01	8.36E-01
Lead	3.85E+01	8.00E+00	4.81E+00	1.00E+00	1.00E+00	1.77E+01	3.69E+00	2.52E+02	5.23E+01	5.60E+01	1.86E-03	3.87E-04	5.60E+01	1.09E+00
Magnesium	7.50E+02	8.00E+00	9.38E+01	1.00E+00	1.00E+00	1.35E+02	1.44E+00	2.06E+03	2.20E+01	2.34E+01	1.11E+01	1.19E-01	2.35E+01	4.46E+02
Manganese	9.77E+03	8.00E+00	1.22E+03	1.00E+00	1.00E+00	2.60E+01	2.13E-02	1.27E+02	1.04E-01	1.25E-01	8.13E-01	6.65E-04	1.26E-01	7.79E-01
Mercury	9.00E-01	8.00E+00	1.13E-01	1.00E+00	1.00E+00	3.76E-03	3.34E-02	5.74E-02	5.10E-01	5.44E-01	0.00E+00	0.00E+00	5.44E-01	1.55E-01
Nickel	1.07E+02	8.00E+00	1.34E+01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium	5.00E+03	8.00E+00	6.25E+02	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.89E-01	1.10E-03	1.10E-03	6.96E-02
Selenium	1.00E+00	8.00E+00	1.25E-01	1.00E+00	1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.40E-04	6.72E-03	6.72E-03	1.27E-04
Sodium	5.00E+03	8.00E+00	6.25E+02	1.00E+00	1.00E+00	4.48E+00	7.17E-03	6.84E+01	1.10E-01	1.17E-01	1.31E+00	2.10E-03	1.19E-01	6.01E+01
Zinc	1.31E+02	8.00E+00	1.64E+01	1.00E+00	1.00E+00	6.10E+00	3.72E-01	2.79E+01	1.71E+00	2.08E+00	0.00E+00	0.00E+00	2.08E+00	3.44E+01
TOTAL							**3.60E+02**		**7.88E+02**	**1.15E+03**		**3.16E-01**	**1.15E+03**	

Body Weight (kg)	0.01
Water intake (L/d)	0.0027
Food intake (kg(dw)/d)	0.0029
Soil intake (kg/d)	0.00019
Plant intake (kg(dw)/d) -- 0% of diet	0
Invertebrate intake (kg(dw)/d) -- 100% of diet	0.0029

Table G-2

Plum Brook Ordnance Works
TNT Area C

Avian predator: **Red-tailed hawk (*Buteo jamaicensis*)**

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (soil)	Foraging Factor (sw)	Soil Intake (mg/kg-d)	Soil Intake Hazard Quotient	Bird Intake (mg/kg-d)	Bird Intake Hazard Quotient	Mouse Intake (mg/kg-d)	Mouse Intake Hazard Quotient	Rabbit Intake (mg/kg-d)	Rabbit Intake Hazard Quotient	Shrew Intake (mg/kg-d)	Shrew Intake Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics																			
Aroclor-1260	1.80E+00	8.00E+00	2.25E-01	6.00E-02	6.00E-02	5.91E-04	2.62E-03	1.44E-01	6.38E-01	4.46E-02	1.98E-01	3.64E-04	1.62E-03	1.18E-01	5.22E-01	1.36E+00	0.00E+00	0.00E+00	1.36E+00
Benzo(a)anthracene	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	8.33E-04	0.00E+00	1.25E-04	0.00E+00	4.00E-05	0.00E+00	1.73E-05	0.00E+00	1.21E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	7.94E-04	0.00E+00	2.81E-04	0.00E+00	8.83E-05	0.00E+00	4.22E-05	0.00E+00	2.87E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	7.93E-11	0.00E+00	5.33E-11	0.00E+00	1.03E-10	0.00E+00	7.27E-11	0.00E+00	0.00E+00	8.26E-05	0.00E+00	0.00E+00
Chrysene	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	5.77E-04	0.00E+00	8.23E-05	0.00E+00	2.65E-05	0.00E+00	1.20E-05	0.00E+00	6.57E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate	1.10E+00	8.00E+00	1.38E-01	6.00E-02	6.00E-02	0.00E+00	0.00E+00	1.24E-07	9.04E-07	8.36E-08	6.08E-07	1.62E-07	1.18E-06	1.14E-07	8.29E-07	3.52E-06	1.88E-05	1.36E-04	1.40E-04
2-Amino-4,6-DNT	1.78E+01	8.00E+00	2.23E+00	6.00E-02	6.00E-02	4.76E-03	2.14E-03	3.39E-08	1.52E-08	2.79E-07	1.25E-07	6.00E-07	2.70E-07	7.98E-08	3.59E-08	2.14E-03	3.52E-06	1.58E-06	2.14E-03
4-Amino-2,6-DNT	1.78E+01	8.00E+00	2.23E+00	6.00E-02	6.00E-02	7.95E-04	3.57E-04	5.66E-09	2.54E-09	4.66E-08	2.09E-08	1.00E-07	4.50E-08	2.70E-08	1.22E-08	3.57E-04	1.96E-06	8.82E-07	3.58E-04
1,3-DNB	2.10E+00	8.00E+00	2.63E-01	6.00E-02	6.00E-02	9.42E-05	3.59E-04	1.99E-10	7.59E-10	3.18E-09	1.21E-08	6.87E-09	2.62E-08	1.48E-10	5.62E-10	3.59E-04	0.00E+00	0.00E+00	3.59E-04
2,4-DNT	1.78E+01	8.00E+00	2.23E+00	6.00E-02	6.00E-02	1.33E-03	5.97E-04	8.97E-09	4.03E-09	7.60E-08	3.42E-08	1.63E-07	7.34E-08	3.62E-08	1.63E-08	5.98E-04	0.00E+00	0.00E+00	5.98E-04
2,6-DNT	1.78E+01	8.00E+00	2.23E+00	6.00E-02	6.00E-02	8.71E-04	3.92E-04	1.20E-08	5.41E-09	6.94E-08	3.12E-08	1.48E-07	6.67E-08	7.37E-09	3.31E-09	3.92E-04	0.00E+00	0.00E+00	3.92E-04
Dinitrotoluene	1.78E+01	8.00E+00	2.23E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	7.71E-11	3.47E-11	5.19E-11	2.33E-11	1.00E-10	4.52E-11	7.07E-11	3.18E-11	1.35E-10	2.83E-05	1.27E-05	1.27E-05
2-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	1.07E-10	4.80E-11	7.19E-11	3.23E-11	1.39E-10	6.25E-11	7.78E-10	3.49E-10	4.92E-10	3.72E-05	1.67E-05	1.67E-05
3-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	6.00E-02	6.00E-02	2.14E-04	9.64E-05	4.47E-09	2.01E-09	2.07E-08	9.31E-09	4.41E-08	1.98E-08	3.19E-09	1.43E-09	9.64E-05	5.25E-06	2.36E-06	9.88E-05
4-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	5.86E-11	2.63E-11	3.94E-11	1.77E-11	7.63E-11	3.43E-11	9.56E-10	4.29E-10	5.08E-10	1.54E-05	6.91E-06	6.91E-06
Tetryl	0.00E+00	8.00E+00	0.00E+00	6.00E-02	6.00E-02	7.85E-05	0.00E+00	2.43E-10	0.00E+00	3.15E-09	0.00E+00	6.79E-09	0.00E+00	2.65E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5-TNB	2.10E+00	8.00E+00	2.63E-01	6.00E-02	6.00E-02	9.94E-04	3.79E-03	1.00E-09	3.82E-09	2.41E-08	9.17E-08	5.22E-08	1.99E-07	5.91E-10	2.25E-09	3.79E-03	0.00E+00	0.00E+00	3.79E-03
2,4,6-TNT	1.78E+01	8.00E+00	2.23E+00	6.00E-02	6.00E-02	5.18E+00	2.33E+00	3.68E-05	1.66E-05	3.03E-04	1.36E-04	6.52E-04	2.93E-04	8.68E-05	3.90E-05	2.33E+00	1.23E-06	5.53E-07	2.33E+00
Inorganics																			
Aluminum	1.10E+03	8.00E+00	1.38E+02	6.00E-02	6.00E-02	0.00E+00	0.00E+00	1.13E-05	8.23E-08	7.61E-06	5.54E-08	1.47E-05	1.07E-07	1.04E-05	7.54E-08	3.20E-07	1.15E-02	8.37E-05	8.40E-05
Barium	4.17E+01	8.00E+00	5.21E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	3.87E-08	7.43E-09	2.61E-08	5.00E-09	5.05E-08	9.68E-09	3.55E-08	6.81E-09	2.89E-08	2.96E-04	5.67E-05	5.67E-05
Cadmium	2.00E+01	8.00E+00	2.50E+00	6.00E-02	6.00E-02	0.00E+00	0.00E+00	4.86E-09	1.94E-09	3.27E-09	1.31E-09	6.33E-09	2.53E-09	4.46E-09	1.78E-09	7.57E-09	1.85E-05	7.42E-06	7.43E-06
Calcium	1.42E+04	8.00E+00	1.77E+03	6.00E-02	6.00E-02	5.37E+00	3.03E-03	2.30E-01	1.30E-04	2.70E-01	1.53E-04	4.48E-01	2.53E-04	2.66E-01	1.50E-04	3.72E-03	6.90E-01	3.90E-04	4.11E-03
Chromium	5.00E+00	8.00E+00	6.25E-01	6.00E-02	6.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.97E-05	1.12E-04	1.12E-04	0.00E+00	0.00E+00	1.12E-04
Copper	6.20E+01	8.00E+00	7.75E+00	6.00E-02	6.00E-02	5.44E-03	7.02E-04	3.10E-04	4.00E-05	4.75E-04	6.13E-05	8.97E-04	1.16E-04	4.10E-04	5.29E-05	9.72E-04	1.32E-05	1.70E-06	9.74E-04
Iron	2.50E+02	8.00E+00	3.13E+01	6.00E-02	6.00E-02	0.00E+00	0.00E+00	7.17E-04	2.29E-05	4.82E-04	1.54E-05	9.34E-04	2.99E-05	6.57E-04	2.10E-05	8.93E-05	5.47E-02	1.75E-03	1.84E-03
Lead	3.85E+01	8.00E+00	4.81E+00	6.00E-02	6.00E-02	1.17E-01	2.43E-02	9.36E-04	1.94E-04	2.88E-04	5.98E-05	6.33E-05	1.31E-05	8.93E-04	1.86E-04	2.48E-02	2.46E-05	5.12E-06	2.48E-02
Magnesium	7.50E+02	8.00E+00	9.38E+01	6.00E-02	6.00E-02	8.90E-01	9.50E-03	3.83E-01	4.08E-03	2.54E-01	2.71E-03	3.21E-01	3.42E-03	4.03E-01	4.30E-03	2.40E-02	1.47E-01	1.57E-03	2.56E-02
Manganese	9.77E+03	8.00E+00	1.22E+03	6.00E-02	6.00E-02	1.72E-01	1.41E-04	6.68E-04	5.47E-07	7.72E-04	6.32E-07	1.36E-03	1.11E-06	7.83E-04	6.41E-07	1.44E-04	1.08E-02	8.81E-06	1.52E-04
Mercury	9.00E-01	8.00E+00	1.13E-01	6.00E-02	6.00E-02	2.48E-05	2.21E-04	1.33E-04	1.18E-03	7.41E-05	6.58E-04	8.07E-05	7.18E-04	1.23E-04	1.09E-03	3.87E-03	0.00E+00	0.00E+00	3.87E-03
Nickel	1.07E+02	8.00E+00	1.34E+01	6.00E-02	6.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.28E-05	5.45E-06	5.45E-06	0.00E+00	0.00E+00	5.45E-06
Potassium	5.00E+03	8.00E+00	6.25E+02	6.00E-02	6.00E-02	0.00E+00	0.00E+00	5.97E-05	9.56E-08	4.02E-05	6.43E-08	7.78E-05	1.24E-07	5.48E-05	8.76E-08	3.72E-07	9.11E-03	1.46E-05	1.50E-05
Selenium	1.00E+00	8.00E+00	1.25E-01	6.00E-02	6.00E-02	0.00E+00	0.00E+00	1.09E-07	8.74E-07	7.35E-08	5.88E-07	1.42E-07	1.14E-06	1.00E-07	8.01E-07	3.40E-06	1.11E-05	8.89E-05	9.23E-05
Sodium	5.00E+03	8.00E+00	6.25E+02	6.00E-02	6.00E-02	2.96E-02	4.73E-05	5.15E-02	8.24E-05	1.77E-02	2.82E-05	7.60E-03	1.22E-05	5.30E-02	8.48E-05	2.55E-04	1.74E-02	2.78E-05	2.83E-04
Zinc	1.31E+02	8.00E+00	1.64E+01	6.00E-02	6.00E-02	4.03E-02	2.46E-03	2.95E-02	1.80E-03	2.57E-02	1.57E-03	4.21E-02	2.57E-03	3.52E-02	2.15E-03	1.06E-02	0.00E+00	0.00E+00	1.06E-02
TOTAL							**2.38E+00**		**6.44E-01**		**2.02E-01**		**6.48E-03**		**5.28E-01**	**3.76E+00**		**4.18E-03**	**3.76E+00**

Body Weight (kg)	0.957
Water intake (L/d)	0.057
Food intake (kg(dw)/d)	0.057
Soil intake (kg/d)	0.002
Bird intake (kg(dw)/d) -- 24% of diet	0.01368
Mouse intake (kg(dw)/d) -- 25.3% of diet	0.01444
Shrew intake (kg(dw)/d) -- 25.3% of diet	0.01444
Rabbit intake (kg(dw)/d) -- 25.3% of diet	0.01444

Table G-3

Plum Brook Ordnance Works
TNT Area C

Chemical Data

Chemical Name	Sediment Conc. (mg/kg)	Water Conc. (mg/L)	log Kow (organics)	Kow (organics)	log Koc (organics) (mL/g)	Koc (organics) (mL/g)	Kd (inorganics) (mL/g)	Foc	Water-to-Invert. BCF	Site-Specific Sediment-to-Invertebrate TF	Sediment-to-Plant TF	Plant Concentration (mg/kgdw)	Pore water Conc. (mg/L)	Solubility (mg/L)	< of the PoreH2O or Solubility	Invert. Conc. (mg/kgww)	Invert Conc. (mg/kgdw)	Food-to-Muscle TF
Organics																		
Aroclor 1260	7.69E-01		7.15E+00	1.40E+07	7.02E+00	1.06E+07	---	6.70E-02	1.40E+07	NA	2.87E-03	2.21E-03	1.08E-06		1.08E-06	1.52E+01	6.07E+01	4.44E-01
2-Amino-4,6-DNT	1.28E+01	9.84E-04	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	3.46E+01	2.06E+00		2.06E+00	2.06E+02	8.26E+02	2.14E-06
4-Amino-2,6-DNT	1.12E+01	5.49E-04	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	3.03E+01	1.81E+00		1.81E+00	1.81E+02	7.23E+02	2.14E-06
Benzo(a)anthracene	9.47E-02		5.61E+00	4.10E+05	5.52E+00	3.29E+05	---	6.70E-02	4.10E+05	NA	2.21E-02	2.09E-03	4.29E-06		4.29E-06	1.76E+00	7.04E+00	1.16E-02
Benzo(a)pyrene	6.99E-02		6.06E+00	1.15E+06	5.96E+00	9.08E+05	---	6.70E-02	1.15E+06	NA	1.22E-02	8.50E-04	1.15E-06		1.15E-06	1.32E+00	5.29E+00	3.36E-02
Carbon disulfide		2.31E-02	1.84E+00	6.92E+01	1.81E+00	6.44E+01	---	6.70E-02	6.92E+01	NA	3.35E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	1.46E-06
Chrysene	7.37E-02		5.61E+00	4.10E+05	5.52E+00	3.29E+05	---	6.70E-02	4.10E+05	NA	2.21E-02	1.63E-03	3.34E-06		3.34E-06	1.37E+00	5.48E+00	1.16E-02
Di-n-butyl phthalate	7.02E-02	5.25E-03	5.56E+00	3.60E+05	5.46E+00	2.90E+05	---	6.70E-02	3.60E+05	NA	2.38E-02	1.67E-03	3.62E-06		3.62E-06	1.30E+00	5.21E+00	1.01E-02
2,4-DNT	2.42E-01		1.98E+00	9.50E+01	1.94E+00	8.80E+01	---	6.70E-02	9.50E+01	NA	2.79E+00	6.74E-01	4.11E-02		4.11E-02	3.90E+00	1.56E+01	2.03E-06
2,6-DNT	1.83E-01		2.28E+00	1.90E+02	2.24E+00	1.74E+02	---	6.70E-02	1.90E+02	NA	1.87E+00	3.41E-01	1.57E-02		1.57E-02	2.98E+00	1.19E+01	4.16E-06
Dinitrotoluene		7.92E-03	2.28E+00	1.90E+02	2.24E+00	1.74E+02	---	6.70E-02	1.90E+02	NA	1.87E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	4.16E-06
Fluoranthene	1.47E-01		4.90E+00	7.90E+04	4.81E+00	6.53E+04	---	6.70E-02	7.90E+04	NA	5.72E-02	8.40E-03	3.36E-05		3.36E-05	2.66E+00	1.06E+01	2.11E-03
2-Nitrotoluene		1.04E-02	2.30E+00	2.00E+02	2.26E+00	1.83E+02	---	6.70E-02	2.00E+02	NA	1.81E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	4.38E-06
3-Nitrotoluene		1.47E-03	2.45E+00	2.82E+02	2.41E+00	2.56E+02	---	6.70E-02	2.82E+02	NA	1.49E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	6.25E-06
4-Nitrotoluene		4.30E-03	2.42E+00	2.63E+02	2.38E+00	2.39E+02	---	6.70E-02	2.63E+02	NA	1.55E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	5.82E-06
Pyrene	1.10E-01		4.90E+00	8.00E+04	4.82E+00	6.61E+04	---	6.70E-02	8.00E+04	NA	5.68E-02	6.24E-03	2.48E-05		2.48E-05	1.99E+00	7.95E+00	2.14E-03
RDX	5.21E-01		8.69E-01	7.40E+00	8.55E-01	7.16E+00	---	6.70E-02	7.40E+00	NA	1.22E+01	6.34E+00	1.09E+00		1.09E+00	8.04E+00	3.22E+01	1.46E-07
1,3,5-TNB	8.32E-01		1.18E+00	1.51E+01	1.16E+00	1.44E+01	---	6.70E-02	1.51E+01	NA	8.06E+00	6.71E+00	8.61E-01		8.61E-01	1.30E+01	5.20E+01	3.04E-07
2,4,6-TNT	1.50E+03	3.44E-04	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	4.06E+03	2.42E+02	1.00E+02	1.00E+02	1.00E+04	4.00E+04	2.14E-06
Inorganics																		
Aluminum	1.10E+04	3.22E+00	---	---	---	---	1.50E+03	6.70E-02	1.00E+02	3.50E-03	2.30E-03	2.53E+01	--		--	3.85E+01	1.54E+02	1.50E-03
Barium		8.27E-02	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-04
Cadmium	7.25E-01	5.19E-03	---	---	---	---	6.50E+00	6.70E-02	2.50E+02	1.00E+02	8.50E-01	6.16E-01	--		--	7.25E+01	2.90E+02	4.00E-04
Calcium	1.06E+05	1.93E+02	---	---	---	---	4.10E+00	6.70E-02	1.00E+02	3.30E-02	1.90E+00	2.01E+05	--		--	3.50E+03	1.40E+04	2.00E-03
Copper		3.68E-03	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	9.00E-03
Iron		1.53E+01	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-02
Lead	4.88E+01	6.89E-03	---	---	---	---	4.00E+02	6.70E-02	3.00E+02	2.50E-02	1.10E-03	5.37E-02	--		--	1.22E+00	4.88E+00	4.00E-04
Magnesium		4.12E+01	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-02
Manganese		3.01E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	5.00E-04
Potassium		2.55E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.00E-02
Selenium	1.77E+00	3.11E-03	---	---	---	---	3.00E+02	6.70E-02	1.00E+02	1.00E+02	2.50E-02	4.43E-02	--		--	1.77E+02	7.08E+02	1.50E-02
Sodium	2.23E+02	4.86E+00	---	---	---	---	1.00E+02	6.70E-02	2.00E+01	7.70E-01	6.50E-02	1.45E+01	--		--	1.72E+02	6.87E+02	8.00E-02

Table G-3

Toxicity Data

Plum Brook Ordnance Works
TNT Area C

Chemical Name	Mammals NOAEL (mg/kg/d)	Mammals Test Species	Mammals Body Wt. (kg)	Birds NOAEL (mg/kg/d)	Birds Test Species	Birds Body Wt. (kg)
Organics						
Aroclor 1260	6.80E-02	mouse	0.014	1.80E-01	ring neck pheasant	1
2-Amino-4,6-DNT	1.39E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
4-Amino-2,6-DNT	9.59E+00	rat	0.35	7.00E-01	Bobwhite quail	0.19
Benzo(a)anthracene	1.00E+00	mouse	0.03	--	--	--
Benzo(a)pyrene	1.00E+00	mouse	0.03	--	--	--
Carbon disulfide	3.19E+01	rat	0.35	--	--	--
Chrysene	1.00E+00	mouse	0.03	--	--	--
Di-n-butyl phthalate	5.50E+02	mouse	0.03	1.10E-01	ringed dove	0.155
2,4-DNT	2.00E-01	dog	11	7.00E-01	Bobwhite quail	0.19
2,6-DNT	2.00E-01	dog	11	7.00E-01	Bobwhite quail	0.19
Dinitrotoluene	2.00E-01	dog	11	7.00E-01	Bobwhite quail	0.19
Fluoranthene	1.00E+00	mouse	0.03	--	--	--
2-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
3-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
4-Nitrotoluene	4.50E+01	rat	0.35	7.00E-01	Bobwhite quail	0.19
Pyrene	1.00E+00	mouse	0.03	--	--	--
RDX	7.00E+00	mouse	0.03	--	--	--
1,3,5-TNB	2.68E+00	rat	0.35	4.20E-01	red-winged black bird	0.077
2,4,6-TNT	1.60E+00	rat	0.35	7.00E-01	Bobwhite quail	0.19
Inorganics						
Aluminum	1.93E+00	mouse	0.03	1.10E+02	ringed dove	0.155
Barium	5.10E+00	rat	0.435	2.08E+01	chicks	0.121
Cadmium	1.00E+00	rat	0.303	1.45E+00	Mallard duck	1.153
Calcium	1.05E+03	rabbit	3.8	2.83E+03	Jap. Quail	0.072
Copper	1.17E+01	mink	1	4.70E+01	chicks	0.534
Iron	2.60E+01	rabbit	3.8	5.00E+01	poultry	1.6
Lead	8.00E+00	rat	0.35	3.85E+00	Am. Kestrel	0.13
Magnesium	1.58E+02	rabbit	3.8	1.50E+02	poultry	1.6
Manganese	8.80E+01	rat	0.35	9.77E+02	Jap. Quail	0.072
Potassium	1.60E+03	rabbit	3.8	1.00E+03	poultry	1.6
Selenium	2.00E-01	rat	0.35	5.00E-01	Mallard duck	1
Sodium	1.60E+03	rabbit	3.8	1.00E+03	poultry	1.6

Table G-3

Plum Brook Ordnance Works
TNT Area C

Omnivorous Bird: **Mallard duck *(Anas platyrhynchos)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (sed./sw.)	Sediment Intake (mg/kg-d)	Sediment Hazard Quotient	Plant Intake (mg/kg-d)	Plant Hazard Quotient	Macroinvert Intake (mg/kg-d)	Macroinvert Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics														
Aroclor 1260	1.80E-01	8.00E+00	2.25E-02	2.00E-01	1.77E-04	7.86E-03	1.54E-05	6.83E-04	2.54E-01	1.13E+01	1.13E+01	0.00E+00	0.00E+00	1.13E+01
2-Amino-4,6-DNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	2.95E-03	3.37E-02	2.41E-01	2.76E+00	3.45E+00	3.95E+01	4.23E+01	1.11E-05	1.27E-04	4.23E+01
4-Amino-2,6-DNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	2.58E-03	2.95E-02	2.11E-01	2.41E+00	3.02E+00	3.45E+01	3.70E+01	6.22E-06	7.11E-05	3.70E+01
Benzo(a)anthracene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	2.18E-05	NA	1.46E-05	NA	2.94E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.61E-05	NA	5.92E-06	NA	2.21E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	0.00E+00	NA	0.00E+00	NA	0.00E+00	2.62E-04	0.00E+00	0.00E+00
Chrysene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.70E-05	NA	1.13E-05	NA	2.29E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate	1.10E-01	8.00E+00	1.38E-02	2.00E-01	1.62E-05	1.17E-03	1.16E-05	8.47E-04	2.18E-02	1.58E+00	1.59E+00	5.95E-05	4.33E-03	1.59E+00
2,4-DNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	5.57E-05	6.36E-04	4.70E-03	5.37E-02	6.52E-02	7.46E-01	8.00E-01	0.00E+00	0.00E+00	8.00E-01
2,6-DNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	4.21E-05	4.81E-04	2.38E-03	2.72E-02	4.99E-02	5.70E-01	5.98E-01	0.00E+00	0.00E+00	5.98E-01
Dinitrotoluene	7.00E-01	8.00E+00	8.75E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.97E-05	1.03E-03	1.03E-03
Fluoranthene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	3.38E-05	NA	5.86E-05	NA	4.44E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-04	1.35E-03	1.35E-03
3-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-05	1.90E-04	1.90E-04
4-Nitrotoluene	7.00E-01	8.00E+00	8.75E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.87E-05	5.57E-04	5.57E-04
Pyrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	2.53E-05	NA	4.35E-05	NA	3.32E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RDX	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.20E-04	NA	4.42E-02	NA	1.34E-01	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5-TNB	4.20E-01	8.00E+00	5.25E-02	2.00E-01	1.91E-04	3.65E-03	4.68E-02	8.91E-01	2.17E-01	4.14E+00	5.03E+00	0.00E+00	0.00E+00	5.03E+00
2,4,6-TNT	7.00E-01	8.00E+00	8.75E-02	2.00E-01	3.45E-01	3.94E+00	2.83E+01	3.23E+02	1.67E+02	1.91E+03	2.24E+03	3.90E-06	4.45E-05	2.24E+03
Inorganics														
Aluminum	1.10E+02	8.00E+00	1.38E+01	2.00E-01	2.53E+00	1.84E-01	1.76E-01	1.28E-02	6.44E-01	4.68E-02	2.44E-01	3.65E-02	2.65E-03	2.46E-01
Barium	2.08E+01	8.00E+00	2.60E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	9.37E-04	3.60E-04	3.60E-04
Cadmium	1.45E+00	1.00E+00	1.45E+00	2.00E-01	1.67E-04	1.15E-04	4.29E-03	2.96E-03	1.21E+00	8.36E-01	8.39E-01	5.88E-05	4.05E-05	8.39E-01
Calcium	2.83E+03	8.00E+00	3.54E+02	2.00E-01	2.44E+01	6.89E-02	1.40E+03	3.96E+00	5.85E+01	1.65E-01	4.20E+00	2.19E+00	6.17E-03	4.20E+00
Copper	4.70E+01	8.00E+00	5.88E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	4.17E-05	7.10E-06	7.10E-06
Iron	5.00E+01	8.00E+00	6.25E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	1.73E-01	2.77E-02	2.77E-02
Lead	3.85E+00	8.00E+00	4.81E-01	2.00E-01	1.12E-02	2.33E-02	3.74E-04	7.77E-04	2.04E-02	4.24E-02	6.65E-02	7.80E-05	1.62E-04	6.67E-02
Magnesium	1.50E+02	8.00E+00	1.88E+01	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	4.67E-01	2.49E-02	2.49E-02
Manganese	9.77E+02	8.00E+00	1.22E+02	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	3.41E-02	2.79E-04	2.79E-04
Potassium	1.00E+03	8.00E+00	1.25E+02	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	2.89E-02	2.31E-04	2.31E-04
Selenium	5.00E-01	1.00E+00	5.00E-01	2.00E-01	4.07E-04	8.15E-04	3.08E-04	6.17E-04	2.96E+00	5.92E+00	5.92E+00	3.52E-05	7.05E-05	5.92E+00
Sodium	1.00E+03	8.00E+00	1.25E+02	2.00E-01	5.13E-02	4.10E-04	1.01E-01	8.08E-04	2.87E+00	2.30E-02	2.42E-02	5.51E-02	4.40E-04	2.46E-02
TOTAL						**4.30E+00**		**3.33E+02**		**2.01E+03**	**2.35E+03**		**7.07E-02**	**2.35E+03**

Body Weight (kg)	1.13
Water intake (L/d)	0.064
Food intake (kg(dw)/d)	0.063
Sediment intake (kg/d)	0.0013
Plant intake (kg(dw)/d) -- 62.5% of diet	0.039375
Macroinvert intake (kg(dw)/d) -- 37.5% of diet	0.023625

Table G-3

Plum Brook Ordnance Works
TNT Area C

Omnivorous mammal: **Raccoon *(Procyon lotor)***

Chemical Name	NOAEL	Uncertainty Factor	Adjusted NOAEL	Foraging Factor (sed./sw.)	Sediment Intake (mg/kg-d)	Sediment Hazard Quotient	Aq. Invert. Intake (mg/kg-d)	Aq. Invert. Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics												
Aroclor 1260	1.56E-02	8.00E+00	1.95E-03	2.00E-01	3.62E-04	1.86E-01	1.30E-01	6.68E+01	6.70E+01	0.00E+00	0.00E+00	6.70E+01
2-Amino-4,6-DNT	7.13E+00	8.00E+00	8.92E-01	2.00E-01	6.02E-03	6.75E-03	1.77E+00	1.98E+00	1.99E+00	8.30E-06	9.30E-06	1.99E+00
4-Amino-2,6-DNT	4.91E+00	8.00E+00	6.14E-01	2.00E-01	5.27E-03	8.59E-03	1.55E+00	2.52E+00	2.53E+00	4.63E-06	7.54E-06	2.53E+00
Benzo(a)anthracene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	4.46E-05	1.29E-03	1.51E-02	4.35E-01	4.37E-01	0.00E+00	0.00E+00	4.37E-01
Benzo(a)pyrene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	3.29E-05	9.50E-04	1.13E-02	3.27E-01	3.28E-01	0.00E+00	0.00E+00	3.28E-01
Carbon disulfide	1.63E+01	8.00E+00	2.04E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.95E-04	9.55E-05	9.55E-05
Chrysene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	3.47E-05	1.00E-03	1.17E-02	3.39E-01	3.40E-01	0.00E+00	0.00E+00	3.40E-01
Di-n-butyl phthalate	1.52E+02	8.00E+00	1.90E+01	2.00E-01	3.30E-05	1.74E-06	1.11E-02	5.85E-04	5.87E-04	4.43E-05	2.32E-06	5.90E-04
2,4-DNT	2.42E-01	8.00E+00	3.03E-02	2.00E-01	1.14E-04	3.76E-03	3.34E-02	1.10E+00	1.11E+00	0.00E+00	0.00E+00	1.11E+00
2,6-DNT	2.42E-01	8.00E+00	3.03E-02	2.00E-01	8.61E-05	2.84E-03	2.56E-02	8.44E-01	8.46E-01	0.00E+00	0.00E+00	8.46E-01
Dinitrotoluene	2.42E-01	8.00E+00	3.03E-02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.68E-05	2.20E-03	2.20E-03
Fluoranthene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	6.92E-05	2.00E-03	2.27E-02	6.57E-01	6.59E-01	0.00E+00	0.00E+00	6.59E-01
2-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.77E-05	3.05E-05	3.05E-05
3-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-05	4.30E-06	4.30E-06
4-Nitrotoluene	2.30E+01	8.00E+00	2.88E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.63E-05	1.26E-05	1.26E-05
Pyrene	2.77E-01	8.00E+00	3.46E-02	2.00E-01	5.18E-05	1.50E-03	1.70E-02	4.92E-01	4.93E-01	0.00E+00	0.00E+00	4.93E-01
RDX	1.94E+00	8.00E+00	2.42E-01	2.00E-01	2.45E-04	1.01E-03	6.89E-02	2.84E-01	2.85E-01	0.00E+00	0.00E+00	2.85E-01
1,3,5-TNB	1.37E+00	8.00E+00	1.71E-01	2.00E-01	3.92E-04	2.28E-03	1.11E-01	6.49E-01	6.51E-01	0.00E+00	0.00E+00	6.51E-01
2,4,6-TNT	8.19E-01	8.00E+00	1.02E-01	2.00E-01	7.06E-01	6.90E+00	8.56E+01	8.37E+02	8.44E+02	2.90E-06	2.83E-05	8.44E+02
Inorganics												
Aluminum	5.34E-01	8.00E+00	6.68E-02	2.00E-01	5.18E+00	7.75E+01	3.30E-01	4.94E+00	8.24E+01	2.71E-02	4.06E-01	8.28E+01
Barium	2.76E+00	8.00E+00	3.45E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.97E-04	2.02E-03	2.02E-03
Cadmium	4.94E-01	8.00E+00	6.17E-02	2.00E-01	3.41E-04	5.53E-03	6.21E-01	1.01E+01	1.01E+01	4.38E-05	7.09E-04	1.01E+01
Calcium	9.78E+02	8.00E+00	1.22E+02	2.00E-01	4.99E+01	4.08E-01	3.00E+01	2.45E-01	6.53E-01	1.63E+00	1.33E-02	6.66E-01
Copper	7.79E+00	8.00E+00	9.73E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.10E-05	3.19E-05	3.19E-05
Iron	2.42E+01	8.00E+00	3.02E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-01	4.27E-02	4.27E-02
Lead	4.09E+00	8.00E+00	5.12E-01	2.00E-01	2.30E-02	4.49E-02	1.04E-02	2.04E-02	6.53E-02	5.81E-05	1.13E-04	6.54E-02
Magnesium	1.47E+02	8.00E+00	1.83E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.47E-01	1.89E-02	1.89E-02
Manganese	4.50E+01	8.00E+00	5.63E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-02	4.51E-03	4.51E-03
Potassium	1.48E+03	8.00E+00	1.85E+02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E-02	1.16E-04	1.16E-04
Selenium	1.02E-01	8.00E+00	1.28E-02	2.00E-01	8.33E-04	6.51E-02	1.52E+00	1.18E+02	1.19E+02	2.62E-05	2.05E-03	1.19E+02
Sodium	1.48E+03	8.00E+00	1.85E+02	2.00E-01	1.05E-01	5.66E-04	1.47E+00	7.93E-03	8.50E-03	4.10E-02	2.21E-04	8.72E-03
TOTAL						**8.51E+01**		**1.05E+03**	**1.13E+03**		**4.93E-01**	**1.13E+03**

Body Weight (kg)	5.1
Water intake (L/d)	0.215
Food intake (kg(dw)/d)	0.26
Sediment intake (kg/d)	0.012
Aquatic Invert. Intake (kg(dw)/d -- 21% of diet	0.0546

Table G-4

Plum Brook Ordnance Works
TNT Area C

Chemical Data

Chemical Name	Sediment Conc. (mg/kg)	Water Conc. (mg/L)	log Kow (organics)	Kow (organics)	log Koc (organics) (mL/g)	Koc (organics) (mL/g)	Kd (inorganics) (mL/g)	Foc	Water-to-Invert. BCF	Site-Specific Sediment-to-Invertebrate TF	Sediment-to-Plant TF	Plant Concentration (mg/kgdw)	Pore water Conc. (mg/L)	Solubility (mg/L)	< of the PoreH2O or Solubility	Invert. Conc. (mg/kgww)	Invert Conc. (mg/kgdw)	Food-to-Muscle TF
Organics																		
Aroclor 1260	7.69E-01		7.15E+00	1.40E+07	7.02E+00	1.06E+07	---	6.70E-02	1.40E+07	NA	2.87E-03	2.21E-03	1.08E-06		1.08E-06	1.52E+01	6.07E+01	4.44E-01
2-Amino-4,6-DNT	1.28E+01	9.84E-04	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	3.46E+01	2.06E+00		2.06E+00	2.06E+02	8.26E+02	2.14E-06
4-Amino-2,6-DNT	1.12E+01	5.49E-04	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	3.03E+01	1.81E+00		1.81E+00	1.81E+02	7.23E+02	2.14E-06
Benzo(a)anthracene	9.47E-02		5.61E+00	4.10E+05	5.52E+00	3.29E+05	---	6.70E-02	4.10E+05	NA	2.21E-02	2.09E-03	4.29E-06		4.29E-06	1.76E+00	7.04E+00	1.16E-02
Benzo(a)pyrene	6.99E-02		6.06E+00	1.15E+06	5.96E+00	9.08E+05	---	6.70E-02	1.15E+06	NA	1.22E-02	8.50E-04	1.15E-06		1.15E-06	1.32E+00	5.29E+00	3.36E-02
Carbon disulfide		2.31E-02	1.84E+00	6.92E+01	1.81E+00	6.44E+01	---	6.70E-02	6.92E+01	NA	3.35E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	1.46E-06
Chrysene	7.37E-02		5.61E+00	4.10E+05	5.52E+00	3.29E+05	---	6.70E-02	4.10E+05	NA	2.21E-02	1.63E-03	3.34E-06		3.34E-06	1.37E+00	5.48E+00	1.16E-02
Di-n-butyl phthalate	7.02E-02	5.25E-03	5.56E+00	3.60E+05	5.46E+00	2.90E+05	---	6.70E-02	3.60E+05	NA	2.38E-02	1.67E-03	3.62E-06		3.62E-06	1.30E+00	5.21E+00	1.01E-02
2,4-DNT	2.42E-01		1.98E+00	9.50E+01	1.94E+00	8.80E+01	---	6.70E-02	9.50E+01	NA	2.79E+00	6.74E-01	4.11E-02		4.11E-02	3.90E+00	1.56E+01	2.03E-06
2,6-DNT	1.83E-01		2.28E+00	1.90E+02	2.24E+00	1.74E+02	---	6.70E-02	1.90E+02	NA	1.87E+00	3.41E-01	1.57E-02		1.57E-02	2.98E+00	1.19E+01	4.16E-06
Dinitrotoluene		7.92E-03	2.28E+00	1.90E+02	2.24E+00	1.74E+02	---	6.70E-02	1.90E+02	NA	1.87E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	4.16E-06
Fluoranthene	1.47E-01		4.90E+00	7.90E+04	4.81E+00	6.53E+04	---	6.70E-02	7.90E+04	NA	5.72E-02	8.40E-03	3.36E-05		3.36E-05	2.66E+00	1.06E+01	2.11E-03
2-Nitrotoluene		1.04E-02	2.30E+00	2.00E+02	2.26E+00	1.83E+02	---	6.70E-02	2.00E+02	NA	1.81E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	4.38E-06
3-Nitrotoluene		1.47E-03	2.45E+00	2.82E+02	2.41E+00	2.56E+02	---	6.70E-02	2.82E+02	NA	1.49E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	6.25E-06
4-Nitrotoluene		4.30E-03	2.42E+00	2.63E+02	2.38E+00	2.39E+02	---	6.70E-02	2.63E+02	NA	1.55E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	5.82E-06
Pyrene	1.10E-01		4.90E+00	8.00E+04	4.82E+00	6.61E+04	---	6.70E-02	8.00E+04	NA	5.68E-02	6.24E-03	2.48E-05		2.48E-05	1.99E+00	7.95E+00	2.14E-03
RDX	5.21E-01		8.69E-01	7.40E+00	8.55E-01	7.16E+00	---	6.70E-02	7.40E+00	NA	1.22E+01	6.34E+00	1.09E+00		1.09E+00	8.04E+00	3.22E+01	1.46E-07
1,3,5-TNB	8.32E-01		1.18E+00	1.51E+01	1.16E+00	1.44E+01	---	6.70E-02	1.51E+01	NA	8.06E+00	6.71E+00	8.61E-01		8.61E-01	1.30E+01	5.20E+01	3.04E-07
2,4,6-TNT	1.50E+03	3.44E-04	2.00E+00	1.00E+02	1.97E+00	9.25E+01	---	6.70E-02	1.00E+02	NA	2.70E+00	4.06E+03	2.42E+02	1.00E+02	1.00E+02	1.00E+04	4.00E+04	2.14E-06
Inorganics																		
Aluminum	1.10E+04	3.22E+00	---	---	---	---	1.50E+03	6.70E-02	1.00E+02	3.50E-03	2.30E-03	2.53E+01	--		--	3.85E+01	1.54E+02	1.50E-03
Barium		8.27E-02	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-04
Cadmium	7.25E-01	5.19E-03	---	---	---	---	6.50E+00	6.70E-02	2.50E+02	1.00E+02	8.50E-01	6.16E-01	--		--	7.25E+01	2.90E+02	4.00E-04
Calcium	1.06E+05	1.93E+02	---	---	---	---	4.10E+00	6.70E-02	1.00E+02	3.30E-02	1.90E+00	2.01E+05	--		--	3.50E+03	1.40E+04	2.00E-03
Copper		3.68E-03	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	9.00E-03
Iron		1.53E+01	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-02
Lead	4.88E+01	6.89E-03	---	---	---	---	4.00E+02	6.70E-02	3.00E+02	2.50E-02	1.10E-03	5.37E-02	--		--	1.22E+00	4.88E+00	4.00E-04
Magnesium		4.12E+01	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	2.00E-02
Manganese		3.01E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	5.00E-04
Potassium		2.55E+00	---	---	---	---	NA	6.70E-02	NA	NA	NA	NA	NA		NA	NA	0.00E+00	1.00E-02
Selenium	1.77E+00	3.11E-03	---	---	---	---	3.00E+02	6.70E-02	1.00E+02	1.00E+02	2.50E-02	4.43E-02	--		--	1.77E+02	7.08E+02	1.50E-02
Sodium	2.23E+02	4.86E+00	---	---	---	---	1.00E+02	6.70E-02	2.00E+01	7.70E-01	6.50E-02	1.45E+01	--		--	1.72E+02	6.87E+02	8.00E-02

Table G-4

Toxicity Data

Plum Brook Ordnance Works
TNT Area C

Chemical Name	Mammals			Birds		
	LOAEL (mg/kg/d)	Test Species	Body Wt. (kg)	LOAEL (mg/kg/d)	Test Species	Body Wt. (kg)
Organics						
Aroclor 1260	6.80E-01	mouse	0.014	1.80E+00	ring neck pheasant	1
2-Amino-4,6-DNT	6.95E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
4-Amino-2,6-DNT	4.80E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
Benzo(a)anthracene	1.00E+01	mouse	0.03	--	--	--
Benzo(a)pyrene	1.00E+01	mouse	0.03	--	--	--
Carbon disulfide	1.59E+02	rat	0.35	--	--	--
Chrysene	1.00E+01	mouse	0.03	--	--	--
Di-n-butyl phthalate	1.83E+03	mouse	0.03	1.10E+00	ringed dove	0.155
2,4-DNT	1.50E+00	dog	11	1.78E+01	Bobwhite quail	0.19
2,6-DNT	1.50E+00	dog	11	1.78E+01	Bobwhite quail	0.19
Dinitrotoluene	1.50E+00	dog	11	1.78E+01	Bobwhite quail	0.19
Fluoranthene	1.00E+01	mouse	0.03	--	--	--
2-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
3-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
4-Nitrotoluene	8.70E+01	rat	0.35	1.78E+01	Bobwhite quail	0.19
Pyrene	1.00E+01	mouse	0.03	--	--	--
RDX	3.50E+01	mouse	0.03	--	--	--
1,3,5-TNB	1.33E+01	rat	0.35	2.10E+00	red-winged black bird	0.077
2,4,6-TNT	8.00E+00	rat	0.35	1.78E+01	Bobwhite quail	0.19
Inorganics						
Aluminum	1.93E+01	mouse	0.03	1.10E+03	ringed dove	0.155
Barium	1.98E+01	rat	0.35	4.17E+01	chicks	0.121
Cadmium	1.00E+01	rat	0.303	2.00E+01	Mallard duck	1.153
Calcium	5.27E+03	rabbit	3.8	1.42E+04	Jap. Quail	0.072
Copper	1.51E+01	mink	1	6.20E+01	chicks	0.534
Iron	1.30E+02	rabbit	3.8	2.50E+02	poultry	1.6
Lead	8.00E+01	rat	0.35	3.85E+01	Am. Kestrel	0.13
Magnesium	7.90E+02	rabbit	3.8	7.50E+02	poultry	1.6
Manganese	2.84E+02	rat	0.35	9.77E+03	Jap. Quail	0.072
Potassium	7.90E+03	rabbit	3.8	5.00E+03	poultry	1.6
Selenium	3.00E-01	rat	0.35	1.00E+00	Mallard duck	1
Sodium	7.90E+03	rabbit	3.8	5.00E+03	poultry	1.6

Table G-4

Plum Brook Ordnance Works
TNT Area C

Omnivorous Bird: **Mallard duck *(Anas platyrhynchos)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (sed./sw.)	Sediment Intake (mg/kg-d)	Sediment Hazard Quotient	Plant Intake (mg/kg-d)	Plant Hazard Quotient	Macroinvert Intake (mg/kg-d)	Macroinvert Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics														
Aroclor 1260	1.80E+00	8.00E+00	2.25E-01	2.00E-01	1.77E-04	7.86E-04	1.54E-05	6.83E-05	2.54E-01	1.13E+00	1.13E+00	0.00E+00	0.00E+00	1.13E+00
2-Amino-4,6-DNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	2.95E-03	1.32E-03	2.41E-01	1.08E-01	3.45E+00	1.55E+00	1.66E+00	1.11E-05	5.01E-06	1.66E+00
4-Amino-2,6-DNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	2.58E-03	1.16E-03	2.11E-01	9.49E-02	3.02E+00	1.36E+00	1.45E+00	6.22E-06	2.79E-06	1.45E+00
Benzo(a)anthracene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	2.18E-05	NA	1.46E-05	NA	2.94E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.61E-05	NA	5.92E-06	NA	2.21E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon disulfide	0.00E+00	8.00E+00	0.00E+00	2.00E-01	0.00E+00	NA	0.00E+00	NA	0.00E+00	NA	0.00E+00	2.62E-04	0.00E+00	0.00E+00
Chrysene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.70E-05	NA	1.13E-05	NA	2.29E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Di-n-butyl phthalate	1.10E+00	8.00E+00	1.38E-01	2.00E-01	1.62E-05	1.17E-04	1.16E-05	8.47E-05	2.18E-02	1.58E-01	1.59E-01	5.95E-05	4.33E-04	1.59E-01
2,4-DNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	5.57E-05	2.50E-05	4.70E-03	2.11E-03	6.52E-02	2.93E-02	3.15E-02	0.00E+00	0.00E+00	3.15E-02
2,6-DNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	4.21E-05	1.89E-05	2.38E-03	1.07E-03	4.99E-02	2.24E-02	2.35E-02	0.00E+00	0.00E+00	2.35E-02
Dinitrotoluene	1.78E+01	8.00E+00	2.23E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.97E-05	4.03E-05	4.03E-05
Fluoranthene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	3.38E-05	NA	5.86E-05	NA	4.44E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.18E-04	5.29E-05	5.29E-05
3-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.67E-05	7.48E-06	7.48E-06
4-Nitrotoluene	1.78E+01	8.00E+00	2.23E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.87E-05	2.19E-05	2.19E-05
Pyrene	0.00E+00	8.00E+00	0.00E+00	2.00E-01	2.53E-05	NA	4.35E-05	NA	3.32E-02	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RDX	0.00E+00	8.00E+00	0.00E+00	2.00E-01	1.20E-04	NA	4.42E-02	NA	1.34E-01	NA	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,3,5-TNB	2.10E+00	8.00E+00	2.63E-01	2.00E-01	1.91E-04	7.29E-04	4.68E-02	1.78E-01	2.17E-01	8.28E-01	1.01E+00	0.00E+00	0.00E+00	1.01E+00
2,4,6-TNT	1.78E+01	8.00E+00	2.23E+00	2.00E-01	3.45E-01	1.55E-01	2.83E+01	1.27E+01	1.67E+02	7.52E+01	8.80E+01	3.90E-06	1.75E-06	8.80E+01
Inorganics														
Aluminum	1.10E+03	8.00E+00	1.38E+02	2.00E-01	2.53E+00	1.84E-02	1.76E-01	1.28E-03	6.44E-01	4.68E-03	2.44E-02	3.65E-02	2.65E-04	2.46E-02
Barium	4.17E+01	8.00E+00	5.21E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	9.37E-04	1.80E-04	1.80E-04
Cadmium	2.00E+01	1.00E+00	2.00E+01	2.00E-01	1.67E-04	8.34E-06	4.29E-03	2.15E-04	1.21E+00	6.06E-02	6.09E-02	5.88E-05	2.94E-06	6.09E-02
Calcium	1.42E+04	8.00E+00	1.77E+03	2.00E-01	2.44E+01	1.38E-02	1.40E+03	7.93E-01	5.85E+01	3.30E-02	8.40E-01	2.19E+00	1.23E-03	8.41E-01
Copper	6.20E+01	8.00E+00	7.75E+00	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	4.17E-05	5.38E-06	5.38E-06
Iron	2.50E+02	8.00E+00	3.13E+01	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	1.73E-01	5.55E-03	5.55E-03
Lead	3.85E+01	8.00E+00	4.81E+00	2.00E-01	1.12E-02	2.33E-03	3.74E-04	7.77E-05	2.04E-02	4.24E-03	6.65E-03	7.80E-05	1.62E-05	6.67E-03
Magnesium	7.50E+02	8.00E+00	9.38E+01	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	4.67E-01	4.98E-03	4.98E-03
Manganese	9.77E+03	8.00E+00	1.22E+03	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	3.41E-02	2.79E-05	2.79E-05
Potassium	5.00E+03	8.00E+00	6.25E+02	2.00E-01	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00E+00	2.89E-02	4.62E-05	4.62E-05
Selenium	1.00E+00	1.00E+00	1.00E+00	2.00E-01	4.07E-04	4.07E-04	3.08E-04	3.08E-04	2.96E+00	2.96E+00	2.96E+00	3.52E-05	3.52E-05	2.96E+00
Sodium	5.00E+03	8.00E+00	6.25E+02	2.00E-01	5.13E-02	8.21E-05	1.01E-01	1.62E-04	2.87E+00	4.60E-03	4.84E-03	5.51E-02	8.81E-05	4.93E-03
TOTAL						**1.94E-01**		**1.39E+01**		**8.33E+01**	**9.74E+01**		**1.30E-02**	**9.74E+01**

Body Weight (kg)	1.13
Water intake (L/d)	0.064
Food intake (kg(dw)/d)	0.063
Sediment intake (kg/d)	0.0013
Plant intake (kg(dw)/d) -- 62.5% of diet	0.039375
Macroinvert intake (kg(dw)/d) -- 37.5% of diet	0.023625

Table G-4

Plum Brook Ordnance Works
TNT Area C

Omnivorous mammal: **Raccoon *(Procyon lotor)***

Chemical Name	LOAEL	Uncertainty Factor	Adjusted LOAEL	Foraging Factor (sed./sw.)	Sediment Intake (mg/kg-d)	Sediment Hazard Quotient	Aq. Invert. Intake (mg/kg-d)	Aq. Invert. Hazard Quotient	Total Intake Hazard Quotient	Water Intake (mg/kg-d)	Water Hazard Quotient	Overall Hazard Index
Organics												
Aroclor 1260	1.56E-01	8.00E+00	1.95E-02	2.00E-01	3.62E-04	1.86E-02	1.30E-01	6.68E+00	6.70E+00	0.00E+00	0.00E+00	6.70E+00
2-Amino-4,6-DNT	3.56E+01	8.00E+00	4.45E+00	2.00E-01	6.02E-03	1.35E-03	1.77E+00	3.98E-01	3.99E-01	8.30E-06	1.87E-06	3.99E-01
4-Amino-2,6-DNT	2.46E+01	8.00E+00	3.07E+00	2.00E-01	5.27E-03	1.72E-03	1.55E+00	5.04E-01	5.06E-01	4.63E-06	1.51E-06	5.06E-01
Benzo(a)anthracene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	4.46E-05	1.29E-04	1.51E-02	4.35E-02	4.37E-02	0.00E+00	0.00E+00	4.37E-02
Benzo(a)pyrene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	3.29E-05	9.50E-05	1.13E-02	3.27E-02	3.28E-02	0.00E+00	0.00E+00	3.28E-02
Carbon disulfide	8.16E+01	8.00E+00	1.02E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.95E-04	1.91E-05	1.91E-05
Chrysene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	3.47E-05	1.00E-04	1.17E-02	3.39E-02	3.40E-02	0.00E+00	0.00E+00	3.40E-02
Di-n-butyl phthalate	5.08E+02	8.00E+00	6.35E+01	2.00E-01	3.30E-05	5.21E-07	1.11E-02	1.76E-04	1.76E-04	4.43E-05	6.98E-07	1.77E-04
2,4-DNT	1.82E+00	8.00E+00	2.27E-01	2.00E-01	1.14E-04	5.01E-04	3.34E-02	1.47E-01	1.48E-01	0.00E+00	0.00E+00	1.48E-01
2,6-DNT	1.82E+00	8.00E+00	2.27E-01	2.00E-01	8.61E-05	3.79E-04	2.56E-02	1.12E-01	1.13E-01	0.00E+00	0.00E+00	1.13E-01
Dinitrotoluene	1.82E+00	8.00E+00	2.27E-01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.68E-05	2.94E-04	2.94E-04
Fluoranthene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	6.92E-05	2.00E-04	2.27E-02	6.57E-02	6.59E-02	0.00E+00	0.00E+00	6.59E-02
2-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.77E-05	1.58E-05	1.58E-05
3-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.24E-05	2.23E-06	2.23E-06
4-Nitrotoluene	4.45E+01	8.00E+00	5.57E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.63E-05	6.51E-06	6.51E-06
Pyrene	2.77E+00	8.00E+00	3.46E-01	2.00E-01	5.18E-05	1.50E-04	1.70E-02	4.92E-02	4.93E-02	0.00E+00	0.00E+00	4.93E-02
RDX	9.69E+00	8.00E+00	1.21E+00	2.00E-01	2.45E-04	2.02E-04	6.89E-02	5.68E-02	5.70E-02	0.00E+00	0.00E+00	5.70E-02
1,3,5-TNB	6.81E+00	8.00E+00	8.52E-01	2.00E-01	3.92E-04	4.60E-04	1.11E-01	1.31E-01	1.31E-01	0.00E+00	0.00E+00	1.31E-01
2,4,6-TNT	4.09E+00	8.00E+00	5.12E-01	2.00E-01	7.06E-01	1.38E+00	8.56E+01	1.67E+02	1.69E+02	2.90E-06	5.67E-06	1.69E+02
Inorganics												
Aluminum	5.34E+00	8.00E+00	6.68E-01	2.00E-01	5.18E+00	7.75E+00	3.30E-01	4.94E-01	8.24E+00	2.71E-02	4.06E-02	8.28E+00
Barium	1.01E+01	8.00E+00	1.27E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.97E-04	5.50E-04	5.50E-04
Cadmium	4.94E+00	8.00E+00	6.17E-01	2.00E-01	3.41E-04	5.53E-04	6.21E-01	1.01E+00	1.01E+00	4.38E-05	7.09E-05	1.01E+00
Calcium	4.89E+03	8.00E+00	6.11E+02	2.00E-01	4.99E+01	8.16E-02	3.00E+01	4.90E-02	1.31E-01	1.63E+00	2.66E-03	1.33E-01
Copper	1.00E+01	8.00E+00	1.26E+00	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.10E-05	2.47E-05	2.47E-05
Iron	1.21E+02	8.00E+00	1.51E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.29E-01	8.54E-03	8.54E-03
Lead	4.09E+01	8.00E+00	5.12E+00	2.00E-01	2.30E-02	4.49E-03	1.04E-02	2.04E-03	6.53E-03	5.81E-05	1.13E-05	6.54E-03
Magnesium	7.34E+02	8.00E+00	9.17E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.47E-01	3.79E-03	3.79E-03
Manganese	1.45E+02	8.00E+00	1.82E+01	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.54E-02	1.40E-03	1.40E-03
Potassium	7.34E+03	8.00E+00	9.17E+02	2.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.15E-02	2.34E-05	2.34E-05
Selenium	1.54E-01	8.00E+00	1.92E-02	2.00E-01	8.33E-04	4.34E-02	1.52E+00	7.90E+01	7.90E+01	2.62E-05	1.37E-03	7.90E+01
Sodium	7.34E+03	8.00E+00	9.17E+02	2.00E-01	1.05E-01	1.14E-04	1.47E+00	1.60E-03	1.72E-03	4.10E-02	4.47E-05	1.76E-03
TOTAL						**9.28E+00**		**2.56E+02**	**2.65E+02**		**5.95E-02**	**2.65E+02**

Body Weight (kg)	5.1
Water intake (L/d)	0.215
Food intake (kg(dw)/d)	0.26
Sediment intake (kg/d)	0.012
Aquatic Invert. Intake (kg(dw)/d -- 21% of diet	0.0546

APPENDIX H

APPLICATION OF ESSENTIAL NUTRIENTS IN ECOLOGICAL RISK ASSESSMENT

Table of Contents

Page

H.1.0 Introduction H-1
H.2.0 Mineral Requirements H-2
H.3.0 Maximum Tolerance Levels H-4
H.4.0 Data Use H-6
H.5.0 References H-6

H.1.0 Introduction

All forms of living matter require inorganic elements, or minerals, for their normal life processes. All animal tissues and feeds contain inorganic or mineral elements in widely varying amounts and proportions. Minerals that are needed in relatively large amounts are referred to as major or macrominerals; those that are needed in very small amounts are referred to as trace minerals or microminerals. These terms represent quantity designations of the amounts required in an animal's diet and their generally low or trace concentrations in tissues. The major minerals are required in concentrations of greater than 100 parts per million (ppm) and are often reported as a percentage of diet, while trace elements are required at less than 100 ppm and are sometimes reported at the parts per billion level. Table H-1 presents 24 elements known to be required by at least some animal species (McDowell, 1992).

Table H-1
General Macro and Microminerals

Major or Macrominerals	Trace or Microminerals		
Calcium (Ca)	Arsenic (As)*	Iodine (I)	Nickel (Ni)*
Chlorine (Cl)	Boron (B)*	Iron (Fe)	Selenium (Se)
Magnesium (Mg)	Chromium (Cr)	Lead (Pb)*	Silicon (Si)*
Phosphorus (P)	Cobalt (Co)	Lithium (Li)*	Tin (Sn)*
Potassium (K)	Copper (Cu)	Manganese (Mn)	Vanadium (V)*
Sodium (Na)	Fluorine (F)	Molybdenum (Mo)	Zinc (Zn)
Sulfur (S)			

* These elements have not been shown to be essential for livestock or humans consuming typical diets.

The listing of some of the trace elements as essential is difficult and sometimes tentative, and rests on experiments with one or more species. In these experiments, diets adequate in all nutrients except the mineral in question produced clinical signs that were prevented or overcome by adding that mineral to the diets (McDowell, 1992).

Unlike other nutrients, mineral elements cannot be synthesized by living organisms. Minerals act as: (1) structural components of body organs and tissues, (2) constituents of body fluids and tissues as electrolytes, and (3) catalysts in enzyme and hormone systems. The most obvious function of mineral elements in the body is to provide structural support (skeleton) for the body. Calcium, phosphorus, magnesium, fluoride, and silicon in bones and teeth all contribute to

mechanical stability. Birds use calcium to produce egg shells, phosphorus, sulfur, and silicon are found in muscle proteins. Minerals are interrelated and balanced against each other, and most often cannot be considered as single elements with independent and self-sufficient roles in the organized bodily processes. The definite relationship of cadmium and phosphorus in the formation of bones and teeth and the interrelationships of iron, copper, and cobalt (in vitamin B_{12}) in hemoglobin synthesis and red blood cell formation are examples. Sodium, potassium, calcium, phosphorus, and chlorine serve individually and collectively in the body fluids. A number of trace elements (i.e., copper, zinc, and selenium) in addition to certain vitamins (i.e., A, D, E, B_6, and folacin) and other nutrients, are strongly related to adequate immune response (McDowell, 1992).

H.2.0 Mineral Requirements

A series of "safe" dietary levels of potentially toxic elements has been established on the extent to which other elements that affect their absorption and retention are present (McDowell, 1992). Table H-2 presents some of these "safe" dietary levels or mineral requirements for selected species.

Table H-2
Mineral Requirements for Selected Species

Species	Mineral (mg/kg of feed)									
	Ca	Mg	K	Na	Cu	Fe	Mn	P	Se	Zn
Japanese Quail	25,000	500	4,000	1,500	6	100	70	5,000	0.2	50
Rat	5,000	400	3,600	500	5	35	50	4,000	0.10	0.25
Mouse	4,000	500	2000	---	4.5	25	44	4,000	---	30
Cat	8,000	400	4,000	500	5	80	5	6,000	0.1	50
Mink	6,000	440	3,000	---	6	80	44	5,500	0.1	66

To determine whether concentrations of these minerals in the environment exceed safe dietary levels, the mineral requirements were converted to dietary doses using the following equation:

$$\text{Dose (mg/kg-day)} = \text{Diet (mg/kg)} \times \text{FI (kg/day)} \times 1/\text{BW (kg)}$$

where:

Diet (mg/kg) = mineral requirement for each nutrient
FI (kg/day) = food ingestion rate
BW (kg/day) = body weight.

Variables for the species are shown in Table H-3.

Table H-3
Food Ingestion and Body Weights

Species	Food Ingestion (FI) (kg/day)	Body Weight (Kg)
Japanese Quail	0.017 derived from $FI(kg/day) = 0.0582*BW(kg)^{0.651}$ [b]	0.15[a]
Rat	0.08[a]	0.35[a]
Mouse	0.0055[a]	0.03[a]
Cat	0.24 derived from $FI(kg/day)=0.0687*BW(kg)^{0.822}$ [b]	4.5 derived from 10lbs*0.4535923 conversion factor.[c]
Mink	0.137[a]	1.0[a]

[a]Oak Ridge National Laboratory (ORNL), 1996.
[b]U.S. Environmental Protection Agency (EPA), 1993.
[c]IT Corporation, 1999.

Table H-4 presents the mineral requirements calculated as dietary doses for selected species presented in Table H-3.

Table H-4
Mineral Requirements as a Dietary Dose for Selected Species

Species	Mineral Dose (mg/kg-day)									
	Ca	Mg	K	Na	Cu	Fe	Mn	P	Se	Zn
Japanese Quail	2,833	56.7	453	170	0.7	11.3	7.9	567	0.02	5.7
Rat	1,143	91.4	823	114	1.1	8	11.4	914	0.02	0.06
Mouse	733	92	367	---	0.8	4.6	8.1	733	---	5.5
Cat	427	21	213	26.7	0.3	4.3	0.3	320	0.01	2.7
Mink	822	60	411	---	0.8	11	6	753	0.01	9

H.3.0 Maximum Tolerance Levels

Information concerning the toxicity or tolerance of minerals is incomplete. According to available information, the toxic level of most major minerals is about 10 times the recommended level for young, growing livestock. The toxic levels of trace minerals appear to be highly variable, ranging between 10 and 1,500 times the recommended level. The National Research Council publishes maximum tolerance levels for domestic animals. The maximum tolerance level is defined as that dietary level that, when fed for a limited period, will not impair animal performance and should not produce unsafe residues in human food derived from animals. The levels listed in Table H-5 were derived from toxicity data on the designated species. Tolerance levels vary with the species, adaptation, duration of receiving the toxicants, age, physical condition of the animal, and many other factors (McDowell, 1992).

Table H-5
Maximum Tolerance Levels for Domestic Animals

Species	Maximum Tolerance Levels of Dietary Minerals (ppm)									
	Ca[a]	Mg	K	Na (as NaCl)	Cu	Fe	Mn	P	Se	Zn
Poultry	40,000[b] 12,000[c]	(3,000)	(20,000)	20,000	300	1,000	2,000	8,000	20,000	1,000
Rabbits	20,000	(3,000)	(30,000)	(30,000)	200	(500)	(400)	10,000	(20,000)	(500)

Source: McDowell, 1992.
The levels in parentheses were derived by interspecific species extrapolation.

[a] Ratio of calcium to phosphorus is important.
[b] Laying hen.
[c] Other poultry.

Using the same procedure described in Section H.2.0, the maximum tolerance levels are converted into dietary doses to determine whether concentrations of these minerals in the environment exceed safe dietary levels. Variables for the domestic animals are shown in Table H-6.

Table H-6
Food Ingestion and Body Weights for Domestic Animals

Species	Food Ingestion (FI) (kg/day)	Body Weight (kg)
Poultry	0.08 derived from $FI(kg/day) = 0.0582*BW(kg)^{0.651}$ [a]	1.6 (mean weight of male and female chicken) [b]
Rabbits	0.2 derived from $FI(kg/day)=0.0687*BW(kg)^{0.822}$ [a]	3.8 [b]

[a] EPA, 1993.
[b] ORNL, 1996.

Table H-7 presents the calculated dietary doses for selected species presented in Table H-6.

Table H-7
Maximum Tolerance Level as a Dietary Dose for Domestic Animals

Species	Dietary Doses (mg/kg-day)									
	Ca	Mg	K	Na (as NaCl)	Cu	Fe	Mn	P	Se	Zn
Poultry	600	150	1,000	1,000	15	50	100	400	1,000	50
Rabbits	1,053	158	1,579	1,579	11	26	21	526	1,053	26

H.4.0 Data Use

Mineral requirements or maximum tolerance levels will be used in ecological risk assessments, as appropriate.

H.5.0 References

IT, 1999. Best professional judgment for cat's (***Felis domesticus***) body weight being 10 lbs.

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